N O T E

Incidence of *Craesus castaneae* (Hymenoptera: Tenthredinidae) on Chestnut Seedlings Planted in the Daniel Boone National Forest, Kentucky[1]

Cornelia C. Pinchot[2], Scott E. Schlarbaum, Arnold M. Saxton[3], Stacy L. Clark[4], Callie J. Schweitzer[5], David R. Smith[6], Alex Mangini[7], and Frederick V. Hebard[8]

Tennessee Tree Improvement Program, The University of Tennessee; Knoxville, Tennessee 37996 USA

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American chestnut [*Castanea dentata* (Marshall) Borkhausen, Fagales: Fagaceae] was a dominant forest tree in the eastern forests of the U.S. until it was eliminated as a canopy tree species by 2 exotic pathogens. Ink disease, a root rot caused by *Phytophthora cinnamomi* Rands (Pythiales: Pythiaceae), began to destroy chestnut populations on bottomland and poorly-drained sites in the mid-1800s, and the chestnut blight fungus [*Cryphonectria parasitica* (Murrill) Barr, Diaporthales: Cryphonectriaceae] reduced the species to short-lived sprouts on upland sites in the first half of the 20th Century (*cf.* Campbell and Schlarbaum 2002, Fading Forests II: Trading Away North America's Heritage, Healing Stones Found., Knoxville, TN). Various organizations have used a backcross breeding approach to integrate blight resistance from Asiatic chestnut species into American chestnut in an effort to restore the species to eastern forests (Anagnostakis 1999, *In* Proc. 2nd Intern. Symp. Chestnut; Hebard 2001, Ecol. Restor. 19: 252 - 254). Putatively blight-resistant hybrid chestnuts became available for planting in 2008 (Clark et al. 2010, *In* Proc. 17th Central Hardwoods Forest Conf.).

American chestnut was eliminated from eastern forests before the species' silvics were clearly defined, leaving the silvicultural parameters important to the initial stages of restoration largely unknown. Consequently, an increasing number of studies have examined the silvicultural requirements for chestnut restoration (Anagnostakis 2007, N. J. Appl. For. 24: 317 - 318; Clark et al. 2009, Tree Planters' Notes 53: 13 - 21; Jacobs and Severeid 2004, Forest Ecol. and Manag. 191: 111 - 120; McCament and McCarthy 2005,

[1]Received 29 October 2010; accepted for publication 31 January 2011.
[2]Corresponding author (email address: cpinchot@utk.edu), TN Tree Improvement Program, The University of Tennessee, Knoxville, Tennessee.
[3]Department of Animal Science, The University of Tennessee, Knoxville, Tennessee.
[4]USDA Forest Service, Southern Research Station, Knoxville, Tennessee.
[5]USDA Forest Service, Southern Research Station, Normal, Alabama.
[6]Systematic Entomology Laboratory, ARS, USDA, Washington, D.C.
[7]USDA Forest Service, Forest Health Protection, Pineville, Louisiana.
[8]The American Chestnut Foundation, Meadowview, Virginia.

2 J. Entomol. Sci. Vol. 46, No. 3 (2011) Canad. J. Forest Res. 35: 740 - 749; McNab 2003, J. Am. Chestnut Found., 6: 32 - 41; Rhoades et al. 2009, Forest Ecol. and Manag. 258: 1211 - 1218; Schlarbaum et al. 2006, *In* Proc. Restoration of American Chestnut Forest Lands Conf.). These experiments will further our understanding of the silvicultural requirements of chestnut, but may also yield information on other factors critical to its successful establishment. Aside from ink and chestnut blight diseases, other exotic organisms such as the chestnut gall wasp (*Dryocosmus kuriphilus* Yasumatsu, Hymenoptera: Cynipidae) and the Asian ambrosia beetle (*Xylosandrus crassiusculus* Motschulsky, Coleoptera: Curculionidae) have become resident pests in eastern forests and may affect restoration (Anagnostakis 2006, Aust. Nutgrower 20: 36 - 38; Oliver and Mannion 2001, Environ. Entomol. 30: 909 - 918). Little is known, however, about native pests affecting American chestnut, particularly in the seedling phase. Native pests, such as the twolined chestnut borer (*Agrilus bilineatus* Weber, Coleoptera: Buprestidae) may pose significant challenges to species restoration. Here we report the significant impact of a rarely observed native defoliating insect, *Craesus castaneae* Rohwer, in a silvicultural study of chestnut species and hybrids.

Three hundred American chestnut, 300 hybrid chestnut (BC_2F_3 generation) (Burnham and Rutter 1986, Pl. Breeding Rev. 4: 347 - 397; Hebard 2001), and 150 Chinese chestnut (*Castanea mollisima* Blume) 1 - 0 bare-root seedlings were planted in the Daniel Boone National Forest in southeastern Kentucky in March 2009. Seedlings were planted in a completely randomized design with a split-plot treatment arrangement. Silvicultural treatments were whole plots, and species and family were planted in a randomized block design in the subplots. Seedlings were planted under 3 silvicultural treatments: (1) oak shelterwood (Loftis 1990, For. Sci. 36: 917 - 929) that left an average residual basal area of 22 m^2/ha and average 96% canopy cover; (2) thinning to the B-level of Gingrich stocking with an average residual basal area of 18 m^2/ha and an average 89% canopy cover (Gingrich 1967, For. Sci. 13: 38 - 53), and; (3) shelterwood with reserves, with an average residual basal area of 5 m^2/ha. and an average 39% canopy cover. The silvicultural treatments were a mixture of regeneration treatments and intermediate stand treatments and created a gradient of light conditions on the forest floor, from high light (shelterwood with reserves) to low light (oak shelterwood) (Schweitzer et al. 2010, *In* Proc. 17th Central Hardwoods Forest Conf.). The oak shelterwood treatment was replicated 6 times, the shelterwood with reserves 5 times, and the thinning replicated 4 times. Seedlings were planted in single line transects in 50 blocks per silvicultural treatment, with 2 American, 2 hybrid and 1 Chinese chestnut seedling per block at a spacing of 2.43 m.

