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Georgette Paola Ancajima Alcalde

Comparative morphology of the epiphyses of Dilophonotini Burmeister, 1878 and Philampelini Burmeister, 1878 (Lepidoptera: Sphingidae)

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Corrected Version

Thesis submitted to the Graduate Program of the Museu de Zoologia da Universidade de São Paulo in partial fulfillment of the requirements for the degree of Master of Science (Systematics, Animal Taxonomy and Biodiversity).

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ABSTRACT

Hawkmoths occupy all regions of the globe, except Antarctica and Greenland. The family has 210 genera and about 1500 species, with about a third of the taxa registered for the Neotropical region. In Brazil, 33 genera and 196 species are known. They are classified into three subfamilies, with Macroglossinae being the most diverse lineage. They play an key in pollination. In this process, sphingids usually have contact with pollen grains in various parts of the body, particularly in the antennae. To clean them, these moths use the epiphyses that are in the foretibiae. In addition to being important for the biology of lepidopterans, the epiphysis also represents one of the synapomorphies that support the monophyly of these insects. However, few studies detail this structure morphologically. In this study, we seek to understand the possible variations in the epiphyses of representatives of Dilophonotini and Philampelini aiming to contribute to the discussions on the structure morphology, sexual dimorphism and the relationship with other body structures. For this, 19 genera and 59 species of both sexes (564 individuals in total) were studied. The extracted legs were placed in 10% KOH and taken to a water bath for four minutes to remove the scales. With the epiphyses cleaned, all individuals were photographed using a stereomicroscope and SEM to perform morphological descriptions of the epiphyses and measurements; after that, an allometric regression analysis was performed with other body structures (length and width of the epiphyses, position, length of the tibiae and length of the antennae); finally, an analysis of geometric morphometrics was conducted. As results, a new terminology was proposed for distinct parts of the epiphysis, 22 morphological characters were established from the epiphyses, greater morphological variation was found in the genera and subtribe levels, variations were found between males and females, a positive allometry was observed between the size of the epiphyses and the size of the antennae, and likewise, between the position of the epiphyses and the length of the tibiae. Morphometric analysis showed positive allometry, a homogeneous pattern with small variations between some genera. It was demonstrated that closely related genera have similar epiphyses, and others do not. This study is an important contribution to the knowledge of the Sphingidae morphology, with the proposal of new phenotypic characters for the group. In addition to being a detailed study of the epiphysis, a structure that has been historically neglected, it highlights the need to expand the comparative analysis to other groups of Lepidoptera for a better understanding of the importance of using the epiphysis morphology in the taxonomy of these insects, as well as for a better understanding of the variation and evolution of the structure and its associated antennal grooming behavior.

Keywords: “hawkmoths”. “grooming structure”. “allometry”. “sexual dimorphism”. “geometric morphometrics”.

RESUMO

Esfingídeos habitam todas as regiões do globo, exceto Antártida e Groenlândia. A família possui 210 gêneros e cerca de 1500 espécies, com cerca de um terço dos táxons registrados para a região neotropical. No Brasil, são conhecidos 33 gêneros e 196 espécies. Os esfingídeos estão classificados em três subfamílias, sendo Macroglossinae a linhagem de maior diversidade. Desempenham um papel importante na polinização. Nesse processo, costumam ter contato com os grãos de pólen em várias partes do corpo, particularmente nas antenas. Para limpá-las utilizam as epífises que estão localizadas nas tíbias anteriores. Além de ser importante para a biologia dos lepidópteros, a epífise também representa uma das sinapomorfias que sustentam a monofilia desses insetos. Porém, existem poucos estudos que detalham morfologicamente esta estrutura. Neste estudo, procura-se compreender as possíveis variações das epífises de representantes de Dilophonotini e Philampelini com o objetivo de contribuir para as discussões sobre a morfologia da estrutura, dimorfismo sexual e a relação com outras estruturas do corpo. Para isso, foram estudados 19 gêneros e 59 espécies, de ambos os sexos (564 indivíduos em total). As pernas extraídas foram colocadas em KOH a 10% e levadas a banho-maria durante quatro minutos para remoção das escamas. Com as epífises limpas, todos os indivíduos foram fotografados com auxílio de estereomicroscópio e MEV dando subsídios às descrições morfológicas das epífises e medições; na sequência, foi realizada uma análise de regressão alométrica com outras estruturas do corpo (comprimento e largura das epífises, posição, comprimento das tíbias e comprimento das antenas); finalmente, foi conduzida uma análise de morfometria geométrica. Como resultados, foi proposta uma nova terminologia para diferentes partes da epífise, foram estabelecidos 22 caracteres morfológicos nas epífises, foi encontrada maior variação morfológica nos níveis de gênero e subtribo, foram encontradas variações entre machos e fêmeas, foi observada uma alometria positiva significativa entre o tamanho das epífises e o tamanho das antenas, e do mesmo modo, entre a posição das epífises e o comprimento das tíbias. A análise morfométrica mostrou corroborou uma alometria positiva, um padrão homogêneo com pequenas variações entre alguns gêneros; foi ainda demostrado que gêneros proximamente relacionados podem ter epífises parecidas ou pouca semelhança nas epífises. Esse estudo é uma contribuição importante para o conhecimento da morfologia dos Sphingidae, com a proposição de novos caracteres fenotípicos para o grupo. Além de ser um estudo detalhado da epífise, uma estrutura historicamente negligenciada, ressalta-se a necessidade de se ampliar a análise morfológica comparativa para outros grupos de Lepidoptera, no intuito de embasar o uso da descrição da epífise na taxonomia desses insetos, como também para melhor compreensão sobre a variação e a evolução da estrutura e do comportamento de limpeza das antenas.

Palavras-chave: “esfingídeos”. “órgão de limpeza”. “alometria”. “dimorfismo sexual”. “morfometria geométrica”.

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1. INTRODUCTION

1.1. Sphingidae Latreille, 1802

Lepidoptera comprises butterflies and moths with approximately 160,000 described species (Van Nieukerken *et al.*, 2011). Moths with nocturnal habits represent >75-85% of lepidopterans species diversity (Kawahara *et al.*, 2018). Bombycoidea is one of the most diversified and species-rich lineages of the clade Macroheterocera (Mitter *et al.*, 2017; Kitching *et al.*, 2018). This superfamily includes 10 families, among them, we highlight Sphingidae Latreille, 1802 for its species richness, relatively stable taxonomy, and its importance in studies of pollination and biological conservation (Kristensen, 1999; Van Nieukerken *et al.*, 2011; Kitching *et al.*, 2018).

Sphingidae comprises 210 genera and more than 1500 species (Van Nieukerken *et al.*, 2011; Kawahara and Barber, 2015; Kitching *et al.*, 2018); therefore, it constitutes the most species-rich group of Bombycoidea (Van Nieukerken *et al.*, 2011). Hawkmoths have a worldwide distribution, and are absent only in Antarctica and Greenland (Kitching and Cadiou, 2000; Moré *et al.*, 2014). In the Neotropical region, they represent approximately one third of the global diversity (Heppner, 1991; 1998). In Brazil, 33 genera and 196 species are known (Haxaire and Mielke, 2020).

The monophyly of Sphingidae is supported by synapomorphies of larvae (1), pupae (1) and adult (7) (Minet, 1994). Currently, it is also corroborated by molecular and morphological data (Kawahara *et al.*, 2009). Several authors classify Sphingidae in three subfamilies: Macroglossinae, Sphinginae and Smerinthinae (Kitching and Cadiou, 2000).

Initially, few researchers explored morphological data in the construction of a relationship hypothesis for Sphingidae. Rothschild and Jordan (1903) showed a comparative morphological study based on adults, however lacking a methodological standardization. These authors divided the family into two groups: “Semanophorae” and “Asemanophorae” by the presence or absence of microtrichia patch on the internal surface of the first segment of the labial palps.

Hodges (1971) changed the names of the groups recognized by Rothschild and Jordan (*op.cit.*) to Macroglossinae and Sphinginae, respectively, based on the genus type of each subfamily. On the other hand, Minet (1994) indicated that the absence of the modification in the labial palp was plesiomorphic, therefore, it could not be used as an autapomorphy of Sphingidae *sensu* Rothschild and Jordan (1903). However, Kitching and Cadiou (2000) indicated that among the three proposed subfamilies (Sphinginae, Smerinthinae and Macroglossinae), only Macroglossinae showed an exclusive apomorphy (modification of the labial palp).

Of all the implications for the classification of Sphingidae, Nakamura (1976) (*apud* Kawahara *et al.*, 2009) made the major contribution to the systematics of the family, grouping Smerinthini and Sphingini in a clade based on larval and pupal characters, but it is important to emphasize that only Japanese representatives were examined. Posteriorly, Regier *et al.* (2001) worked on the first molecular phylogeny for the hawkmoths. They employed only two genes (EF-1α and DDC) and low representation of taxa (18 genera; 14 of Sphingidae, two of Brahmaeidae and two of Saturniidae); despite that, their results corroborated those proposed by Rothschild and Jordan (1903) and Nakamura (1976). However, it was evident that the number of genera might be expanded and three important tribes that were not previously considered (Acherontiini, Ambulycini and Sphingulini) in those works might be added in future analyses.

The study of Kawahara *et al.* (2009) supported what was found by previous authors, grouping Smerinthinae plus Sphinginae, and confirmed Macroglossinae as a monophyletic group. In the latter, three groups are recognized: Hemarina, Dilophonotina *sensu lato* and Macroglossini *sensu stricto* (Kawahara *et al.* 2009). The “Dilophonotina *sensu lato*” groups exclusively representatives from the Neotropical region and includes Dilophonotini (except Hemarina), Philampelini and *Proserpinus* group with *Amphion* and *Sphecodina* (Kitching and Cadiou, 2000; Kawahara *et al.*, 2009). Implications from this phylogeny include the closest relationship of Hemarina and Dilophonotini, and the inclusion of the genus *Enyo* in the tribe Dilophonotini.

Kawahara and Barber (2015) analyzed the evolution of anti-bat ultrasound in Sphingidae based on molecular and behavioral data and concluded that: 1) the subtribe Hemarina is phylogenetically close related to Macroglossini, 2) *Enyo* is placed in Macroglossina and 3) Philampelini comprise only one genus, *Eumorpha*. On the other hand, the global checklist of Bombycoidea proposed by Kitching *et al.* (2018) concluded that: 1) Hemarina is considered as tribe, 2) Philampelini is considered as subtribe of Dilophonotini including 11 genera (e.g. *Aleuron*, *Enyo*, *Unzela* and *Eumorpha*).

There are several conjectures about the Macroglossinae taxonomy. I decided to work with the classification of Kawahara *et al.* (2009), using the clade Dilophonotini *sensu lato* on which it is included the subtribe Hemarina (*Cephonodes* and *Hemaris*) without *Proserpinus* group.

