

# ORIGINS AND COMPOSITION OF THE “*CHRYSOPERLA CARNEA* COMPLEX” (NEUROPTERA: CHRYSOPIDAE) IN THE AZORES AND MADEIRA ISLANDS

VENTURA, M. A., D. THIERRY & D. CODERRE

*Chrysoperla carnea* (Stephens), foi durante muito tempo considerada uma espécie cosmopolita de distribuição holártica, mas é hoje considerada um complexo de espécies irmãs, cujo estatuto taxonómico ainda não se encontra totalmente esclarecido. Para uma primeira separação, consideram-se aspectos morfológicos dos adultos e das larvas neonatas.

Nos arquipélagos dos Açores e Madeira, dois tipos morfológicos foram já identificados, correspondendo às espécies *Chrysoperla lucasina* (Lacroix) e *Chrysoperla agilis* Henry *et al.* (2003), duas novas adições para a fauna de Chrysopidae dos arquipélagos. A amostragem conduzida nos dois grupos insulares demonstrou que a “verdadeira” *Chrysoperla carnea*, antes considerada um antigo habitante destas ilhas, até ao momento nunca foi encontrada em nenhum dos arquipélagos Portugueses da Macaronésia.

As implicações biogeográficas desta constatação são discutidas à luz dos possíveis padrões de colonização insular, e das origens possíveis das populações locais.

M.A. Ventura (e-mail: mateus@notes.uac.pt), Dep. Biologia e CIRN, Univ. dos Açores, Apt 1422, 9501-855 Ponta Delgada, Portugal. – D. Thierry (e-mail: dominique.thierry@wanadoo.fr), Dep. des Sciences de la Vie, Institut des Recherches Fondamentale et Appliquée, Université Catholique de l'Ouest, F-4900 Angers Cedex, France. – D. Coderre (e-mail: coderre.d@uqam.ca), Université du Québec à Montréal, Dep. Sciences Biologiques, CP 8888, Montréal, Québec, Canada.

## INTRODUCTION

Due to its isolation and youth when compared to other Macaronesian archipelagos (BEYHL *et al.* 1995), the Azores have a less developed and a less diverse indigenous entomological fauna (EVERS *et al.* 1973), which may have contributed to an easy introduction of several insect species after human arrival (OHM & KLEMMER 1973). Since these human populations came mostly from the mainland Portugal, many of the introduced species have also that origin (LE GRAND 1984). Azorean native species have in fact a predominantly Palearctic origin (WALLACE 1872; BIVAR DE SOUSA 1985)

and, according to BALLETO *et al.* (1990), Madeira archipelago must have served as a stepping-stone to the Azores colonization, due to its geographic location (Table I) and greater geological age. This hypothesis is corroborated by OHM (1973), who mentions the biogeographic affinities between the Neuropterological fauna of both archipelagos.

Neuroptera is in fact one of the less studied orders mainly in the Azores however, because it contains predatory families, it has achieved a great deal of importance for biological control programmes. For instance, Chrysopidae family contains the holarctic predatory species (Stephens), known to exist in the

Azores since 1963 through TJEDER's work, and considered by OHM (1973) an ancient inhabitant of the islands. Its presence in the Azorean archipelago was confirmed by ASPÖCK *et al.* in 1980. Later on, OHM & HÖLZEL (1982; 1984) stated that this species was the only member of the Chrysopidae family present in the archipelago. In Madeira the scenario is very similar for *Chrysoperla* species. In 1882, McLACHLAN reported the presence of *Chrysopa vulgaris* Schneider, later on synonymized to *Chrysopa* (*Chrysoperla*) *carnea* by Schneider himself (LERAUT 1991). Posterior, TJEDER (1939) described two new species from Madeira: *Chrysopa* (*Chrysoperla*) *lundbladi* and *Chrysopa* (*Chrysoperla*) *maderensis*, also synonymized to *Ch. carnea* by ASPÖCK *et al.* (1980).



