

## **Costa Rican sphingid moths diversity**

(Lepidoptera: Sphingidae)

by

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### **Introduction**

The Sphingidae of Costa Rica are systematically and faunistically well-known if compared to those of other neotropical countries (MOSS, 1912, 1920; SEIFERT, 1974; HABER, 1983), yet distributional records as well as abundance of species and of individuals occurring at selected sites are far from being thoroughly studied (LAMAS, 1985). Otherwise, Sphingidae are an useful tool for estimates of species diversity (OWEN, 1969).

During may-june 1991 the authors carried out in Costa Rica a preliminary study on sphingids in different habitats. The aim of the study is twofold, to gather informations on hawk moths species composition at different Costa Rican sites and to correlate them with bio-geographical inferences.

### **Material and methods**

Specimens were collected with a classic light trap, using a 160W mercury vapour lamp supplied with an electricity generator and a white sheet in the background. The light trap, on the top of a pole 2m high, was set on from 18.30 to 4.00 during several nights at each locality. The trap was positioned in a prominent position except in La Virgen (loc. 1), where the collecting site was placed on the bank opposite the forest edging the Rio Sarapiquí.

The localities were chosen along a wide N-S transect encompassing various diverse habitats and vegetational formations at different altitudes. Their locations are as follows:

- 1 - VIR = Heredia, La Virgen, 250m, tropical wet forest
- 2 - CRS = Puntarenas, Las Cruces, 1200m, premontane rain forest
- 3 - CIN = Alajuela, Cinchona, 1350m, premontane rain forest
- 4 - MTV = Alajuela, Monteverde, 1400m, tropical lower montane wet forest and cloud forest
- 5 - HER = Guanacaste, Playa Hermosa, 0m, tropical dry and deciduous forest
- 6 - GAF = San José, Cañon, Macho Gaff, 2500m, oak forest, montane rain forest.

Other localities considered in this study are as follows:

MEX = Mexico

TEN = Alajuela, Tenorio, 1400m, premontane rain forest

COR = Puntarenas, Corcovado, 0-600m, tropical wet and lower montane forest

PAC = Guanacaste, La Pacifica, 100m, tropical dry and deciduous forest

SEL = Heredia, La Selva, 50-100m, tropical wet forest

TUR = Cartago, Turrialba, 600m, premontane rain forest

ROS = Guanacaste, Santa Rosa, 0-100m, tropical dry and deciduous forest.

Species and numbers of specimens at each locality are summarized in table 1.

The collected species ( $n=69$ ) were tabulated as a matrix for binary data (presence/absence) occurring at each collecting site. A similarity analysis on these qualitative data was carried out using the coefficient of JACCARD. As far as quantitative data are concerned MORISITA-HORN index was used. The choice of similarity indices is a very controversial matter. However, statistical analysis on the results from wide sets of bioassociational units all concur to demonstrate the validity of JACCARD's index, which however emphasizes differences (CHEETHAM & HAZEL, 1969; RAUP & CRICK, 1979; HUBALEK, 1982; DUNN & EVERITT, 1982). Moreover, this method is a measure of  $\beta$ -diversity, that is the variation of species composition between communities or habitat types.

The similarity values obtained were subjected to cluster analysis with the UPGMA algorithm (Unweighted Pair Group Method using Arithmetic averages).

For each dendrogram the cophenetic correlation ( $r$ ) has been calculated for evaluating the grade of distortion of the dendrograms in respect to the similarity matrices. For each of the matrices assayed,  $r$  was  $\geq 0.86$ . The one-tail probabilities, after Mantel-test, out of 2000 random permutations, were  $p \leq 0.001$ .

The same procedures, except for quantitative data, were carried out on the presence/absence of species from other Costa Rican localities given by HABER (1983) and JANZEN (1984), and for the species occurring in Mexico for comparison of the results. Calculations were performed with a NTSYS-package (ROHLF, 1988) run on an IBM PC.