1.2. Grooming in insects

Grooming is a normal and innate behavior in animals (Jander, 1966; Murray, 1987; Böröczky *et al.*, 2013). This behavior is performed frequently to avoid contamination on the body surface (Hlavac, 1975; Böröczky *et al.* 2013; Zhukovskaya *et al.* 2013). Thus, it helps maintaining the acuity of the sensory organs (Robinson, 1996; Böröczky *et al.*, 2013; Hackmann *et al.*, 2015), removing pathogens, fungi (Chouvenc *et al.* 2009; Yanagawa *et al.* 2014), dirt and pollen from the body (Jones and Jones, 2001; Hackmann *et al.*, 2015). Also, grooming prevents attacks by ectoparasites (Pettis and Pankiw, 1998; Léonard *et al.*, 1999; Leung *et al.*, 2001) and parasitoids (Vincent and Bertram, 2010). Additionally, parasitoids clean the antennae to remove compounds released by the hosts, without which it could compromise the location of new host and their own fitness (Corbet, 1973).

Another advantage of the grooming behavior is to help in locomotion (Wendler and Vlatten, 1993). Finally, grooming helps the distribution of hydrocarbons, brochosomes, antiseptic, antimicrobial and grooming secretions over the body surface (Kovac and Maschwitz, 1990, 1991; Lusebrink *et al.*, 2008; Böröczky *et al.*, 2013; Dong and Huang, 2013).

Grooming is, as seen, a crucial and beneficial behavior for the development of insects. The insects are numerous, a diverse group (Grimaldi and Engel, 2005; Trautwein *et al.*, 2012; Misof *et al.*, 2014), and they developed distinct types of adaptation for cleaning (Jander, 1966; Hlavac, 1971, 1975; Robbins, 1989; Hackmann *et al.*, 2015).

Based on the phylogenetic hypothesis of the insect evolution of Trautwein *et al.* (2012) and Misof *et al.* (2014), the antennal grooming in these animals is described in the following paragraphs.

Archaeognatha cleans the body with oral grooming; there are no reports about antennal grooming, instead they used only the mouthpiece (Valentine 1986, Basibuyuk and Quicke 1999), while *Thermobia domestica* (Packard, 1873) (Zygentoma) uses the first pair of legs and the oral apparatus (Jander, 1966; Valentine, 1986).

In Palaeoptera, the dragonflies (Odonata) clean head, antennae, and eyes using only their legs and post-tarsus (Jander, 1966; Leung, *et al.*, 2001). Jander (1966) tried to document the cleaning behavior in mayflies (Ephemeroptera) without success. She concluded that they possibly missed this behavior or it is unknown yet (Jander, 1966; Jander and Jander, 2011).

There are several studies of grooming in Polyneoptera. Many species of grasshoppers (Orthoptera) hold the antennae with the prothoracic legs and pull into the mouth to clean them (Jander, 1966; Lefebvre, 1981; Chapman, 1998). As opposed, *Diradius vandykei* (Ross, 1944) (Embioptera) does not use the legs to assist in cleaning, instead, it uses the basal musculature of the antennae. With this musculature, the antennae are bent and held by the mouthparts, and the flagellomeres are gradually cleaned (Jander, 1966; Valentine, 1986).

Grylloblattodea also uses the front legs to bend the antennae towards the mouth to clean them as observed in Orthoptera (Kostromytska *et al.*, 2015). In *Aborolabis mauritanica* (H.Lucas, 1849) (Dermaptera) the antennae reach to the mouthpiece by a sudden movement, and there, they are cleaned piece by piece (Jander, 1966). We can also observe Dermaptera using the legs to place the antennae on the mouthparts (Valentine, 1986), thus, the grooming can be of two types in Dermaptera. *Zorotypus hubbardi* Caudell, 1918 (Zoraptera) pulls the antennae with the prothoracic legs towards the mouthpiece, and remain there to hold the antennae, while they are cleaned by the mouthparts (Valentine, 1986), however, as mentioned by this author it may not be a standard behavior for the species, concluding that sampling was biased.

Within the Dictyoptera (Trautwein *et al.*, 2012), the praying mantises (Mantodea) use the first pair of legs to move the antennae to mouth, thus cleaning the flagellomeres with the mouthparts (Jander, 1966; Valentine, 1986; Basibuyuk and Quicke, 1999). Similarly, Blattodea also clean the antennae with the mouthparts (Robinson, 1996; Chapman, 1998). *Battela germanica* Linnaeus, 1767 uses the labium and maxilla for the antennal grooming (Robinson, 1996); however, some cockroaches clean the antennae with the mandibles (Chapman, 1998). This behavior in cockroaches may vary among families (Smith and Valentine, 1985). There are few studies with termites (Isoptera) on cleaning behavior; however, the grooming is like other Dictyoptera, they also employ the first pair of legs to place the antennae on the mouthparts and there the grooming is performed (Grassé, 1986). In summary, several studies within Polyneoptera show that these insects use the forelegs to bring the antennae to the mouthparts, except in *Diradius vandykei* (Ross, 1944) (Embioptera), which uses the basal muscles of the antennae.

Paraneoptera includes Psocoptera, Phthiraptera, Thysanoptera and Hemiptera. They all possess piercing-sucking mouthparts (Grimaldi and Engel, 2005; Trautwein *et al.*, 2012; Misof *et al.*, 2014), therefore they do not employ the mouthparts for the antennal grooming (Jander, 1966; Hlavac, 1975). Jander (1966) indicated that *Ectopsocus parvulus* Kolbe, 1880 (Psocoptera) might perform a derivative behavior using the prothoracic legs. Regarding the order Phthiraptera, no information about grooming is available. On the other hand, there are reports about wing cleaning in thrips (Thysanoptera) (Ellington, 1980; Mound and Walker, 1982; Moritz, 1999), but, again, no data on the antennal grooming was found in the literature.

Hemiptera is the most diverse order of hemimetabolous insects (Grimaldi and Engel, 2005). Heteropterans use a comb located at the apex of the foretibia to clean the antennae, and it has been observed in *Nezara viridula* Linnaeus, 1758 (Pentatomidae), *Oncopeltus* *fasciatus* (Dallas, 1852) (Lygaeidae) and others species (Hlavac, 1975; Barão *et al.*, 2013; Rebora *et al.*, 2019). Other structures may also be found on the tibia of Asopinae (Pentatomidae). Foretibial expansion with a channel on the ventral surface and the foretibial apparatus have been reported, but the function of both structures is unknown (Brugnera *et al.*, 2018). In summary, paraneopterans do not use the mouthparts for antennal grooming, which is done by the first pair of legs.

Holometabola or Endopterygota is a well resolved phylogenetically group and the most diverse lineage of living being on the planet (Grimaldi and Engel, 2005; Trautwein *et al.*, 2012; Misof, *et al.*, 2014). There is wide grooming diversity in this group.

Many hymenopterans employ a specialized tibia-tarsal complex (named as *strigilis* by some authors, Schönitzer and Lawitzky, 1987) on the prothoracic legs for cleaning the antennae. The tibia-tarsal complex is composed of a notched (on the inner surface of the proximal end of the basitarsus) and a movable tibial spur (Thelen and Farish, 1977). Several authors have studied the behavior and the structure involved in the grooming (Schönitzer and Renner, 1984; Schönitzer and Lawitzky, 1987; Hackmann *et al.*, 2015). Bees (Apidae) have a tibial-tarsal complex with comb in the notched (Schönitzer and Renner, 1984). Ants (Formicidae) have a spur (called *strigilis*) with comb and bristles, and a notched with comb, bristles and brush (Schönitzer and Lawitzky, 1987; Hackmann *et al.*, 2015). Mutilids (Mutillidae) have a velum with a smooth edge and two rows of teeth in the apex, a notched deeper than ants; tiphiid wasps (Thiphiidae) show diversity in the antenna cleaner (Schönitzer and Lawitzky, 1987) and paper wasps (Vespidae) do not have a specialized tibia-tarsal complex for the antenna grooming (Sumana and Starks, 2004).

Hymenopterans pass the entire length of the antenna through antenna cleaner using one or two legs (Farish, 1972; Basibuyuk and Quicke, 1999). Finally, they clean the tibia-tarsus complex with the mouthparts (Jander, 1966) or rubs the prothoracic legs along the antenna (Vespidae) (Sumana and Starks, 2004). A more detailed review about the grooming in hymenopterans may be consulted in Farish (1972).

Strepsiptera has no information about the antenna grooming, even its biology is complex (Kathirithamby, 1989; Cook, 2014). Coleoptera that is the sister group of Strepsiptera is one of the most diverse groups in Holometabola (Trautwein *et al.*, 2012). Beetles have two types of grooming, one of them includes the forelegs, and in the other there is, an antenna cleaner (specialized structure for grooming) (Jander, 1966; Hlavac, 1971; Valentine, 1973). The grooming employing the forelegs can be “antenna-clean” or “antenna rub”. The antenna-clean mechanism is when the foretibia or tarsus reaches the antenna and pulls it into mouth where it is cleaned with a chewing motion. It has been observed in 27 families of Coleoptera except in most weevils, Carabidae, Cicindelidae, and some Cerambycidae and Meloidae (Valentine, 1973). Antenna rub is when the foretibia or tarsus rub along of the antenna, starting at or near the base and progressing distally. After cleaning the antennae with the foretibia, these beetles clean the legs using the mouthparts, and this behavior has been recorded in 29 families, but it is absent in non-anthribid weevils and Cicindelidae (Jander, 1966; Valentine, 1973).

The antenna cleaners or grooming tools have been described in Carabidae and Chrysomelidae. These can be formed from setal aggregations on the foretibia (Carabidae), or can be comb-like array of cuticle outgrowths (Chrysomelidae) (Hlavac, 1971; Hosoda and Gorb, 2011). On the other hand, the loss of oral antennal cleaning in Adephaga indicates that this type of behavior can have independently evolved within the order (Valentine, 1986).

The grooming behavior is similar among the three orders in the clade Neuropterida. Neuropterans hold the antennae between both forelegs (Jander, 1966; Chapman, 1998). Jander's investigation describes antenna grooming in representatives of Chrysopidae, Hemerobiidae, Osmylidae and Myrmeleontidae. Chrysopidae, Hemerobiidae and Osmylidae rub the head with both tarsi of the forelegs, thus hold the antenna from the base with the crossed tarsi and they form a big loop that is cleaned from the base to the tip. Antlions (Myrmeleontidae) have short antennae therefore and may not loop them as in the other families mentioned previously. On the other hand, dustywings (Coniopterygidae) have a similar behavior but they bow their heads to the side and cross both forelegs at the level of their tibiae and pull the antenna down towards the front. Finally, *Libelloides coccajus* (Denis & Schiffermüller, 1775) (Ascalaphidae) grooms the antennae using only one leg and the cleaning movements are slow compared to Chrysopidae.

The behavior cleaning in Megaloptera was observed in *Sialis fuliginosa* Pictet, 1836 (Jander, 1966). These insects employ the forelegs for antenna grooming. First, the head and thorax are moved down; after that, both antennae are cleaned together with the forelegs. In the same way, the grooming in Raphidioptera was described in Jander (1966). The species *Raphidia notata* Fabricius, 1781 and *Agulla* sp. clean the antennae using the forelegs. Both forelegs are held together and pass through both antennae, remarkably similar to the behavior of the megalopterans (Acker, 1966; Jander, 1966).