Since the discovery of a species complex within *Ch. carnea* (TAUBER & TAUBER 1986; THIERRY *et al.* 1992; WELLS & HENRY 1992), researchers from all over the world try to sort out the taxonomic status of their populations and, unless we know for sure which species we are dealing with, *Ch. carnea* sensu lato is used to designate an unknown sibling species, like it is mentioned in the ASPÖCK *et al.* (2001) review, concerning these archipelagos. Such reference implies that more than one species can be present. In order to separate the species included in the western Palaearctic "*carnea* complex", THIERRY *et al.* (1992) selected a group of morphological characteristics, able to discriminate among some of these species. DUELLI (1995) added new morph types discovered meanwhile, some of which are already considered new species.

This work is then a preliminary approach to the sibling species problem in the Azores and Madeira, and the biogeographic implications

involved. HENRY in 1983 has demonstrated the existence of a reproductive isolation between these sibling species based on different courtship songs, which makes them accepted as valid biological species. We explore the morphological resemblances between the Insular and Palaearctic populations, and update the state-of-the-art related to the *Chrysoperla* species present in the Portuguese Macaronesian archipelagos.

## MATERIAL & METHODS

Table I – Location and composition of the Portuguese Macaronesian Archipelagos.

ARCHIPELAGO	LATITUDE/ LONGITUDE	MAP (↑N)	MAIN ISLANDS
Azores	38° 31' 60" N 28° 19' 12" W		9
Madeira	32° 43' 33" N 16° 57' 36" W		2

The Chrysopidae sampling covered all sorts of different accessible habitats below 500m of altitude, with a two hours searching effort made by two people. All stages of the insect life cycle were caught. If death occurred in adults, they were preserved in the dark inside a solution of 70% alcohol plus glycerol [9:1]. Specimens caught in a pre-imaginal state, were fed and reared in individual vials until adult emergence. First instars larvae were subjected to a preliminary identification, based on their cephalic marks (THIERRY 1991). Final species identification was conducted on adults. The adults were grouped according to the morphological characteristics defined by THIERRY *et al.* (1992).

Some individuals were prepared for scanning electron microscopy, according to the meth-

ods described by WATSON *et al.* (1980) and YOUNG *et al.* (1993), and photographs were made on a JEOL JSM 5410, operating at 15 kV. A Wild® binocular microscope was used for optical microscopy photographs.

## RESULTS & DISCUSSION

Archipelagos' mild temperature and high atmospheric humidity, makes them suitable habitats for most entomologic fauna. Among the specimens caught on the Azorean (around 400) and Madeira (around 100) archipelagos, two morph types corresponding to two different courtship songs (HENRY pers. com.), have been separated. One of them is, no doubt, *Chrysoperla lucasina* (Lacroix), a Mediterranean species of the European "carnea complex" (HENRY *et al.* 1996). Its morphological features (Figs. 1, 2, 3, 4 and 5) and song analysis confirmed it. The presence of *Ch. lucasina* in Madeira is actually known since 1939 through TJEDER's work, at the time taken as the endemic *Chrysopa maderensis*. But in 1980 ASPÖCK *et al.* include this species in the *Ch. carnea* (Stephens) group, and later on it is synonymized to *Ch. lucasina* by LERAUT (1991). In spite of the biogeographic affinities of both archipelagos (OHM 1973), there are no previous evidences of its existence in the Azores.

The second species initially raised some doubts due to the fact that the morphological type (according to THIERRY *et al.* 1992), didn't match the courtship song analysis. It was firstly described as *Chrysoperla koltsoffi* (Navás), using Cloupeau terminology (THIERRY *et al.* 1992). However, because of the Asian origin of the species lectotype, HENRY *et al.* (2002) suggested that this name

should be abandoned, and specimens that match this morph type, should be included in *Chrysoperla carnea* (Stephens) species. Thus, this would confirm the presence of *Ch. carnea* sensu stricto on the Portuguese Atlantic islands. In fact, many similarities, in several morphological features, can be found among the sibling species of the complex. The cephalic marks on the neonate larvae (Fig. 3) or the melanic marks on the adult's head (Fig. 4), are some examples.

