

A NOISE PRODUCING BUTTERFLY, *YPHTHIMOIDES CASTRENSIS* (NYMPHALIDAE, SATYRINAE)
FROM SOUTH BRAZIL

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ABSTRACT. A new noise producing system is described for the Nymphalidae. *Ypthimoides castrensis* from south Brasil in Rio Grande do Sul, was studied to find the origin and the purpose of the sound. The noise accompanied interactions with other species of small satyrids butterflies, like *Paryphthimoides phronius* and with their own species. Illustrations of the sub-costal vein of the forewings were made to show details of the new organ in charge of this click sound, and it has been compared with the already known *Hamadryas* Vogel's organ.

Additional key words: *Paryphthimoides*, Behavior, *Hamadryas*, Vogel's organ, wing structure

INTRODUCTION

Sound production has been used by many species of animals for communication. In butterflies not many species have developed this ability, or at least they do not produce loud enough sounds for humans to hear. *Ypthimoides castrensis* (Schaus, 1902) is documented for the first time to produce sounds. Only one record of acoustic signals is documented in the satyrinae group (Kane 1982). The most studied noise producing butterfly is *Hamadryas*. Its sound is emitted because of the wing's upstroke movement, then is amplified through special veins mainly the sub-costal, which leads to a four chambered organ, called Vogel's organ (Monge-Nájera *et al.* 1998). The Vogel's organ, in the side of the butterfly body wall, is also proposed to be a hearing organ (Vogel 1912).

Y. castrensis, is often seen fling with other small butterflies like *Paryphthimoides phronius* (Godart, 1823) which belong to the Satyrinae. Many species in this sub family present a very thick area in the sub-costal vein of the forewings (DeVries, 1987), even thicker than in *Hamadryas*. The function of this structure has been unknown for many years. Seven specimens of *Y. castrensis* were studied, and the sub-costal vein of the forewings was dissected under a stereoscope. The thicker area is a little smaller than half the length of the discal cell, and it has a prominent structure like a callus, that might be the surface which is struck to produce the sound.

MATERIALS AND METHODS

Collecting in the Floresta Nacional de San Francisco de Paula in Rio Grande Do Sul (FLONA), Brazil, was done on November 2003. Collecting was done with a butterfly net between 0930 and 1400. During this time *Y. castrensis* and *P. phronius* were active and flying in

low pastures areas. The specimens studied were taken to the Insects Bioecology Laboratory, in the Zoology Department of the Universidad Federal de Rio Grande do Sul. The specimens were identified, and compared with the laboratory research collection. The sub-costal vein was dissected under a stereoscope, for studying the structure of the sound organ. The wing and sound producing structures were drawn. Five more specimens of the same species from the laboratory research collection were studied and were identical in structure.

RESULTS

There are many interactions of small satyrids in the study site. Sometimes it is possible to hear a clicking noise while two, three or four of them fly together. *Y. castrensis* proved to be responsible for this sound, by catching the two species together in the net, and observing that *Y. castrensis* kept producing the sound inside the net. Each click was related to each up stroking movement of the wings, with a frequency of one click per two or three seconds, unlike *Hamadryas* where the frequency is around 2 clicks per second. This observation lasted around 10 seconds. The other species in the net, *P. phronius*, also kept doing the same movement but without producing any sound.

External structures

The sound system studied in *Y. castrensis* appears to be in the sub-costal vein (SC) of the forewings as shown in *Hamadryas* (Fig. 1), where *Y. castrensis* presents a big swelling. The widest part of the swollen area is 800 μm . more or less eight times the 100 μm . width of the base of the vein. The length of the swollen area of the vein is 6000 μm . 1/3 of the distance to the distal wing border. Close to the distal part of the swelling is a structure that seems to be a kind of spherical callus (C) with a stronger surface; this callus is 500 μm . long and

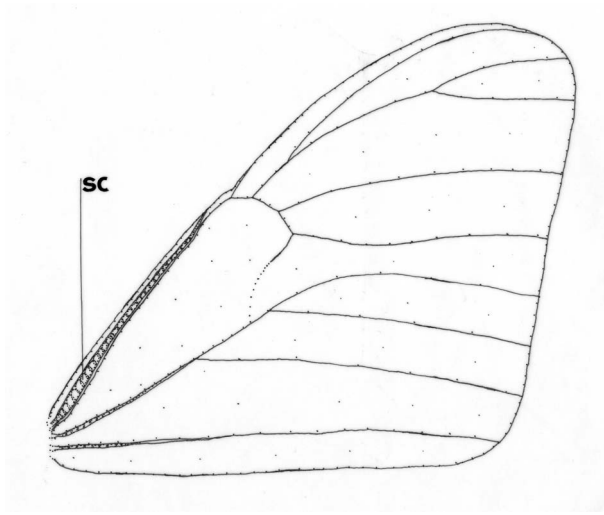


FIG. 1: Details of the sound production structures in the wing of *H. guatemalena*

300 μm . wide. The callus is at the end of the swelling; after this point the vein changes to its normal 50 μm . width. The (2A) and (3M) veins close to their origin level also presents inflation, but not as pronounced as in the (SC) (Fig. 2).