Amphiesmenoptera is well-established as a monophyletic group and includes Trichoptera and Lepidoptera (Kristensen *et al.*, 2007; Mitter *et al.*, 2017). Trichoptera has a report about cleaning behavior. *Phryganea striata* Linnaeus, 1758 and *Limnephilus flavicornis* (Fabricius, 1787) put both antennae horizontally forward in parallel and with both tarsi (forelegs) take both antennae to clean them (Jander, 1966).

Butterflies and moths (Lepidoptera) have two kinds of antennal grooming behavior: with or without a specialized grooming structure (Philpott, 1924; Jander, 1966; Robbins, 1989). In many lepidopterans, antenna cleaning is done with the epiphysis, a structure located in the foretibia (details below in section 1.3) (Philpott, 1924; Jander, 1966; Odell *et al.*, 1982; Robbins, 1989). However, other groups lack the epiphysis; they use other mechanisms for grooming. In Pieridae, grooming occurs with the movement of the foretibia and tarsus against the antennae. They may or may not possess a brush of long scales on the foretibia and a scale brush on the middle tibia (Robbins, 1989). The families Lycaenidae, Riodinidae and Nymphalidae do not have a brush on the foretibia or on the middle tibia. These butterflies clean the antennae by moving them between the basal middle tibia and distal midleg femur; or midleg tarsus and middle tibia (Jander, 1966; Robbins, 1989).

Mecoptera and Siphonaptera are sister groups closest relatives of Diptera in the clade Antliphora (Misof *et al.*, 2014). There are few records of the grooming behavior in Mecoptera (Setty, 1940; Jander, 1966). One of them described the antennal grooming of these insects (Jander, 1966). The genus *Panorpa* cleans the antennae with both forelegs; they grip the antenna from the base, and forming a concavity between the protarsus and the spurs of the foretibia through which the antenna passes to be cleaned (Jander, 1966), and the other author does not mention antennal grooming (Setty, 1940). For Siphonaptera, no information about grooming was found in the literature.

Diptera has few information about antennal grooming. There is one report of antennal grooming in Brachycera; *Musca domestica* Linnaeus, 1758 (Muscidae) does not use the mouthparts for antennal grooming, but instead it sweeps the forelegs for cleaning head appendages (Barber and Starnes, 1949). This behavior is similar to the specie *Volucella inflata* (Fabricius, 1794) (Syrphidae), this species usually rubs one antenna between the raised forelegs (Jander, 1966).

In contrast, mosquitoes (Culicidae) and biting midges (Ceratopogonidae) have a structure for grooming (Linley and Cheng, 1974; Walker and Archer, 1988). The females of *Ochlerotatus triseriatus* (Say, 1823) (Culicidae) bear tibial combs that function as grooming organs. They grasp the antenna with apices of both foretibia with both legs working synchronously (Walker and Archer, 1988), and *Culicoides melleus* (Coquillett, 1901) and *C. furens* (Poey, 1853) (Ceratopogonidae) have comb with spines on the fore and hind legs, and the grooming organs are sexually dimorphic. There is a similarity between the antennal grooming of Diptera (Muscidae and Syrphidae) and Mecoptera due to use of the forelegs (Barber and Starnes, 1949; Jander, 1966).

To briefly summarize, the wingless insects have an oral grooming with (Zygentoma) or without use of the legs (Archaeognatha). In Palaeoptera, oral grooming is lacking, and in Polyneoptera, except for Embioptera, it is regained. In Paraneoptera, the oral grooming is not observed due to the type of mouthpart, but in Hemiptera it is present as a structure for antennal grooming. Then, until Paraneoptera (except for Hemiptera), there was no specialized structure for the cleaning function. On the other hand, certain holometabolous have a complex antenna cleaning, showing some exclusive and specialized structures for this purpose. Thereby, Hymenoptera, Coleoptera, Lepidoptera and Diptera have these grooming structures, which coincidentally are the most diverse groups of Insecta.

1.3. Epiphysis: Origin of term, description of structure, function, shape and importance

A historical review of term ‘epiphysis’ is provided in the present study, based on all bibliographic sources at our disposal. At the beginning of the 19th century, Fabricius (1807) published a glossary of entomological terms. The term *Pedes* is referred for the legs of the Lepidoptera, but in the description, there is no single allusion to the epiphysis.

Kirby and Spence (1826) mention that in the foretibia of Lepidoptera and Trichoptera possess two or three mobile spurs called *‘Calcaria’*, which are positioned at the apex or in the middle tibia. This term would be what is known as *‘epiphysis’* today. Burmeister and Shuckard (1836) also described spurs using the term *‘Calcaria’,* but these authors did not mention its presence in Lepidoptera. Thus, the descriptions of species were made without considering the epiphysis as a taxonomic character (Walker, 1869). A year later, Meyrick (1895, p. 4) mentioned that on the foretibia there is a *‘median spine-like process, sometimes also with an apical hook’*. However, in that same year, the term *‘epiphysis’* was already associated with a structure located in the foretibia of butterflies and moths (Smith, 1895). Four years later, Sharp (1899, p. 314) described the epiphysis as a ‘*peculiar mobile pad’* with peculiar scales, which could be used as comb organ.

In the early 20th century, Rothschild and Jordan (1903) used the term *‘epiphysis’* as a spur of the foretibia, indicating to be homologous to the spur of the middle tibia. Thereafter, the term *‘epiphysis’* appeared in glossaries as ‘*a movable process attached near the base of the inner side of the anterior tibia in many Lepidoptera’* (Smith 1906, p. 140). But in others glossaries, the term *‘Calcaria’* appeared to refer to the tibial spurs (Jardine, 1913). Other terms are also found in the literature as *‘strigils or strigilis’* (Philpott, 1924; Costa Lima, 1945; Chapman, 1998) or *‘fibula’* (Zombori and Steinmann, 1999).

Of all the terms proposed in the literature to name the cleaning structure present in Lepidoptera (‘*Calcaria’*, ‘*Epiphysis’*, ‘*Strigil’*, ‘*Fibula’*), the most used is *‘epiphysis’*; which I will use throughout the current research, due to the others terms are obsolete and *‘strigilis’* is used for the cleaning structure in ants.

The epiphysis is an synapomorphy of lepidopterans (Common, 1975; Kristensen, 2003; Kristensen *et al.*, 2007), but it may be reduced or absent in some families (e.g. Acanthopteroctetidae, Lophocoronidae, Palaeosetidae, Anomosetidae, Cyclotornidae, Megalopygidae, Dalceridae, Pieridae, Nymphalidae and Lycaenidae). Whether present or reduced, it is located on inner surface of the foretibia (Philpott, 1924; Callahan and Carlysle, 1971; Odell *et al.*, 1982; Robbins, 1989; Kristensen, 1999, 2003; Kristensen *et al.*, 2007).

Epiphyses are multicellular outgrowths, which may be derived from the unpaired spur present in the same location in the Amphiesmenoptera ground plan (Whalley, 1986; Kristensen, 2003; Kristensen *et al.*, 2007). This specialized spur is a movable process (Rothschild and Jordan, 1903; Richards and Richards, 1979; Odell *et al.*, 1982; Kristensen, 2003; Triplehorn and Johnson, 2005) and it is covered by a cuticular protuberances called acanthae (Richards and Richards, 1979; Odell *et al.*, 1982; Gorb, 2001).

Acanthae are projections of unicellular composition that have as morphological characteristic the lack a socket and a sensory cell (Richards and Richards, 1979; Gorb, 2001). Those projections are present in various structures of many insects and can to be various shapes (bifurcated, fimbriate, composed pectines or combs, with straight or bent tips) (Richards and Richards, 1979; Gorb, 2001). In Lepidoptera, they have a spatulated-shaped and have a mechanic function on the epiphysis (Odell *et al.*, 1982).

Due to the presence of acanthae covering the structure, the function of the epiphyses as an antenna cleaning structure is not debatable. Several authors indicate that butterflies and moths clean themselves using the epiphyses, which is a very efficient mechanism for the grooming (Philpott, 1924; Costa Lima, 1945; Callahan and Carlysle, 1971; Odell *et al.*, 1982; Robbins, 1989; Kristensen, 2003; Sambaraju *et al.*, 2016). The antennae are cleaned with the legs of its corresponding side, for that, the antenna is put in the angle between the appendage and the foretibia, doing this repeatedly (Jander, 1966; Robbins, 1989; Kristensen, 2003; Sambaraju *et al.*, 2016).

On the other hand, this cleaning structures vary in shape, size and origin. Such variation is widespread in several families, genera and species (Philpott, 1924) and some examples may be found in the following species: *Helicoverpa zea* (Boddie, 1850), *Lymantria dispar* (Linnaeus, 1758), *Manduca sexta* (Linnaeus, 1763), various species of Papilionidae (*Papilio glaucus* Linnaeus, 1758, *Baronia brevicornis* Salvin, 1893 and *Parnassius clodius* Ménétries, 1855) and Hesperiidae (*Erynnis juvenalis* (Fabricius, 1793), *Poanes zabulon* Boisduval & LeConte (1837), *Pyrrhopyge araxes* Hewitson, 1867, *Megathymus yuccae* (Boisduval & Leconte, [1837]), *M. ursus* Poling, 1902 and *Carterocephalus palaemon* (Pallas, 1771) (Callahan and Carlysle, 1971; Odell *et al.*, 1982; Robbins, 1989; Kent and Griffin, 1990). Descriptions of the epiphyses in the works abovementioned were poorly detailed.

For all the above, the importance of the epiphysis is highlighted by its role as antennal cleaner and as informative character for taxonomists. First, the structure is important for butterflies and moths, which need to clean the antennae regularly for maintaining the fitness (details below in section 1.4). Second, these structures are useful for taxonomists. In the literature, there are several scientific articles considering the epiphysis as diagnostic character for the description of species (Philpott, 1924; Burrows, 1932; Lemaire and Wolfe, 1988; Schoorl, 1990; Minet, 1994; Schmitt *et al.*, 1996; Mielke *et al.*, 2008; Mielke and Drechsel, 2009; Pinheiro *et al.*, 2011; Mielke and Casagrande, 2013; Castro-Torres and Llanderal-Cázares, 2016; Perini *et al.*, 2019).

In our group of study, there is little information on the epiphyses. Hawkmoths have prominent and well-developed epiphyses (Philpott, 1924; Madden, 1944; Kristensen, 1999, 2003). These structures may vary in length, position (Rothschild and Jordan, 1903; Philpott, 1924), and they also may vary between sexes (Kent and Griffin, 1990) with a comb on the margin of inner fold (Philpott, 1924; Madden, 1944). These characteristics are taxonomically informative in Sphingidae; nevertheless, in addition to the characters already mentioned (length and position), there may exist others features potentially important for taxonomic purposes.

1.4. Antenna: Function, shape, importance and its relation with the epiphysis

Antennae are appendages of the head; they are movable olfactory sensors found in all insects (Callahan, 1975; Snodgrass and Eickwort, 1993; Chapman, 1998). Due to the high presence and variety of sensilla, they are sensory structures (Snodgrass and Eickwort, 1993; Chapman, 1998; Field and Matheson, 1998), and function olfactory, gravitational, thermosensory and thermo-hygrosensory (Trouvelot, 1877; Chapman, 1998; Field and Matheson, 1998; Shields and Hildebrand, 1999a, 1999b; Böröczky *et al.*, 2013).