Recording lacewings courtship songs became a useful tool in the sibling species discrimination (HENRY 1985) and our second "morph type", matched the "song type" of a new species within the "carnea complex" commonly present in the Mediterranean islands, whose morphological features are described in DUELLI (1995). It is the former "Cc3 maltese song species", for it was firstly discovered in Malta (HENRY pers. com.), and recently nominated *Chrysoperla agilis* (HENRY *et al.* 2003). To describe this species, HENRY *et al.* (2003) have also used some insular specimens that we sent from both archipelagos. We can then say that in Madeira and the Azores, so far two sibling species of *Ch. carnea* have been found: *Ch. lucasina* and *Ch. agilis*. The "true carnea" is apparently not present on the islands.

Our results show, not only a proximity of the shared Chrysopidae fauna between the two Macaronesian archipelagos, but also the presence of species common in Mediterranean region and islands, in Europe. The greater diversity of Chrysopidae in Madeira archipelago where, apart from *Chrysoperla* spp. one can also find *Atlantochrysa atlantica* (McLachlan) and *Dichochrysa sensitiva* (Tjeder) (ASPÖCK *et al.* 2001), is not surprising since Madeira's geological age (around 15 million years) is approximately the double

of that of the Azores. Because of the Palaearctic origin of most of the Azorean and Madeira populations, and since it is accepted that the latter acted as a stepping-stone to the Azorean colonizers, our approach to the sib-

ling species problem in both archipelagos confirms, for the first time, the presence of *Ch. agilis* n. sp. (Henry *et al.* 2003) and *Ch. lucasina* (Lacroix) on these groups of islands.

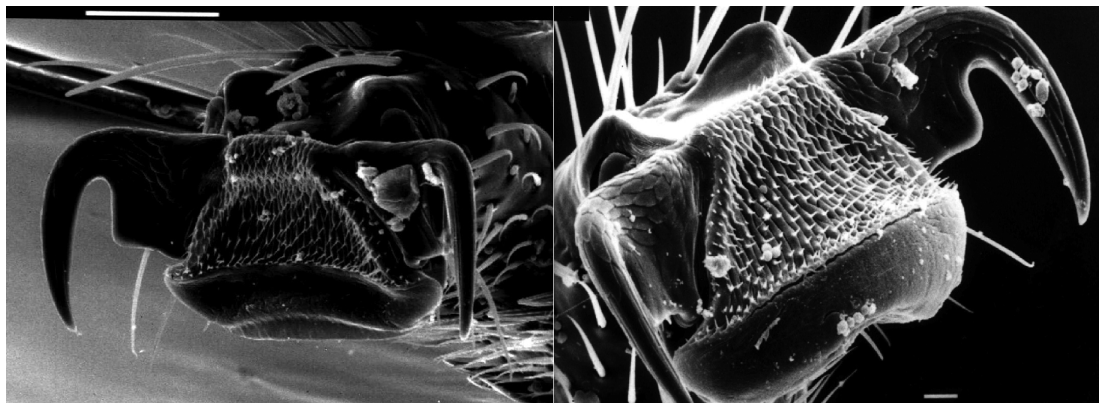


Fig. 1: Scanning electron microscopy photographs of claws, showing differences in the quadrangular base, the length of extremity claw, and angle between both: left - *Ch. agilis* (bar=50µm); right - *Ch. lucasina* (bar=10µm).

