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Discrimination of the bumble bee species *Bombus occidentalis* Greene and *B. terricola* Kirby by morphometric, colour and RAPD variation

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Abstract

The taxonomic status of *B. terricola* Kirby and *B. occidentalis* Greene has long been questioned. However recent COI gene sequence data suggests that *B. occidentalis* and *B. terricola* do represent good biological species. In this paper we test the hypothesis that *B. terricola* and *B. occidentalis* are conspecific by using independent morphometric and genetic (RAPD) data. For comparison we also analyzed one consubgeneric species, *B. moderatus* (now *B. crytptarum*), and one non-consubgeneric species *B.* (*Pyrobombus*) *perplexus*. Discriminant function analysis of wing morphometric data correctly classified over 85% of the specimens of *B. occidentalis* and *B. terricola*. Analysis of molecular variance of the RAPD data showed a significant difference ($P < 0.0001$) between *B. occidentalis* and *B. terricola*. Colour variation from laboratory reared colonies of *B. occidentalis* suggests that probably two gene locus inheritance is likely but that hybridization as the sole basis for the colour variation seen in the nominate taxon *B. occidentalis* can be excluded. We conclude that *B. terricola* and *B. occidentalis* should be regarded as distinct species which have recently diverged, and that they can be distinguished by wing morphometrics and RAPD genotypes. Where they are sympatric (e.g. in Alberta) colour pattern variation is confined to *B. occidentalis.*

Key words: Bumble bees, taxonomy, morphometrics, colour variation

Introduction

Taxonomic and systematic difficulties with bumble bees (*Bombus* spp.) arise from a combination of morphological monotony and ambiguous pile colouration patterns (Franklin 1913, Plowright and Owen 1980, Laverty and Harder 1988, Michener 1990, Williams 1995, 1998). Two such taxa, where the evolutionary status and taxonomic classification are unclear, are *B. terricola* Kirby and *B. occidentalis* Greene. The basis of this confusion originates with their identification being based primarily on pile colour pattern. Greene's (1858) original description of a female *B. occidentalis* reads "…first four abdominal segments black, the rest, including anus, white…". Given that this is the type specimen description, specimens with the first four abdominal segments being black should be considered 'typical' *B. occidentalis* (Fig. 1). In contrast, typical *B. terricola* have metasomal terga II and III, hereafter TII and TIII, that are consistently and clearly defined by complete yellow bands, and lack the large amount of white to cream-coloured pile typical of *B. occidentalis* on TV and TVI (Fig. 1). However, in some parts of its distribution including areas of overlap with *B. terricola*, *B. occidentalis* exhibits considerable pile colour variation (Figs. 2, 3) with some specimens (Fig. 4) closely resembling *B. terricola* (Franklin 1913, Stephen 1957, Milliron 1971). The primary ambiguous components of these bees are the complete to incomplete yellow bands on metasomal terga III and IV (Figs. 2, 3) and even extending somewhat to TII (Fig. 4). Although Franklin (1913, pp. 239–240) was doubtful over their specific status, Stephen (1957) was more definite and noted that *B. terricola* was "one of the most color stable species in western America (p. 82) showing little or no variation throughout its range, and that it could be distinguished from *B. occidentalis* in having TII always yellow and TIV black (Fig. 1). On this basis many authors have regarded *B. occidentalis* and *B. terricola* to be separate species (Sladen 1919, Hobbs

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