These sensorial structures are quite variable in shape among insect groups; and sexual dimorphism is common (Chapman, 1998; Triplehorn and Johnson, 2005). Moths and butterflies have morphologically distinct antennae, and it is often possible to observe sexual dimorphism in these structures (Chapman, 1998; Symonds *et al.*, 2011; Li *et al.*, 2018). Having the hawkmoths as the object of our study, they have antennae often lamellate ventrally and roughly filiform, clavate, setiform or pectinate (bi-, tri- or quadripectinate) and apex usually hook-shaped (Schreiber, 1978; Kristensen, 1999). Furthermore, there may have differences between male and female (Madden, 1944; Schreiber, 1978; Kristensen, 1999). Males have two rows of long trichoid sensilla, while in females these sensilla are absent or shorter (Madden, 1944; Kristensen, 1999).

The association between the antennae and epiphyses is indisputable; because the only function of the epiphysis is to clean the sensory organ (Philpott, 1924; Jander, 1966; Callahan and Carlysle, 1971; Odell *et al.*, 1982; Kent and Griffin, 1990). Philpott (1924) (p. 215) indicated: *'Species with the most plumose antennae have the most highly developed strigilis'*. He concluded that the development of the epiphysis could to be associated with shape of the antennae. However, the variation of the epiphysis may also be correlated with other parameters not yet studied.

To summarize, there are still discrepancies in the taxonomy of Sphingidae, and to clarify or resolve some uncertainties of a taxonomic nature, more and better characters are needed. Epiphyses as a synapomorphy of moths and butterflies can be one of those key characters; however, the details of such characteristics have been little explored. On the other hand, as it is a potential antenna cleaning organ in Lepidoptera, it is presumed that its morphology is associated with the shape of the antennae and other parameters. For all the reasons, the main objectives of this study are:

- To present a detailed morphological study of the epiphyses of representatives of the tribes Dilophonotini and Philampelini.
- To describe the morphological variation among species of Dilophonotini and Philampelini.
- To quantify the size and shape variation of the epiphyses of Dilophonotini and Philampelini.
- To clarify the correlation between the epiphysis (epiphysis length, epiphysis width, position of the epiphysis) and others parameters (antenna length and foretibia length).

2. MATERIAL AND METHODS

2.1. Morphological data

2.1.1. Specimens

The material analyzed comprised 564 legs of the tribes Dilophonotini (18 genera, 51 species) and Philampelini (1 genus, 8 species). All samples belong to the Lepidoptera Collection of the Museum of Zoology, University of São Paulo (MZUSP). At least one specimen of each sex was examined. Finally, an attempt was made to examine all species of each genus of each tribe studied (Table 1). Images and detailed list of all studied species are available in Appendices A and B.

Table 1. List of the studied species and number of specimens examined by each sex.

Specie	Male	Female
Cephonodes hylas (Linnaeus, 1771)	2	2
Hemaris diffinis (Boisduval, 1836)	1	1
Hemaris croatica (Esper, 1800)	1	1
Pachylia darceta Druce, 1881	8	7
Pachylia ficus (Linnaeus, 1758)	8	7
Pachylia syces (Hübner, [1819])	8	7
Callionima guiarti (Debauche, 1934)	8	7
Callionima innus Rothschild & Jordan, 1903	8	7
Callionima nomius (Walker, 1856)	8	7
Callionima parce (Fabricius, 1775)	8	7
Nyceryx alophus (Boisduval, [1875])	2	2
Nyceryx continua continua (Walker, 1856)	10	5
Nyceryx nictitans nictitans Boisduval, [1875]	10	5
Nyceryx stuarti (Rothschild, 1894)	1	1
Perigonia lusca (Fabricius, 1777)	1	1
Perigonia pallida Rothschild & Jordan, 1903	2	2
Perigonia passerina Boisduval, [1875]	1	1
Perigonia stulta Herrich-Schäffer, [1854]	10	5
Eupyrrhoglossum sagra (Poey, 1832)	2	2
Aellopos ceculus(Cramer, 1777)	2	2
Aellopos fadus (Cramer, 1775)	2	2
Aellopos tantalus (Linnaeus, 1758)	1	1
Aellopos titan (Cramer, 1777)	2	2
Oryba achemenides (Cramer, 1779)	1	1
Oryba kadeni (Schaufuss, 1870)	2	2
Pachylioides resumens (Walker, 1856)	8	7
Madoryx bubastus (Cramer, 1777)	2	2
Madoryx oiclus (Cramer, 1779)	1	1

Table 1. Continuation.

Madoryx plutonius (Hübner, [1819])	2	2
Hemeroplanes longistriga (Rothschild & Jordan, 1903)	1	1
Hemeroplanes ornatus Rothschild, 1894	2	2
Hemeroplanes triptolemus (Cramer, 1779)	2	2
Erinnyis alope (Drury, 1773)	8	7
Erinnyis crameri (Schaus, 1898)	8	7
Erinnyis ello(Linnaeus, 1758)	8	7
Erinnyis impunctata Rothschild & Jordan, 1903	8	7
Erinnyis lassauxii (Boisduval, 1859)	9	6
Erinnyis obscura (Fabricius, 1775)	8	7
Erinnyis oenotrus (Cramer, 1780)	8	7
Isognathus allamandae Clark, 1920	8	7
Isognathus caricae (Linnaeus, 1758)	8	7
Isognathus menechus (Boisduval, [1875])	8	7
Pseudosphinx tetrio (Linnaeus, 1771)	8	7
Aleuron carinata (Walker, 1856)	1	1
Aleuron chloroptera (Perty, [1833])	1	1
Aleuron iphis (Walker, 1856)	2	2
Aleuron neglectum Rothschild & Jordan, 1903	1	1
Unzela japix discrepans Walker, 1856	2	2
Enyo gorgon (Cramer, 1777)	2	2
Enyo lugubris (Linnaeus, 1771)	8	7
Enyo ocypete (Linnaeus, 1758)	8	7
Eumorpha analis (Rothschild & Jordan, 1903)	8	7
Eumorpha anchemolus (Cramer, 1779)	8	7
Eumorpha fasciatus (Sulzer, 1776)	8	7
Eumorpha labruscae (Linnaeus, 1758)	8	7
Eumorpha megaeacus (Hübner, [1819])	8	7
Eumorpha obliquus Rothschild & Jordan, 1903	8	7
Eumorpha translineatus (Rothschild, 1895)	8	7
Eumorpha vitis (Linnaeus, 1758)	8	7

2.1.2. Cleaning and preparation of the epiphyses

With the purpose of standardizing the samples, the left forelegs of each specimen were extracted, but for some specimens only the right forelegs was undamaged (Appendix B). Forelegs were removed with forceps and were placed into tubes with 10% potassium hydroxide (KOH). Posteriorly, the tubes were boiled in water bath for four minutes to soften the scales. Additionally, the legs were rinsed with water and deposited in 70% alcohol. The scales were manually removed with a fine brush and epiphyses were cleaned carefully to avoid the loss of combs. Finally, all the studied forelegs (epiphyses) were preserved in glycerin and were deposited at the Museum of Zoology (MZUSP).

2.1.3. Illustrations and measurements

Epiphyses were photographed in anterolateral and posterior views using a ZEISS AxioCam MRc5 camera couple to the ZEISS SteREO Discovery V20 stereomicroscope. Photos in multiple focal planes were extracted with the AxioVision Rel. 4.8 software and saved in TIFF format; posteriorly, they were combined using the software CombineZP. The obtained images were edited with Adobe Photoshop CC 2018 and the scale bars were added using the ImageJ 1.52a program. These images were also used for the morphometric geometric analyses (see below item 2.3.2). Quantitative parameters were estimated using the ImageJ 1.52a program (Rasband, 1997-2018). Figure 1 shows the epiphyses' measurements that were considered in the present study.

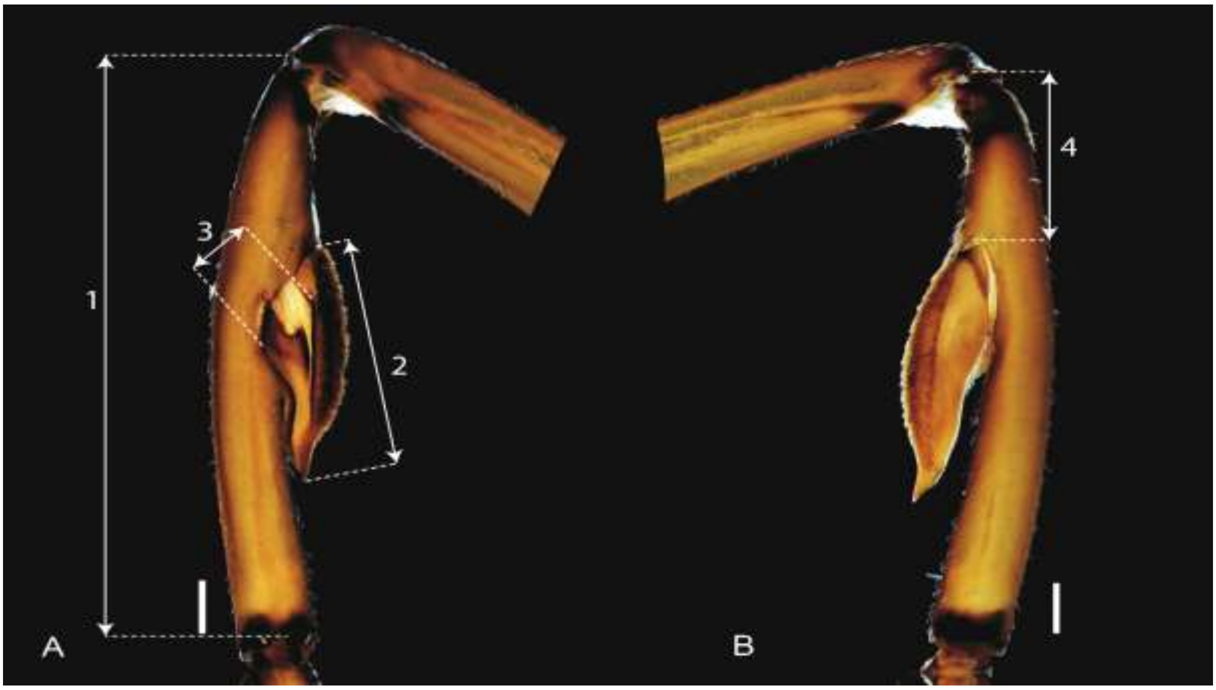


Figure 1. Measurements of the epiphyses (A) anterolateral view, (B) posterior view. 1. Length of the foretibia. 2. Length of the epiphysis. 3. Width of the epiphysis. 4. Distance from the insertion of the epiphysis on the foretibia and the apex of the tibia. Scale bar: 0.5 mm.

2.1.3.1. Scanning electron microscope

To avoid loss of material with low representativeness in the collection, genera with higher quantity of specimens were selected for SEM. In some cases, the chosen species coincided with the type species of the genus (Table 2). In total, 38 epiphysis were photographed with the aid of SEM (males and females of 19 genera). All legs were dried through an alcoholic series, remaining 30 minutes in each concentration (70%, 80%, 90%, and 100%), and then passed to the critical point for the total dehydration. The preparations were placed on supports with double-sided tape, and then metallized in gold before being observed using a ZEISS LEO 440 scanning electron microscope at the Electron Microscopy Laboratory of the Museum of Zoology (MZUSP).