Internal Structure

The swollen area contains many small polygonal chambers of membranous walls with an irregular volume. The chamber sides are around 200 μm . The borders are weak sclerotized membranes, that might vibrate with the hitting of the callus. The volume of the swollen area was approximately 0.883 mm^3 . The other partially swollen veins are not filled with individual chambers.

This complex of chambers seems to be a sound amplifier. The walls in the chambers vibrate along the structure, and the more walls that vibrate, the louder the sound might be.

The median length of the chambers walls is around 200 μm .

DISCUSSION

Apparently the sound of *Y. castrensis* is produced for communication. It is known that many animals use noise signals for different situations, like attracting mates (Wakamura 1997, Spangler *et al.* 1984), expelling territorial intruders (Alcock 1989), and to deter predators (Busnell 1963).

In the case of *Y. castrensis*, the interaction was proved to be with other species so it may have a role in

territorial behavior. The host plant of these two species might be the same grass. It may be important for females and males to protect food resources against the same species, and other species. *Y. castrensis* could also use the noise to attract mates, as in *Hamadryas* (Monge-Nájera & Hernández 1991 and Monge-Nájera *et al.* 1998).

The noise production organ in *Y. castrensis* seems to be different from that studied in *Hamadryas*. *Y. castrensis* has pneumatic chambers. When hitting the callus, the independent chambers inside the organ vibrate, and each chamber helps to amplify the sound. More chambers will produce more vibration surface and louder sounds. The callus must be the structure in responsible for the first contact between the wings.

The sound structures are located in the same vein (Sc) in *Hamadryas* and in *Y. castrensis*. These similarities suggest that these structures are homologous as modifications of the veins. Otherwise, the internal structure is highly modified in the two cases, and it is

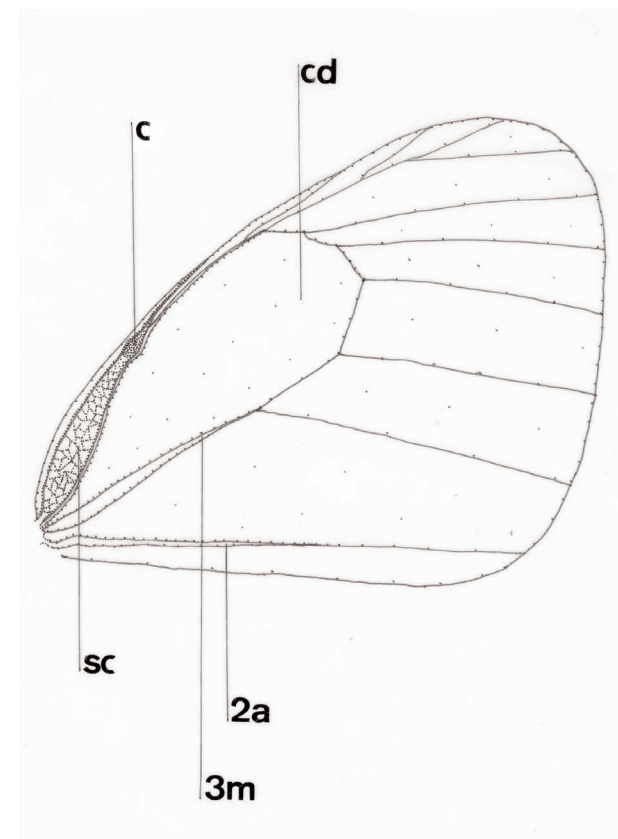


FIG. 2: Details of the sound production structures in the wing of *Y. castrensis*.

not possible to be sure if these internal structures are homologous.

In the case of *Y. castrensis* the organ is a modification of the internal membrane of the tegument of the vein. In the case of *Hamadryas* new studies are necessary about the tegument that becomes the spiral organ.

The presence of these structures suggests two possible origins: a) the sound structure develops from the vein wall; in this case the structures are examples of homoplasy or b) the sound organ in each species is a different modification with the same venal structures involved; in this case the structure may be homologous.

The phylogenetic relationships among these two species suggest the first of these possibilities.

In order to compare the effectiveness of the organ in *Y. castrensis* approximations of the (Sc) vein volume were done. The wing surface in *Hamadryas* is around three times the surface of the *Y. castrensis* wing. The volume of the *Hamadryas* (Sc) vein is around 0,041mm³ in contrast to the *Y. castrensis* (Sc) vein, which is around 0,883 mm³. The organ seems to be more effective in *Y. castrensis* because it is twenty one times bigger than the *Hamadryas* organ in a wing that is three times smaller, allowing it to produce a similar noise to the *Hamadryas*.

Many species of Satyrinae present this characteristic sub-costal vein, but no function has been described for it. Genera such as *Pierella*, *Taygetis*, *Chloreuptychia* and *Dioriste* could be good to compare the structures, and find out if they also produce noise; sonograms might show noises not audible to humans.

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