Severe predation by *C. castaneae* larvae was noticed on both planted chestnut seedlings and naturally-occurring sprouts during the 2009 growing season, specifically June through August. Predation ranged from minimal, evident only on the leaf edges, to complete, with only leaf midribs and petioles remaining. The presence/absence of leaf predation was recorded toward the end of the growing season (12 - 15 August 2009). Predation presence was recorded for seedlings having at least one leaf with evidence of insect predation. Few instances of leaf predation and no *C. castaneae* larvae were observed during the 2010 field season (April-September), therefore no 2010 defoliation data were recorded. Proc Glimmix in SAS® 9.2 (SAS Institute, Cary, NC) was used to conduct an analysis of variance on the 2009 presence/absence data using a binomial distribution. Fisher's least significant difference was used to separate treatment means.

Craesus castaneae larvae were confirmed to be consuming the leaves of seedlings at the time that defoliation presence/absence data were collected. No other insect

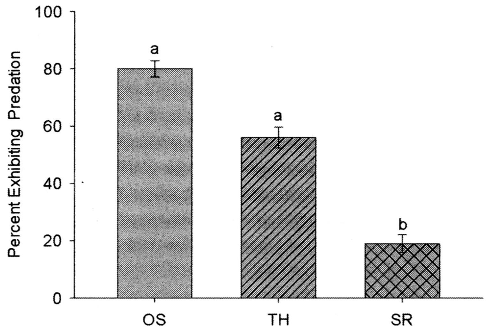

Fig. 1. Percent of seedlings with evidence of leaf predation for each silvicultural treatment August 2009. OS = oak shelterwood; TH = thinning; SR = shelterwood with reserves. Letters on bars indicate means separation.

species were observed consuming the leaves at this time or during other site visits. Seedlings in the oak shelterwood and thinning treatments experienced greater predation incidence ($F = 9.27$; df = 2; $P = 0.003$) than seedlings growing in the shelterwood with reserves treatment (Fig. 1). Additionally, American and hybrid seedlings exhibited greater predation frequency ($F = 6.05$; df = 2; $P = 0.007$) than did Chinese chestnut seedlings (Fig. 2). No significant interaction between species and silvicultural treatments was found ($F = 0.38$; df = 4; $P = 0.822$).

Little information about *C. castaneae* biology and predation habits has been published probably because the pest became rare with the decimation of American chestnut. *Craesus castaneae* has been previously recorded in Virginia, MD, NY, KY, and Pennsylvania (Middleton 1922, Proc. U.S. National Mus. 61: 1 - 31; Rohwer 1915, Proc. U.S. National Mus. 49: 205 - 249; Smith 1972, Proc. Entomol. Soc. Wash. 74: 169 - 180). It is described as feeding gregariously on the edges of chestnut leaves during the summer and entering the ground for pupation in early fall. Defoliation from *C. castaneae* may present a challenge to the restoration of American chestnut as seedlings could be weakened or killed due to leaf loss.

Our results show that chestnuts planted in areas with more available light experienced significantly fewer incidences of predation from *C. castaneae* than in areas with

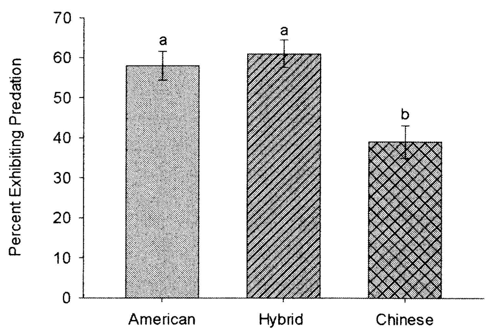

Fig. 2. Percent of seedlings with evidence of leaf predation for each chestnut species August 2009. Letters on bars indicate means separation.

less light. Several studies have found that hardwood species, including tulip polar (*Liriodendron tulipifera* L., Magnoliidae: Magnoliaceae), flowering dogwood (*Cornus florida* L., Cornales: Cornaeae), and sessil oak [*Quercus petraea* (Mattuschka) Lieblein, Fagales: Fagaceae], increase production of defense compounds with increased light availability, presumably due to greater carbohydrate production (Dudt and Shure 1994, Eco. 75: 86 - 98; Kelly 2001, Forest Ecol. and Manag. 166: 207 - 226; Roberts and Paul 2006, New Phytologist 170: 677 - 699). These studies suggest that the lower predation rates found in chestnut seedlings with increased light availability in the present study may result from an increase in defense compound production. Further testing is necessary to assess this theory.

Our results indicate that site selection for restoration plantings should consider the potential impact of *C. castaneae* and that a pest management strategy may be beneficial to ensure seedling establishment. Further research is needed to gain a better understanding of *C. castaneae* biology and how predation on chestnut seedlings affects establishment, growth and survival.

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