Table 2. List of species analyzed in SEM and type-species of each genus included in the studied material.

Genus	Type-species	Specie analyzed
Cephonodes Hübner, [1819]	*hylas* L., 1771	*
Hemaris Dalman, 1816	*fuciformis* L., 1771 (Sphinx)	*Hemaris diffinis*
Pachylia Walker, 1856	*ficus* L. 1758 (sphinx)	*Pachylia darceta*
Callionima Lucas, 1857	*parce* Fabricius, 1775 (Sphinx)	*
Nyceryx Boisduval, [1875]	*hyposticta* Felder, 1874 (Ambulyx)	*Nyceryx nictitans*
Perigonia Herrich-Schäffer, [1854]	*stulta* Herrich-Schäffer, [1854] (Ambulyx)	*
Eupyrrhoglossum Grote, 1865	*sagra* Poey, 1832 (Macroglossum)	*
Aellopos Hübner, [1819]	*titan* Cramer, 1777 (Sphinx)	*Aellopos fadus*
Oryba Walker, 1856	*robusta* Walker, 1856 (Oryba)	*Oryba kadeni*
Pachylioides Hodges, 1971	*resumens* Walker, 1856 (Pachylia)	*
Madoryx Boisduval, [1875]	*oiclus* Cramer, 1780 (Sphinx)	*Madoryx plutonius*
Hemeroplanes Hübner, 1819	*triptolemus* Cramer, 1779	*Hemeroplanes ornatus*
Erinnyis Hübner, 1819	*ello* L., 1758 (Sphinx)	*Erinnyis oenotrus*
Isognathus Felder, 1862	*caricae* L., 1764 (Sphinx)	*Isognathus menechus*
Pseudosphinx Burmeister, 1856	*tetrio* L., 1771 (Sphinx)	*
Aleuron Boisduval, 1870	*chloroptera* Perty, 1834 (Sphinx)	*Aleuron iphis*
Unzela Walker, 1856	*discrepans* Walker 1856	*
Enyo Hübner, 1819	*lugubris* L. 1771 (Sphinx)	*
Eumorpha Hübner, 1819	*labruscae* L., 1758 (Sphinx)	*Eumorpha obliquus*

(*) Type-species was used.

2.1.4. Descriptions and terminology

For the morphological descriptions of the epiphyses, we proposed four regions and 11 parts on the structure (Figures 2, 3). Specific descriptions were established on morphological characters using a ZEISS SteREO Discovery.V8 stereomicroscope and images acquired according to item 2.1.3. Some descriptive terms were adopted from Rothschild and Jordan (1903), Philpott (1924), and Callahan and Carlysle (1971).

For the generic descriptions, in addition to the characters used at the species-level, other characters obtained with scanning electron microscopy (SEM) images were also studied. Some terms used to describe the acanthae were adopted from Richards and Richards (1979), Odell *et al.* (1982) and Gorb (2001).

Figure 2. Proposed regions of the epiphysis shown in *Erinnyis ello* (anterolateral view): anterior region (AR) (green), posterior region (PR) (blue), upper region (UR) (red), lower region (LR) (yellow). Scale bar: 0.5 mm.

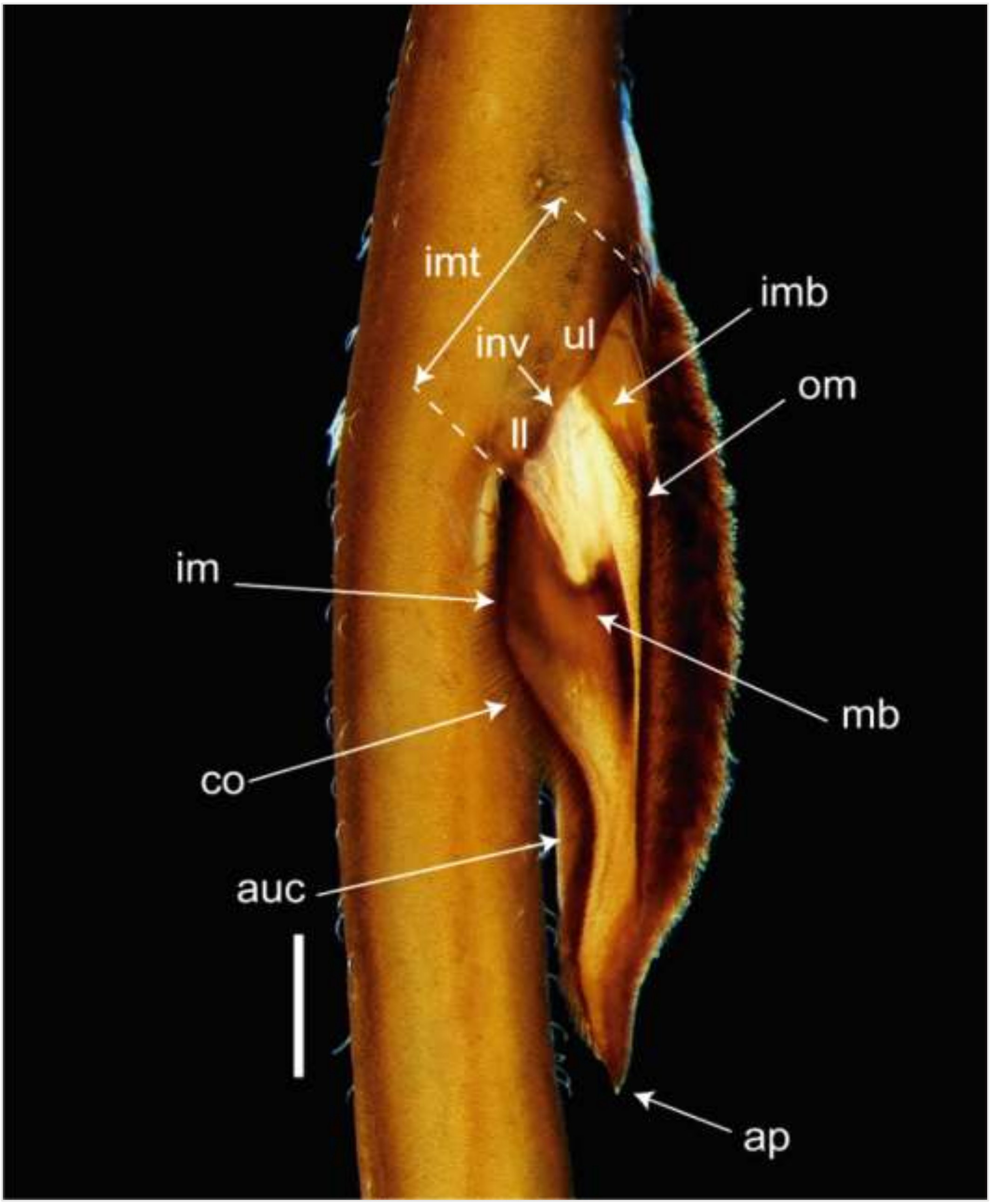


Figure 3. Proposed parts of the epiphysis shown in *Erinnyis ello* (anterolateral view). Abbreviations: (ap) apex, (auc) acanthae located under the comb, (co) comb, (im) inner margin of epiphysis, (imb) macula of the inner margin, (imt) margin of the foretibia, (inv) invagination, (ll) lower lobe, (ul) upper lobe, (mb) medial macula, (om) outer margin of the epiphysis. Scale bar: 0.5 mm.

2.2. Antennae data

Antennae were measured using a ZEISS SteREO Discovery.V8 stereomicroscope with a ruler incorporated in the ocular. Left or right antenna (depending on which leg was available for study) of all specimens used for epiphysis study was measured (n = 564). Measurements were used for statistical (see item 2.3.1) and geometric morphometric analyses (see item 2.3.2).

In addition, SEM images of four genera (male and female) were obtained. These images were acquired using a ZEISS LEO 440 scanning electron microscope at the Electron Microscopy Laboratory of the Museum of Zoology (MZUSP). However, our initial objective was to acquire SEM images of the antennae of 38 individuals as described in item 2.1.4.1; but due to the COVID-19 pandemic, this phase could not be completed. Therefore, images of the antennae of 59 studied species (n = 108, males and females) were obtained using a ZEISS AxioCam MRc5 camera coupled to the ZEISS SteREO Discovery V20 stereo microscope. The photos in multiple focal planes were extracted with AxioVision Rel. 4.8 software and saved in TIFF format; then they were combined with the CombineZP software.

2.3. Analytical methodology

2.3.1. Statistical analysis

Data analyses were conducted with the aid of the software R statistical package version 3.6.1 (R Core Team 2018) and RStudio version 1.3.1056 (RStudio Team, 2020). Descriptive statistical analyses were performed to summarize the data set and to plot the graphs. It was performed a QQplot to show a plausible normality, and after that, it was computed a Shapiro-Wilk test with the hypothesis of normal distribution (H_0) of the data. When the normality test had a p-value <0.05, the null hypothesis was rejected and the data were considered as non-normal distribution. In those cases, a Box-Cox transformation was applied generating a new data set. These analyses were computed using 'car package' (Fox and Weisberg, 2019), 'forecast package' (Hyndman and Khandakar, 2008) and 'ggplot2 package' (Wickham, 2016).

Initially, a PCA (Principal Component Analysis) was performed to target the variables that are likely to be involved in an allometric relationship and summarize all of their measurements into a single variable. Additionally, a biplot was used to visualize the relationship between measurements in the PC1, and to show the variation among genera was used a boxplot.

Finally, antenna length and epiphysis length, antenna length and epiphysis width, epiphysis length and epiphysis width, and position of the epiphysis and foretibia length were correlated using a model II regression (Fit using Standardized Major Axis) in the 'smatr package' (Warton *et al.*, 2012). In addition, the entire data set was used to compute the correlation between the measurements, and 10 genera (32 species, 480 specimens) were employed to graph the relationship of the measurements among genera.

2.3.2. Morphometric approach

In addition to statistical analyses, geometric morphometrics (GM) was applied to visualize morphological differences and sexual dimorphism in the shape of the epiphyses. For this analysis, 10 genera and 32 species were considered due to the high number of specimens in the collection (15 specimens per species, 480 individuals) (Table 3). Epiphyses were photographed according to item 2.1.4. Thus, the 480 photographs in TIFF format were transformed in TPS file using software TpsUtil version 1.78 (Rohlf, 2019).

Four type I and three type III landmarks (Figure 4, Table 3) were defined on the epiphyses. Landmarks were chosen due to ease of marking in all specimens. Each landmark and outline were digitized using TpsDig2 version 2.31 (Rohlf, 2017). Then, TPS files were imported into MorphoJ version 1.06d for further analyses (Klingenberg, 2011). Finally, 100 samples (epiphyses) were randomly chosen and were digitized twice to compute the measurement error (ME), for this analysis Procrustes ANOVA was used (Arnqvist and Mårtensson, 1998) also in MorphoJ software.

