

## Imaging the world's sharpshooter leafhoppers

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### Abstract

The leafhoppers comprise by far the largest family within the Hemiptera, with approximately 19,500 described species in over 40 subfamilies of which the subfamily Cicadellinae comprises around 2,300 species in around 330 genera. The availability of taxonomic monographs on the group and subsequent publications has made the Cicadellinae a relatively well-known group. In 2004 a project was started, funded by UK-based Leverhulme Trust, which has enabled a compilation of digital images of Cicadellinae. A background to this study is given together with details of availability of the images.

**Key words:** sharpshooter leafhoppers, Cicadellidae, Cicadellinae, digital images.

### Introduction

The leafhoppers comprise by far the largest family within the Hemiptera, with approximately 19,500 described species in over 40 subfamilies (Oman *et al.*, 1990) of which the subfamily Cicadellinae comprises around 2,300 species in around 330 genera. The name "sharpshooter" (Hemiptera Auchenorrhyncha Cicadellinae) for this group of xylem-feeding leafhoppers has increasingly been used especially in the USA. The Cicadellinae, as currently defined, was revised by David Young (1915–1991) in three remarkable volumes (Young, 1968; 1977; 1986). The availability of these taxonomic monographs and subsequent publications has made the Cicadellinae a relatively well-known group and has enabled the evaluation and description of additional genera and species, primarily by researchers in Brazil and China. A brief history of the study of sharpshooter research has been given by Wilson and Turner (2007). Recently some re-analysis of generic and species relationships using phylogenetic analysis both morphological and molecular data and has been carried out in the tribe Proconiini (Takiya, 2007). In 2004 a project was started, funded by UK-based Leverhulme Trust, which has enabled a compilation of digital images of Cicadellinae. A new catalogue to the Cicadellinae has been produced (McKamey, 2007) which will further make the group accessible.

### Background and methods

The current Imaging project has arisen by having seen a large collection of unidentified Cicadellinae in Quito, Ecuador. Many of these might have been identified to genus and to species if access to a good collection and the monographs by Young were possible. Neither of these was available in Ecuador. Another approach was to accumulate images of species that might be placed on a website or in a modern monographic treatment, which would nevertheless be based on the work of David Young and subsequent studies. It was this approach that resulted in a successful application for funding by The Leverhulme Trust. The intention was to take images that

would provide a web-accessible information source, as well as volumes of images that would reflect the three monographs by Young.

Each photograph (figure 1) was made using a JVC KY70 3CCD camera on a Leica microscope MZ8 and Synoptics Automontage software. This software allows for a number of images (we usually used around 20) each at a slightly different focus to be 'montaged' to provide an image with an enhanced depth of focus. Images were saved both as TIFF files and as JPG (for use in the database). Each TIFF image was around 4MB in size.



**Figure 1.** Example of one picture from the database, *Deselvana pervirgata* Amyot et Serville 1843.

Where possible, specimens were selected that had been card pointed so that no pin had been used. Where pins had been used for mounting they were 'removed' using Adobe Photoshop, as were the legs so that each specimen is consistent. Minor damage to specimens was also 'repaired' using Photoshop. However, there would be no doubt as to which specimen has been illustrated since information as to the museum where the specimen is stored is given with the image. In addition a unique number is also attached. All images were managed in the relational database FilemakerPro, comprising taxonomic, image and loan databases. Images are given a unique reference number, which has been added to the imaged specimens as a label. Museums from which imaged specimens have been loaned will be provided with a spreadsheet with this information and copies of the images.

Some have assumed that during this project type material would be imaged as a priority. But many historic type specimens are in relatively poor condition and unsuitable to provide good quality images. Given that David Young examined many of these type specimens the selection of specimens to photograph was initially based on the quality of available specimens identified by him in the course of his work. Following the publication of the monographs other specialists have identified some species. Many species, presumably those that are more common and widespread, are to be found in a number of museums and there was plenty of choice of suitable specimens. Many species are known from only small numbers of specimens in the type series located in a limited range of museums. In practice each museum visited or contacted during the course of this work enabled a new range of species to be added to the database. Also Young described 745 species so the specimens he utilised in the description of each species may be regarded as authoritative.

## Conclusions

During the 2 years of the Leverhulme project around 5,000 images have been taken and 88% of the world fauna represented at species level. Over 95% of genera have been imaged. The accumulation of images has continued since the formal end of the project. Visits to European museums have also resulted in the discovery of specimens not seen by Young during his studies and a listing of syntypic material of some authors such as Melichar (Wilson and Takiya, 2007) and Fowler (Wilson, in preparation). A website has been completed based on the FileMakerPro database. Three volumes of images will be produced as an illustrated checklist (based on McKamey, 2007), with the first being a vol-

ume on Old World Cicadellini. In this volume, for ease of use, the species have been divided into sections relating to geographical regions in the Old World. There is little overlap between species. The section "Species of uncertain position" reflects Young's list at the end of his 1977 and 1986 monographs. We are sure that the volumes will encourage even more work to be carried out on this group of leafhoppers.

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