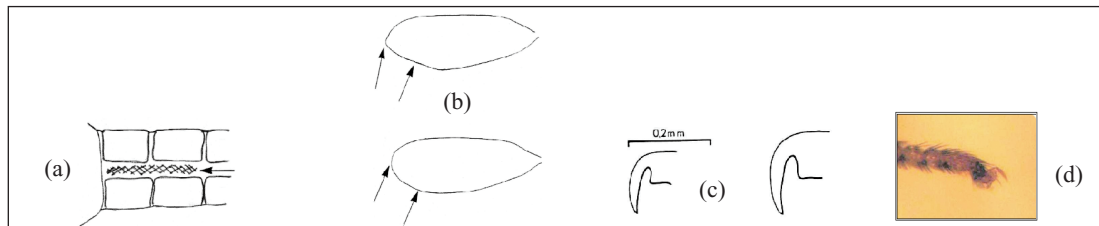


Fig. 2: Morphological features of the abdomen, wings and paws, useful in the sibling species discrimination: (a) Arrow points to the coloured pleural membrane uniting both sides of the abdomen, found in *Ch. lucasina*; (b) Arrows point to differences between the wings of *Ch. lucasina* (upper wing) and *Ch. carnea* (down wing) (“a” and “b” adapted from PLANT 1997); (c) Claw of *Ch. lucasina* (left) and *Ch. carnea* (right) (adapted from LERAUT 1991); (d) Detail of the extremity of the paw viewing the claw (12X magnification).

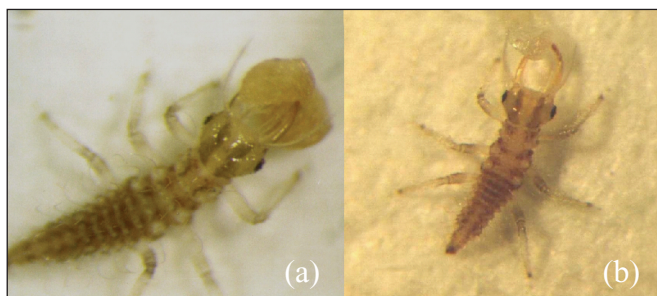


Fig. 3 – Binocular microscopy photographs of neonate larvae, showing different draws made by the brownish stripes on the head: (a) *Ch. agilis*; (b) *Ch. lucasina* (50X and 25X magnification).



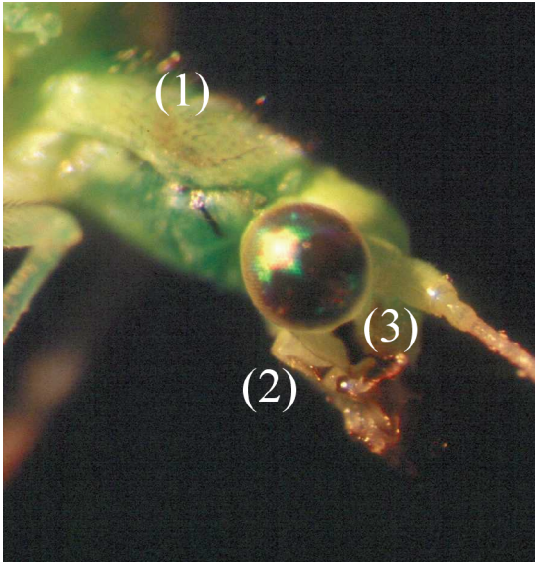


Fig. 4: Detail of some morphological characteristics found on the cephalo-torax region of a “*Ch. carnea* complex” adult (photo of *Ch. lucasina*), useful in the sibling species discrimination: (1) number and colour of pronotum silk hairs; (2) melanistic marks on the stipe; (3) cheek melanistic marks (25X magnification).

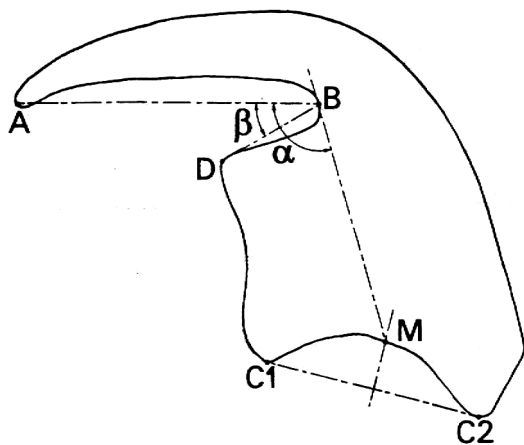


Fig. 5: Morphometry of the claw: measures and angles taken from the claw, to evaluate ratios for identification purposes (extracted from THIERRY *et al.* 1998).

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