2.3.2.1. Shape analysis

The shape is defined as all the geometric information except for size, position and orientation (Dryden and Mardia, 2016). To eliminate the additional information in the shape the Generalized Procrustes Analysis was performed (Rohlf and Slice, 1990). This method is used to remove the translation superimposing the landmark configurations on a common centroid, then, they are scaled to a common size, and finally, the configurations are rotated to the shortest possible distance between landmarks, with orientation elimination (Toro Ibacache *et al.*, 2010, Klingenberg 2011, 2013; Benítez and Püschel 2014, Dryden and Mardia 2016). Therefore, only with the shape information, the allometric effect was assessed by a multivariate regression of shape on centroid size (Monteiro, 1999), pooling the dataset by genera, subfamilies and sex. After that, the covariance matrix of the residuals was assessed to perform multivariate analysis.

2.3.2.2. Multivariate Analysis

The main patterns of variation in the epiphyses were visualized through a Principal Component Analysis (PCA). The differences in the epiphyses between sexes, tribe and genera were tested using Discriminant Analysis followed by a leave-one-out cross-validation test (Klingenberg, 2011; Benítez and Püschel, 2014) and permutation test of the Mahalanobis distance (10000 permutations per test). Mahalanobis distances were exported to the PAST software for cluster analysis using UPGMA method (Rossa *et al.*, 2016).

For mapping the shape in an existing phylogenetic tree the squared-change parsimony was adopted in MorphoJ, and to show the evolutionary allometry was used the multivariate regression of the independent contrasts (Klingenberg and Gidaszewski, 2010; Klingenberg, 2011). The phylogenetic tree was reconstructed considering the Sphingidae phylogeny of Kawahara *et al.* (2009), after that, the tree was exported to MorphoJ and the analysis was performed.

Finally, all morphometric analyses were performed with the aid of software MorphoJ (Klingenberg, 2011), Past version 2.17c software to computed and draw

Mahalanobis distances (Hammer *et al.*, 2001) and Mesquite version 2.61 to draw phylogenetic trees (Maddison and Maddison, 2019).

Table 3. List of species and number of specimens by sex employed for the morphometric analysis.

Species	Male	Female
Pachylia darceta Druce, 1881	8	7
Pachylia ficus (Linnaeus, 1758)	8	7
Pachylia syces (Hübner, [1819])	8	7
Callionima guiarti (Debauche, 1934)	8	7
Callionima innus Rothschild & Jordan, 1903	8	7
Callionima nomius (Walker, 1856)	8	7
Callionima parce (Fabricius, 1775)	8	7
Nyceryx continua continua (Walker, 1856)	10	5
Nyceryx nictitans nictitans Boisduval, [1875]	10	5
Perigonia stulta Herrich-Schäffer, [1854]	10	5
Pachylioides resumens (Walker, 1856)	8	7
Erinnyis alope (Drury, 1773)	8	7
Erinnyis crameri (Schaus, 1898)	8	7
Erinnyis ello(Linnaeus, 1758)	8	7
Erinnyis impunctata Rothschild & Jordan, 1903	8	7
Erinnyis lassauxii (Boisduval, 1859)	9	6
Erinnyis obscura (Fabricius, 1775)	8	7
Erinnyis oenotrus (Cramer, 1780)	8	7
Isognathus allamandae Clark, 1920	8	7
Isognathus caricae (Linnaeus, 1758)	8	7
Isognathus menechus (Boisduval, [1875])	8	7
Pseudosphinx tetrio (Linnaeus, 1771)	8	7
Enyo lugubris (Linnaeus, 1771)	8	7
Enyo ocypete (Linnaeus, 1758)	8	7
Eumorpha analis (Rothschild & Jordan, 1903)	8	7
Eumorpha anchemolus (Cramer, 1779)	8	7
Eumorpha fasciatus (Sulzer, 1776)	8	7
Eumorpha labruscae (Linnaeus, 1758)	8	7
Eumorpha megaeacus (Hübner, [1819])	8	7
Eumorpha obliquus Rothschild & Jordan, 1903	8	7
Eumorpha translineatus (Rothschild, 1895)	8	7
Eumorpha vitis (Linnaeus, 1758)	8	7

Table 4. Description of the landmarks.

Landmark	Type	Position
#1	I	Intersection of inner-margin on the foretibia (imt) and upper-posterior region
#2	I	Apex
#3	I	Intersection of margin of foretibia (imt) and inner margin of epiphysis (im)
#4	I	Invagination (iv)
#5	III	To the middle of posterior region (PR)
#6	III	To the middle of the upper curve situated in inner margin of epiphysis (im)
#7	III	To the middle of the lower curve situated in inner margin of epiphysis (im)

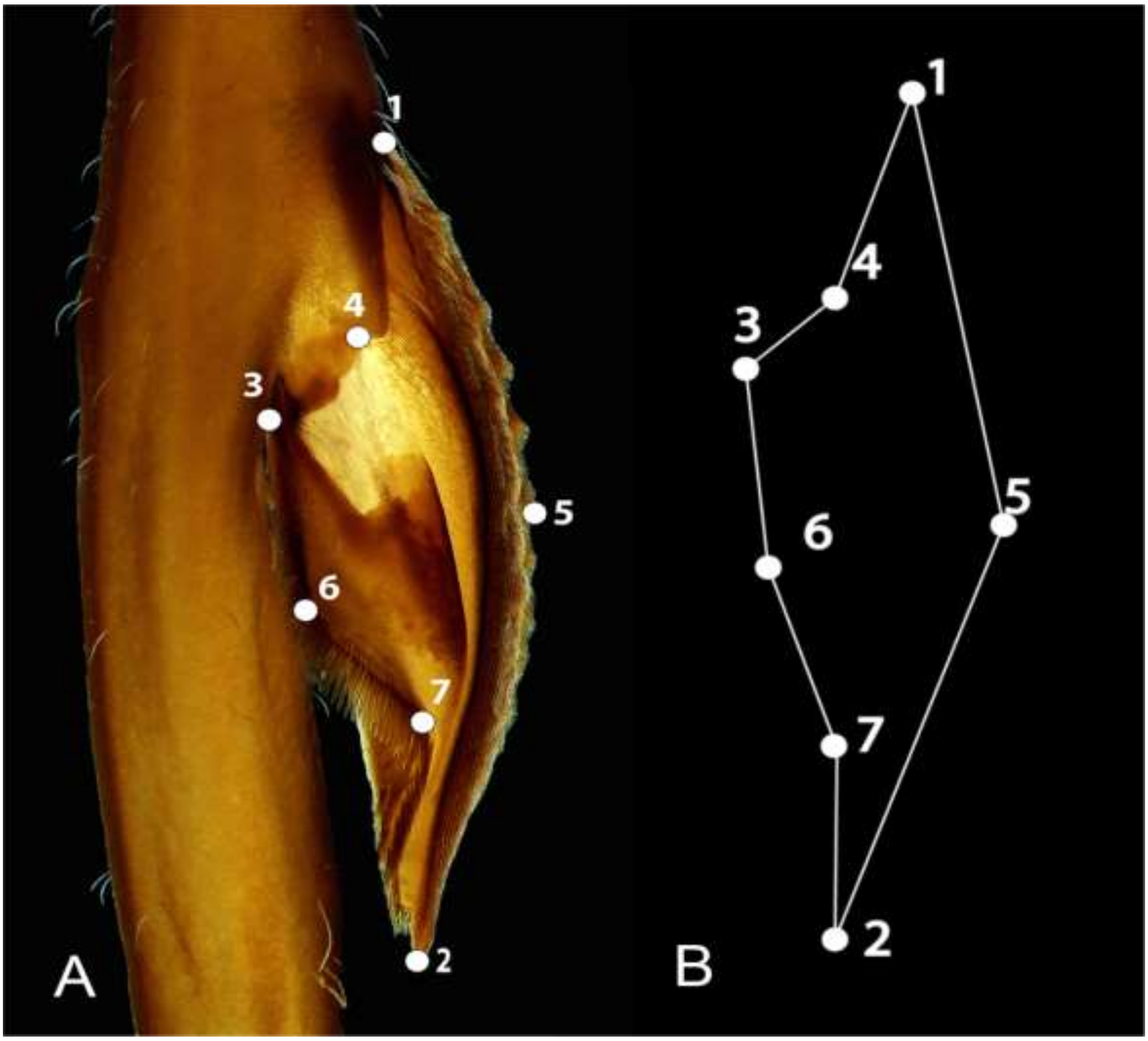


Figure 4. Landmark configuration. (A) View of the landmarks on the epiphysis. (B) Outline generated by MorphoJ after linking the landmarks.

3. RESULTS

3.1. Morphological analyses

3.1.1. Epiphysis morphology

In this section, all the morphological characters used in the epiphysis descriptions at species and genus levels are described. Twenty-two characters have been found informative; of which, 17 refer to the epiphysis itself and five to the acanthae found under the comb. Eleven characters were obtained with the aid of a stereomicroscope or based on photographs; these characters were considered in all studied specimens to comparison among species (Characters: 1-7; 9-10; 21; 22). Additionally, 11 characters were obtained using SEM, which were considered only to comparison among genera (Characters: 8; 11-20).

Abbreviations and symbols shown in the text: n = number of specimens, (*) characters compared among species, (**) characters compared among genera, (im) inner margin of epiphysis, (imb) macula of the inner margin, (imt) margin of the foretibia, (inv) invagination, (ll) lower lobe, (ul) upper lobe, (mb) medial macula, (om) outer margin. For details of parts of the epiphysis, see Figure 3.

[1] Shape (*): (a) elongated (Figure 5A); (b) lanceolate (Figure 5B); (c) spoon-shaped (Figure 5C).

Elongated epiphyses are characterized by having the inner and outer margins very close to each other throughout their entire length and have both margins almost straight. This shape appears in both sexes of *Cephonodes hylas*, *Hemarina croatica* and *H. diffinis* (Figures 16-18).

Lanceolate epiphyses are characterized by having inner and outer margins distant from each other in the upper anterior region; inner margin with well-pronounced curvature. This shape appears in most species examined (Figures 19-38, 41-74).

Spoon-shaped epiphyses are characterized by the large separation between inner and outer margin along of this structure and an inner margins almost straight and outer margin slightly curved. This shape appears in *Oryba achemenides* (in both sexes) and *Oryba kadeni* (in male only) (Figures 39-40).

