



## Morphological and molecular delineation of a new species in the *Ceratina dupla* species-group (Hymenoptera: Apidae: Xylocopinae) of eastern North America<sup>1</sup>

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### Abstract

DNA barcoding is used to verify characters to morphologically differentiate genetically distinct species of eastern North American small carpenter bees, *Ceratina*. Here we reveal that the common eastern North American species, *Ceratina dupla* s. l., is actually three separate species based on fixed differences in DNA barcode sequences and morphological characters. This study adds a new species, *C. mikmaqi* Rehan & Sheffield, to the *Ceratina dupla* species-group of eastern North America, and raises another form, *C. floridana* formerly *C. dupla floridana*, to full species. Temporal niche partitioning between *C. dupla* and *C. mikmaqi* and geographic isolation of *C. floridana* further support the division of the *C. dupla* s. l. group into three species. A diagnosis and description of the new species are provided, as is a key for eastern North American species of *Ceratina*.

**Key words:** small carpenter bee, DNA barcodes, cryptic species, *Ceratina (Zadontomerus)*, *Ceratina floridana*, *Ceratina mikmaqi*

### Introduction

The small carpenter bees, *Ceratina* Latreille (Apidae: Xylocopinae), are a common and diverse group (Michener 2007). There are 21 described subgenera in this cosmopolitan genus, 16 of which are endemic to the Old World and five to the New World (Terzo 2000; Michener 2007). In America north of Mexico there are three subgenera containing 22 described species (Daly 1973). The subgenera *Ceratinula* Moure and *Zadontomerus* Ashmead are indigenous to North America, whereas *C. (Euceratina) dallatorreana* Friese was introduced to California from the Mediterranean region (Daly 1966). The subgenus *Ceratinula* is most diverse in Central and South America (Michener 1954; Moure 2007) but two species, *C. arizonensis* Cockerell and *C. cockerelli* H.S. Smith are found in the southern United States (Daly 1973). In contrast, the subgenus *Zadontomerus* is most diverse and widespread in North America, with 18 of the 25 described species occurring north of Mexico (Daly 1973; Michener 2007). Among the North American *Zadontomerus* species, there is a clear geographic division between morphological species groups, with 14 species found west and three species found east of the 104<sup>th</sup> meridian (Daly 1973).

In eastern North America the four recognized species are *Ceratina (Ceratinula) cockerelli* H. S. Smith, *C. (Zadontomerus) calcarata* Robertson, *C. (Z.) dupla* Say, and *C. (Z.) strenua* F. Smith (Daly 1973). *Ceratina cockerelli* is a small, black, mostly impunctate bee easily distinguished from the larger, metallic blue-green *Zadontomerus* species found in the east, and has a restricted distribution; found in Texas, Louisiana, Georgia and Florida. The three recognized eastern *Zadontomerus* species often occur in sympatry in more southern parts of their range, but *C. strenua* is rarely found in Canada, with southern Ontario likely the northern edge of its range. In contrast, both *C. calcarata* and *C. dupla* are largely sympatric and occur from Florida, north to Ontario and east to Nova Scotia (Sheffield *et al.* 2003). Of the three *Zadontomerus* species in the east, *C. strenua* is easiest to distinguish due to its tergal sculpturing and distinct maculations, and it is generally smaller than the other *Zadontomerus* species in