Table 1: Species of Sphingidae collected in Costa Rica during may-june 1991. Those marked \* are new records for Costa Rica.

|  |      |     |      |      |      |      |
|--|------|-----|------|------|------|------|
| n. of individuals of the most abundant species | 12   | 15  | 72   | 3    | 44   | 35   |
| n. of individuals ( $\Sigma=964$ )             | 32   | 96  | 277  | 5    | 180  | 374  |
| n. of species ( $\Sigma=69$ )                  | 5    | 16  | 21   | 4    | 14   | 50   |
| MENHINICK's index                              | .88  | 1.6 | 1.26 | 1.79 | 1.04 | 2.59 |
| BERGER-PARKER's index (1/d)                    | 1.13 | .62 | .79  | .56  | .96  | .39  |
|  | VIR  | CIN | HER  | GAF  | MTV  | CRS  |
| <i>Aellopos clavipes</i>                       |      |     | 1    |      |      |      |
| <i>Agrius cingulatus</i>                       |      |     | 22   | 1    |      | 1    |
| <i>Amphyterus donysa dariensis</i>             |      | 1   |      | 1    |      | 1    |
| <i>A. gannascus</i>                            |      | 6   |      |      | 15   | 9    |
| <i>A. ypsilon</i>                              |      | 6   |      |      |      | 14   |
| <i>Callionima falcifera</i>                    |      |     | 4    |      | 7    | 12   |
| * <i>C. denticulata</i>                        |      |     |      |      |      | 1    |
| <i>Cauthetia spuria</i>                        |      |     | 5    |      |      |      |
| <i>C. yucatana</i>                             |      |     | 5    |      |      |      |
| <i>Cocytius antaeus = maedor</i>               |      |     |      |      |      | 7    |
| <i>C. duponchel</i>                            |      | 10  |      |      |      |      |

|                                 |    |    |    |    |
|---------------------------------|----|----|----|----|
| <i>Dolbogene igualana</i>       |    | 2  |    |    |
| <i>Enyo lugubris</i>            |    |    |    | 5  |
| <i>E. ocypete</i>               |    | 6  | 13 | 10 |
| <i>*E. taedium</i>              |    |    |    | 1  |
| <i>Erinnyis alope</i>           |    |    |    | 1  |
| <i>E. crameri</i>               |    |    | 9  |    |
| <i>E. lassauxii</i>             |    |    |    | 14 |
| <i>E. oenotrus</i>              |    |    |    | 10 |
| <i>Eumorpha anchemola</i>       |    | 3  |    |    |
| <i>E. capronnieri</i>           |    |    |    | 1  |
| <i>E. labruscae</i>             |    |    |    | 2  |
| <i>E. forbas</i>                |    |    |    | 3  |
| <i>E. satellita</i>             |    | 28 | 6  |    |
| <i>E. triangulum</i>            | 1  | 1  | 1  | 4  |
| <i>E. vitis</i>                 |    | 4  | 6  | 9  |
| <i>Eupyrhroglossum sagra</i>    |    |    |    | 5  |
| <i>Hemeroplanes triptolemus</i> | 7  |    |    |    |
| <i>Isognathus rimosus</i>       |    | 1  |    |    |
| <i>Madoryx pluto</i>            | 1  |    |    | 3  |
| <i>*M. bubastus</i>             |    |    |    | 1  |
| <i>Manduca corallina</i>        |    | 20 |    | 13 |
| <i>M. dilucida</i>              | 15 | 72 | 6  |    |
| <i>M. florestan</i>             |    | 19 |    |    |
| <i>M. lanuginosa</i>            |    |    |    | 8  |
| <i>M. lefeburei</i>             |    | 14 |    |    |
| <i>M. lichenea</i>              |    |    |    | 1  |
| <i>M. occulta</i>               |    |    | 19 | 10 |
| <i>M. pellenia</i>              | 3  |    |    | 6  |
| <i>M. rustica</i>               |    | 18 |    | 25 |
| <i>M. sexta</i>                 |    | 12 | 15 | 22 |
| <i>Nyceryx eximia</i>           |    |    | 1  |    |
| <i>N. riscus</i>                | 7  |    |    |    |
| <i>N. tacita</i>                |    |    |    | 1  |
| <i>Pachylia darceta</i>         |    |    |    | 6  |
| <i>P. ficus</i>                 | 12 | 6  |    | 14 |
| <i>Pachylioides resumens</i>    | 7  |    |    | 13 |
| <i>Perigonia lusca</i>          | 14 | 12 |    | 9  |
| <i>Protambulyx strigilis</i>    |    | 5  |    | 3  |
| <i>Sphinx merops</i>            | 7  | 14 | 10 | 8  |
| <i>Stolidoptera tachasara</i>   |    |    |    | 1  |
| <i>Xylophanes acrus</i>         | 3  |    |    | 2  |
| <i>X. belti</i>                 |    |    |    | 5  |
| <i>X. ceratomioides</i>         |    |    | 3  | 3  |
| <i>X. chiron</i>                |    |    |    | 6  |
| <i>X. crotonis</i>              |    |    |    | 1  |
| <i>X. sp.</i>                   |    |    | 1  |    |