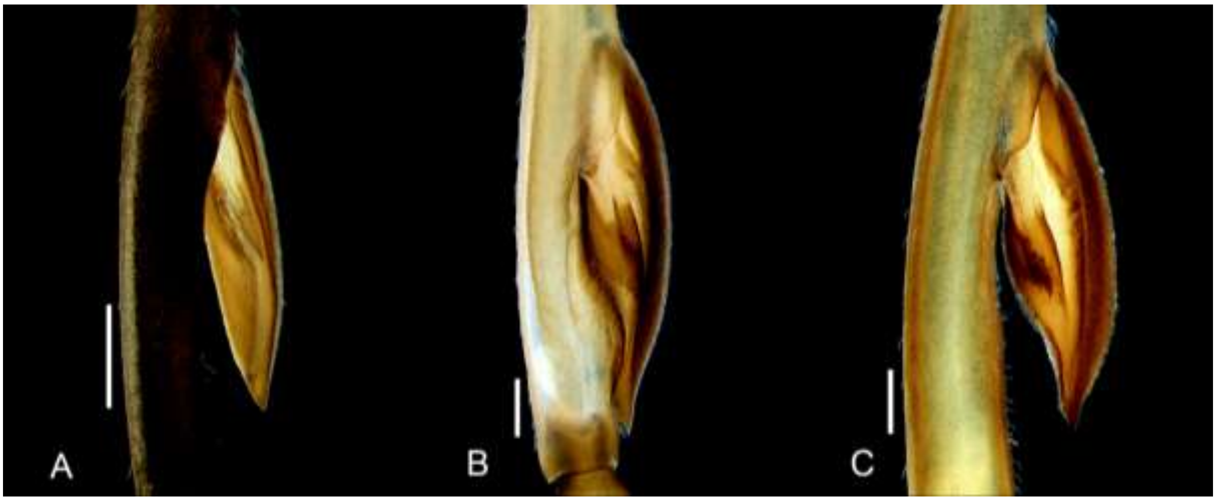


Figure 5. Epiphysis shapes. (A) Elongated. (B) Lanceolate. (C) Spoon-shaped. Scale bar: 0.5 mm.

[2] Position in relation to the foretibia length (*): (a) one third (Figure 6A); (b) one quarter (Figure 6B); (c) two fifths (Figure 6C); (d) two sevenths (Figure 6D); (e) three sevenths (Figure 6E); (f) three eighths (Figure 6F).

Epiphyses usually apically placed at about one third of the foretibia length (51 species, 300 specimens). Also, the epiphyses can be commonly placed at about two sevenths (35 species, 157 specimens) and one quarter (14 species, 75 specimens) of the foretibia length.

The epiphyses apically placed at about two-fifths and three-sevenths of the foretibia are less common. They occur in *Enyo lugubris* and *Aellopos titan*, respectively.

[3] Margin of the foretibia (imt) (*): (a) straight; (b) sinuous.

Cephonodes hylas is the only one with straight margin (Figure 5A, Figures 16-18).

[4] Upper lobe (ul) (*): (a) absent; (b) present.

Cephonodes hylas is the only species examined without the upper lobe (Figure 5A, Figures 16-18).

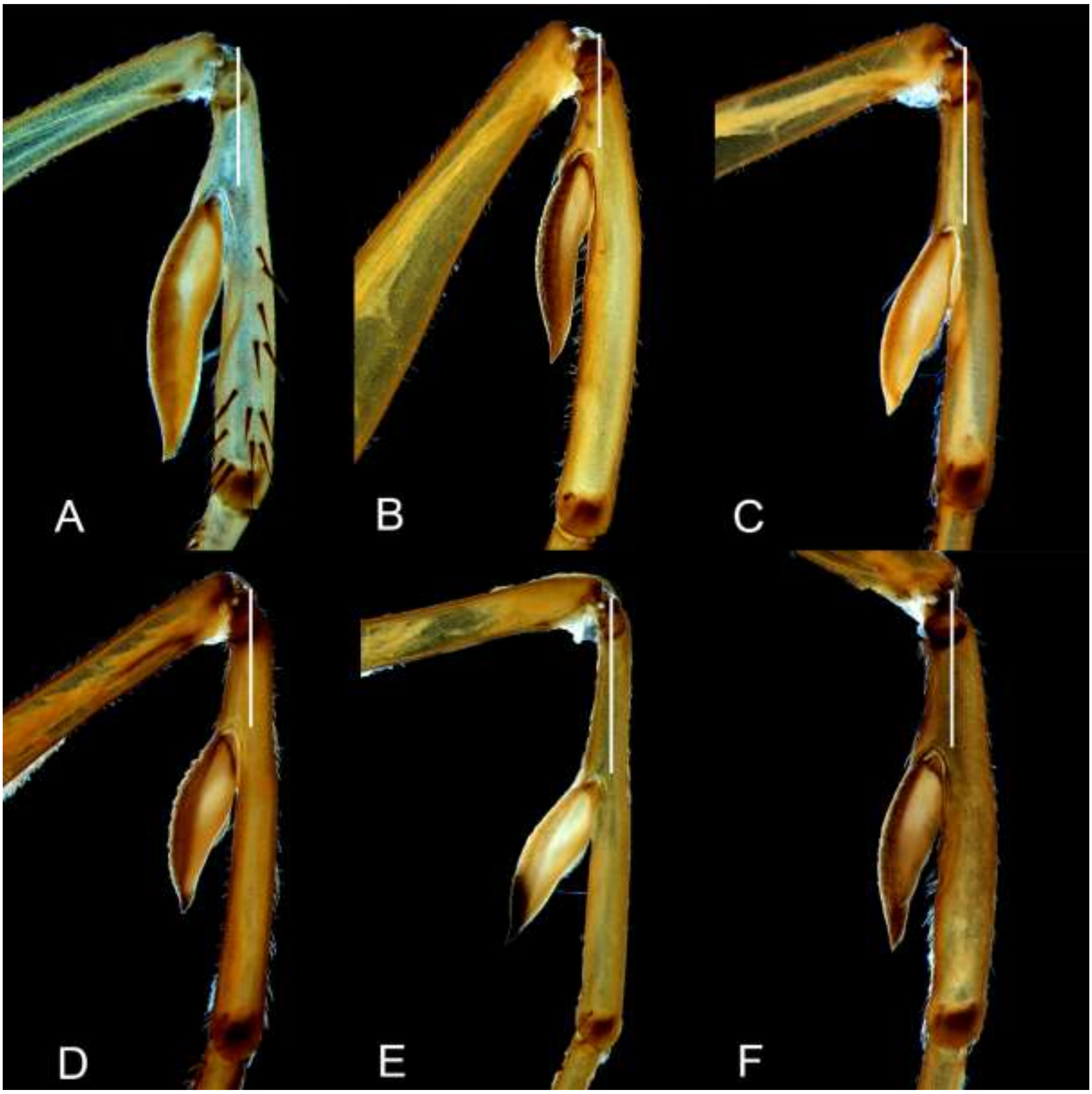


Figure 6. Position of the epiphysis on the foretibia. (A) One third position (1/3). (B) One quarter position (1/4). (C) Two fifths position (2/5). (D) Two sevenths position (2/7). (E) Three-sevenths position (3/7). (F) Three eighths position (3/8). White lines indicate the distance between the epiphysis and the base of the tibia.

[5] Upper lobe shape (*): (a) straight; (b) rounded; (c) subtriangular (Figure 7)

Subtriangular upper lobe is observed in 16 species (n = 36), straight in 21 species (n = 53) and rounded in 54 species (n = 471). However, all specimens of *Nyceryx stuarti* have subtriangular lobe (n = 2) (Figure 29), and all specimens of *Aellopos ceculus* (n = 4) and *Enyo gorgon* (n = 4) have straight lobe (Figures 35, 64).

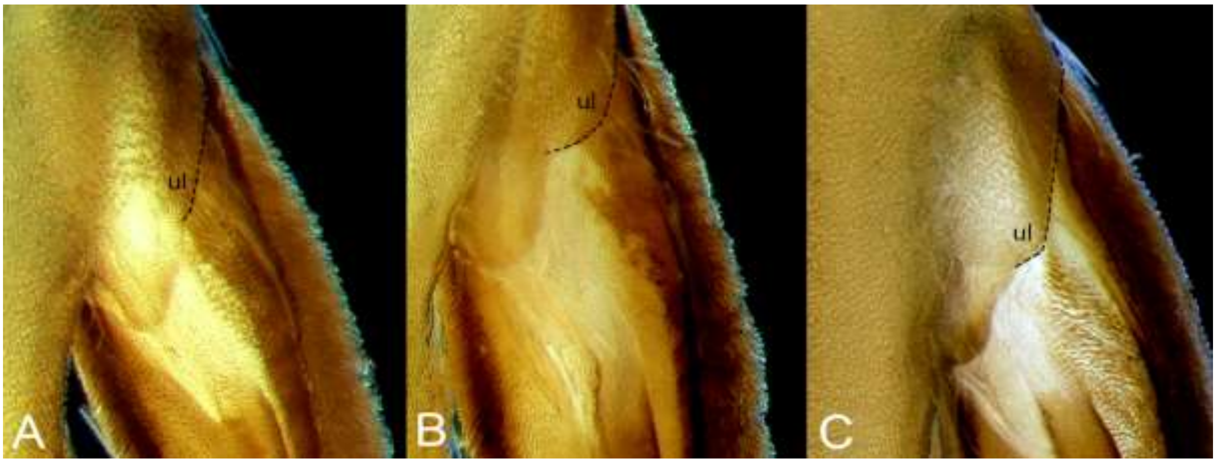


Figure 7. Shape of the upper lobe. (A) Straight. (B) Rounded. (C) Subtriangular. (ul) Upper lobe.

[6] Lower lobe (ll) (*): (a) absent; (b) present.

Hemaris diffinis and *Cephonodes hylas* lack the lower lobe (Figures 16-17). *Hemaris croatica*, Dilophonotina and Philampelini always bear the lower lobe, which may vary in shape (Figure 8).

[7] Lower lobe shape (*): (a) straight (Figure 8A); (b) subtriangular; (c) truncated; (d) rounded. Sometimes the (c1) truncated with crested margin, (d1) rounded with crested margin, (c2) truncated with two lobes or (c3) truncated with three lobes (Figure 8B-I).

Lower lobe is usually rounded and occurs in 55 species (n = 372), in some specimens we may observe crested margin (17 species, n = 62). Other common shape is the truncated lower lobe

(34 species, n = 161), bearing has other modifications such as the crested margin in 10 species (n = 33) or the presence of two or three lobes as occurs in *Eumorpha obliquus.* Subtriangular lower lobe is observed in eight species (n = 15); and straight in *Nyceryx continua continua*, *N. nictitans nictitans* and *Eupyrrhoglossum sagra* (n = 10).

Figure 8. Shape of the lower lobe. (A) Lobeless. (B) Straight. (C) Subtriangular. (D) Rounded. (E) Truncated (F) Rounded with crested margin. (G) Truncated with crested margin. (H) Two lobes. (I) Three lobes. (ll) Lower lobe.

[8] Spines in lower lobe (**): (a) absent; (b) present (Figure 10).

Only four species have spines in the lower lobe: *Aleuron iphis* (Figure 90), *Unzela japix discrepans* (Figure 91), *Enyo lugubris* (Figure 92) and male of *Aellopos fadus* (Figure 82).

[9] Invagination shape (inv) (*): (a) no invagination (Figure 5A); (b) v-notched (Figure 9A-C); (c) u-notched (Figure 9B).

Cephonodes hylas and *Hemaris diffinis* lack invagination because they do not have two lobes to in order to form an invagination (Figures 16-17). Fifty species (n = 282) have an invagination in shape of a 'V' and in 49 species (n = 276) the invagination is 'U-shaped. Both shapes may be observed concurrently in some species, since the variation occurs among individuals. However, in most species, only one shape is found.

