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Multivariate ratio analysis reveals *Trigonoderus pedicellaris* Thomson (Hymenoptera, Chalcidoidea, Pteromalidae) as a valid species

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Abstract. We demonstrate by multivariate ratio analysis (MRA) the validity of two female colour morphs as separate species in what was previously regarded as a single species, *Trigonoderus cyanescens* (Förster, 1841) (Hymenoptera: Pteromalidae). As a result, *T. pedicellaris* Thomson, 1878 **stat.r**., is resurrected from synonymy under *T. cyanescens* and *T. filatus binubilatus* Erdős, 1960 **syn.n.** is synonymized with *T. cyanescens*. More than 20 characters were measured as part of two MRA dataset analyses. The first analysis excluded all measurements related to the gaster, whereas the second included gaster length, gaster breadth and seventh gaster tergite breadth. The first analysis revealed that the best separating morphometric ratios for the two species are *head breadth:metatibia length* and *OOL:parastigma length*, whereas the second analysis revealed *OOL:gaster length* as the second best separating ratio. The measurement error of all characters was below the admissible level of 30%. Gaster length proved to be a good character for separating the two groups, showed the lowest measurement error, and its percentage coefficient of variation was not greater than for other characters. This indicates that *gaster length* should not be discarded out-of-hand as a morphometric character in Pteromalidae. The variables that gave the best separating ratios included different body parts; therefore we suggest that the body of a specimen should be taken as a whole for use in MRA analyses, where each distance measurement can interact freely with any other. A key, figures and re-descriptions of *T. cyanescens* and *T. pedicellaris* are provided.

Introduction

In insect taxonomy multivariate morphometrics of distance measurements are widely applied to separate putative species in difficult species complexes (e.g. Sorensen & Foottit, 1992; Kenis & Mills, 1998; Steiner *et al.*, 2010). The most often used methods are principal component analysis (PCA) and linear discriminant analysis (LDA). These methods are usually applied along with conventional analysis of body ratios that are then included in descriptions and identification keys (e.g. Polaszek *et al.*, 2004). Problems may arise concerning the interpretation of data when the two approaches are combined because different definitions of size and shape are applied (Bookstein, 1989, 1998; Klingenberg, 1998; Richtsmeier *et al.*, 2002; Baur & Leuenberger, 2011). In ratio analysis, usually one character or a combination thereof (such as body length), serves as a measure of size, and ratios are used as descriptors of shape. Size is statistically independent of shape that, on the other hand, reflects differences in the geometry of the objects. In multivariate morphometrics, one linear combination of characters (usually the first component of a PCA) is considered as a size axis and the residual variation defines the shape space (in a PCA the second and following components). In contrast to ratio analysis, the size vector additionally comprises the size-dependent shape variation (allometry) and thus is no longer statistically independent from the geometry of objects (see Baur & Leuenberger, 2011: 823, fig. 6);

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