|                                |   |    |    |    |
|--------------------------------|---|----|----|----|
| <i>X. lybia</i>                | 5 |    |    |    |
| <i>X. loelia</i>               |   |    |    | 4  |
| <i>X. maculator</i>            |   | 3  |    |    |
| <i>X. neptolemus</i>           | 6 |    |    | 10 |
| <i>X. pistacina</i>            |   |    |    | 3  |
| <i>X. pluto</i>                |   | 14 | 13 | 26 |
| <i>X. porcus continentalis</i> |   |    | 44 | 35 |
| <i>X. tersa</i>                |   |    |    | 18 |
| <i>X. thyelia</i>              |   |    |    | 3  |
| <i>X. titana</i>               |   |    |    | 2  |
| <i>X. zurcheri</i>             |   |    |    | 3  |

## Results and discussion

The total number of specimens collected is not very high ( $n=946$ ), but rather high is the total number of species ( $n=69$ ), if they are compared with 66 species collected during a five month study by SEIFERT (1974) in Turrialba, and 68 species reported by YOUNG (1972) during eleven months at La Selva. It is to underline that most of the species ( $n=50$ ) of the present study were collected in a single locality, i.e. Las Cruces.

The phenogram resulting from our data (fig. 1A) shows a very low overall similarity among the study sites, the highest resemblance, being approx. 0.30, is that between Playa Hermosa and Monteverde. However these results are mostly preliminary being based on data gathered during a short period of time.

The quantitative data (fig. 1B) show also a very low similarity among sites, and these results are perhaps influenced by the different phenologies of the species in each locality. The wide separation of La Virgen and Macho Gaff and the clustering of Cinchona with Playa Hermosa, and Monteverde with Las Cruces are evidenced. The dominant species in each locality are constituted by widespread species except in Playa Hermosa and Cinchona where is represented by *Manduca dilucida*, a central american element.

SCHREIBER (1978) recognizes Costa Rica as an important neotropical centre (sensu MÜLLER, 1972) where species evolved and differentiated, and he reports on 137 species of hawk moths occurring in this country. Although this figure might be somewhat high, HABER (1983) in fact lists 117 species, there is a high species richness in Costa Rica in comparison with other neotropical countries. Many northern taxa, as well as southern ones, meet together along the Isthmus, especially in Costa Rica. The "double corridor" between the northern and southern continents, phenomenon supported also with other animals, may have acted also on Sphingidae. The high dissimilarity between places as shown by our data, as well as those by other sources, cannot be interpreted as a result of a corridor effect, inasmuch as there would be more balance in the species composition. It is better to consider the dissimilarity resulting from a succession of stoppages for highly dispersive animals, or from recent ecological premises.

The phenogram obtained from presence/absence data of the species (fig. 1C) listed by HABER (1983) and JANZEN (1984) shows three main clusters and a very low similarity among sites. Las Cruces is separated from all other localities. The only two localities with 0.73 of similarity are Santa Rosa and La Pacifica which share similar habitat. Corcovado

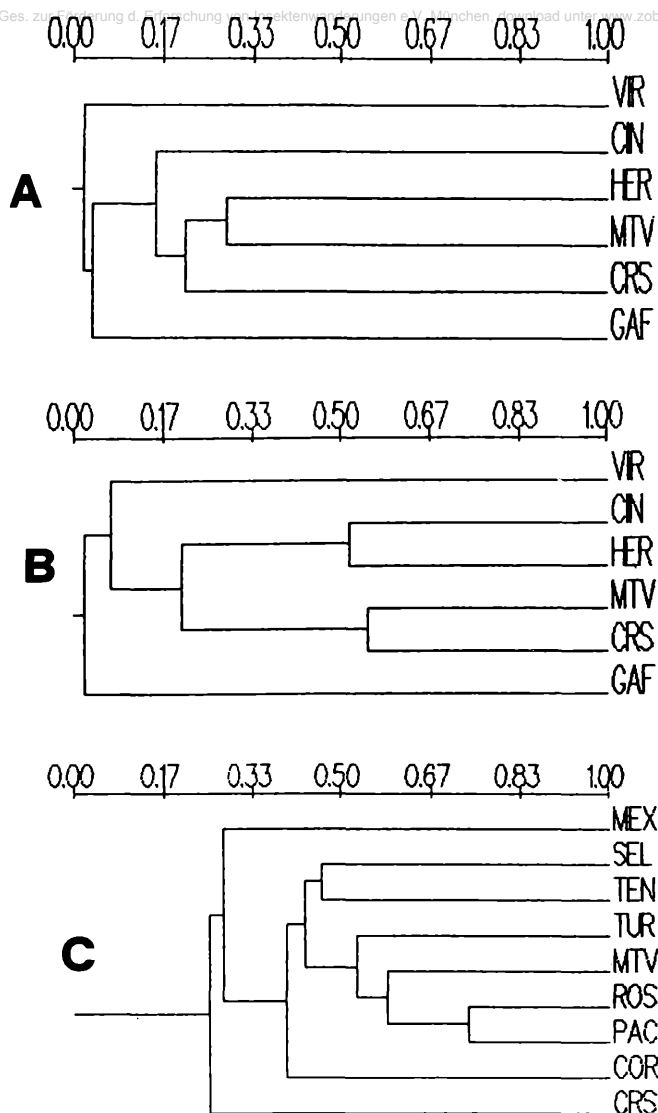


Fig. 1: Phenograms of similarity (JACCARD's and MORISITA-HORN's indexes) obtained by UPGMA on 69 species from Costa Rica (A); on 964 specimens from diverse Costa Rican localities (B); on 209 Mexican and Costa Rican species (C). For details see text.

also is well separated with 0.45 of similarity in respect to a subcluster which includes all the remaining Costa Rican localities.

The cases when two similar habitats, for instance Tenorio and Las Cruces, are quite dissimilar each other for the number of shared species, may reflect biogeographical phenomena, like the impossibility for the species to overcome Chiriqui Massif in the south, while in the north the influence of Mexican species is strong and the Cordilleras de Tilaran and Central acted or are acting as unsurmountable barriers for a southward spreading of the species. In fact, the phenogram (fig. 1C) resulting from the presence/absence of 209 Mexican and Costa Rican species seems to support this view because there is still a low similarity, and Las Cruces is separated from all other localities, including Mexico. Otherwise, this general tendency can be explained not as a geographical trend but as a separation of past different biotas which persist still today. It can be speculated also that the diverse position on the dendrograms of localities with similar habitat, other than physical barriers, is due to the possibility of the movement into Central America of the neotropical rain forest, occurred during Pleistocene and recent times.

Other species of Lepidoptera, e.g. Papilionidae, show a similar distribution pattern: some Mexican species stop in the northern Costa Rica whilst others, strictly neotropical, find their end of distribution in the Chiriqui area.

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