Callionima innus, *Perigonia lusca*, *Hemeroplanes triptolemus*, *Aleuron chloroptera*, *A. neglectum*, *Hemaris croatica* and *Eupyrrhoglossum sagra* have exclusively the invagination "v-notched". *Aellopos ceculus*, *A. tantalus*, *Madoryx oiclus*, *M. plutonius*, *Hemeroplanes longistriga*, *H. ornatus*, *Aleuron iphis* and *Eumorpha labruscae* have exclusively the "u-notched".

[10] Invagination degree (*): (a) slightly accentuated (Figure 9A); (b) strongly accentuated (Figures 9B-C).

Invagination strongly accentuated occurs in 45 species (n = 289) and slightly accentuated in 51 species (n = 269). In general, both invagination degrees can be seen in one species, since the variation occurs among individuals. However, some species have only one type.

Species that have invagination strongly accentuated include, for example: *Perigonia passarina*, *Oryba kadeni*, *Hemeroplanes triptolemus*, *Isognathus menechus* and *Aleuron chloroptera*.

Species that have only invagination slightly accentuated include, for example: *Nyceryx nictitans nictitans*, *N. stuarti*, *Perigonia lusca*, *Madoryx oiclus*, *Aleuron iphis*, *Enyo gorgon* and *Eumorpha labruscae*.

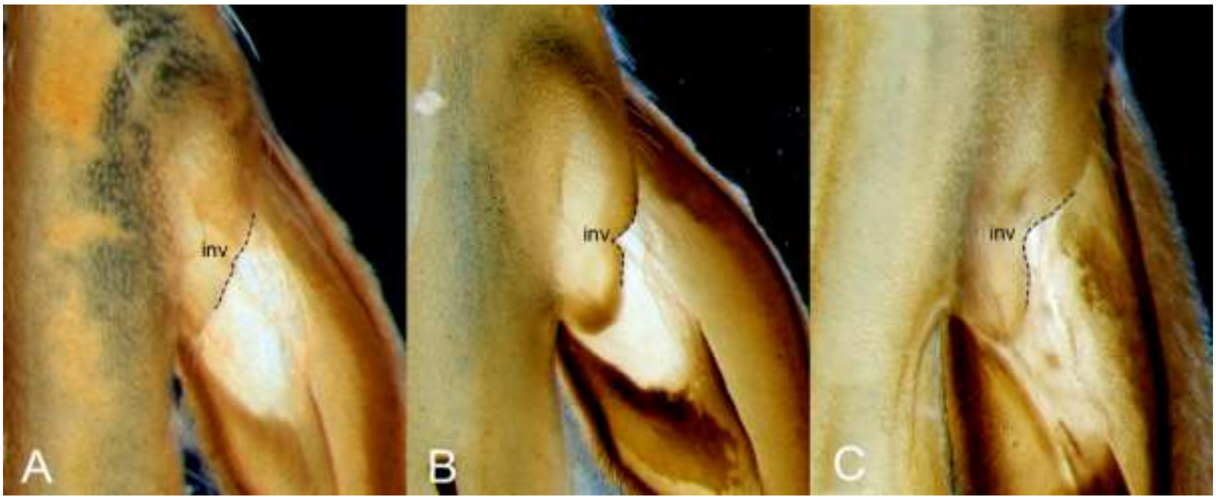


Figure 9. Invagination shapes. (A) V-notched with slightly accentuated invagination. (B) V-notched with strongly accentuated invagination. (C) Curved with strongly accentuated invagination. (inv) Invagination.

[11] Spines in invagination (**): (a) absent; (b) present (Figure 10).

Only *Aellopos fadus* (Figure 82) and *Enyo lugubris* (Figure 92) have spines on the invagination surface.

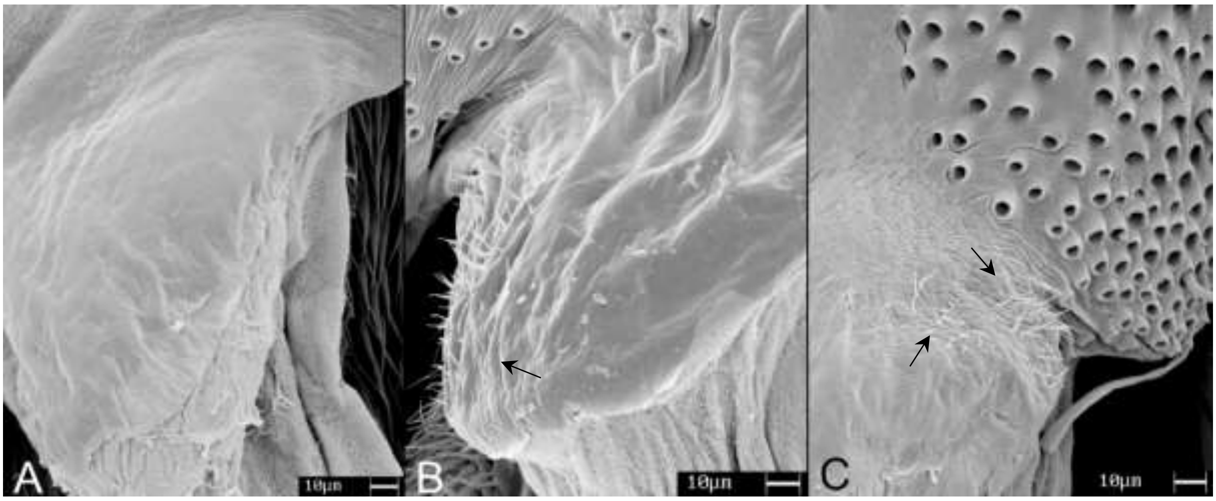


Figure 10. Spines in the lower lobe, invagination or both. (A) Lacking spines as in *Callionima parce* ♂. (B) Presence of spines only in the lower lobe as in *Unzela japix discrepans* ♂. (C) Presence of spines as in *Aellopos fadus* ♂.

[12] Surface/outer margin in upper anterior region (**): (a) striate; (b) with spinules; (c) with spatulate projections; (d) spiny with erect spines; (e) spiny with decumbent spines.

The striate surface occurs exclusively in male of *Eupyrrhoglossum sagra* (Figure 81). Spinules over the surface occur in *Hemaris diffinis* (Figure 76) and the male of *Cephonodes hylas* (Figure 75). Spatulate projections occur in male of *Callionima parce* (Figure 78).

Spiny surfaces are widespread in the species herein examined; the spines can be erect or decumbent. Sixteen species show erect spines on their tegument. This characteristic occurs in both sexes in 11 species, and is present only in males of *Isognathus menechus* (Figure 88) and *Unzela japix discrepans* (Figure 91)*;* and only in females of *Callionima parce* (Figure 78), *Nyceryx nictitans nictitans* (Figure 79) and *Cephonodes hylas* (Figure 75). Six species have decumbent spines on the outer margin. This characteristic occurs in both sexes of *Oryba kadeni*, and only in males of *Nyceryx nictitans nictitans* (Figure 79), and in females of *Eupyrrhoglossum sagra* (Figure 81), *Isognathus menechus* (Figure 88) and *Unzela japix discrepans* (Figure 91).

[13] Surface/inner margin surface in upper anterior region (**): (a) smooth; (b) with spiny plates; (c) sculptured. If the surface is sculptured, it can have the following shapes: (c1) striated; (c2) with spiny projection; (c3) with tubercles; (c4) scaled forming hexagonal; (c5) scaled forming irregular processes.

The smooth surface occurs in males of *Cephonodes hylas* (Figure 75), *Hemaris diffinis* (Figure 76) and *Callionima parce* (Figure 78), and females of *Pachylia darceta* (Figure 77) and *Enyo lugubris* (Figure 92). Surface with spiny plates occurs in male of *Unzela japix discrepans* (Figure 91), female of *Callionima parce* (Figure 78) and both sexes of *Nyceryx nictitans nictitans* (Figure 79).

Seventeen species have sculptured surface. Among them, striated surface is the most frequent. This surface occurs in both sexes of *Perigonia lusca* (Figure 80), *Eupyrrhoglossum sagra* (Figure 81), *Oryba kadeni* (Figure 83), *Pachylioides resumens* (Figure 84) and *Eumorpha obliquus* (Figure 93), and only in males of *Aleuron iphis* (Figure 90) and *Unzela japix discrepans* (Figure 91), and in females of *Pachylia darceta* (Figure 77), *Madoryx plutonius* (Figure 85) and *Enyo lugubris* (Figure 92).

The scaled surface with pentagonal processes occurs exclusively in both sexes of *Hemeroplanes ornatus* (Figure 86); and scaled surface with irregular processes can be in both sexes of *Erinnyis oenotrus* (Figure 87), *Isognathus menechus* (Figure 88), *Pseudosphinx tetrio* (Figure 89) and the female of *Madoryx plutonius* (Figure 85).

Finally, surface with spiny projection and tubercles was less common in the species examined. Spiny projections occur in both sexes of *Aellopos fadus* (Figure 82) and the tubercles were observed in the male of *Aleuron iphis* (Figure 90).

[14] Surface/inner margin of upper anterior region, spines (**): (a) smooth; (b) with spines.

Spines occur in both sexes of *Nyceryx nictitans nictitans* (Figure 79), *Aellopos fadus* (Figure 82), *Oryba kadeni* (Figure 83), *Aleuron iphis* (Figure 90) and *Eumorpha obliquus* (Figure 93) and also in male of *Unzela japix discrepans* (Figure 91) and females of *Callionima parce* (Figure 78), *Perigonia stulta* (Figure 80) and *Pachylioides resumens* (Figure 84).

[15] Surface/inner margin in upper anterior region, tubercles (**): (a) smooth; (b) with tubercles.

These tubercles are present in the females of *Callionima parce* (Figure 78) and the males of *Aleuron iphis* (Figure 90).

[16] Acanthae shape (**): (a) straight (Figure 11A); (b) curved (Figure 11B).

Straight acanthae occur in both sexes of *Callionima parce* (Figure 78), *Oryba kadeni* (Figure 83), *Madoryx plutonius* (Figure 85), *Hemeroplanes ornatus* (Figure 86) and *Enyo lugubris* (Figure 49F), but only in female of *Pachylia darceta* (Figure 34F), *Pachylioides resumens* (Figure 84) and *Eumorpha obliquus* (Figure 93), and only in males of *Perigonia stulta* (Figure 80) and *Aellopos fadus* (Figure 82). However, curved acanthae are more frequent than the other type.

[17] Narrowness of acanthae (**): (a) not narrowed towards the tip (Figure 11A); (b) narrowed towards the tip (Figure 11B).

Most of the examined species have acanthae not narrowing towards the tip; it is present in 29 specimens. On the other hand, acanthae narrowed towards the tip occur in both sexes of *Madoryx plutonius* (Figure 85) and *Erinnyis oenotrus* (Figure 87), and only in males of *Nyceryx nictitans nictitans* (Figure 79), *Eupyrrhoglossum sagra* (Figure 81), *Aellopos fadus* (Figure 82), *Pseudosphinx tetrio* (Figure 89) and *Eumorpha obliquus* (Figure 93).

[18] Acanthae tip (**): (a) straight (Figure 11A); (b) bent tip (Figure 11B).

Straight tip occurs in both sexes of *Callionima parce* (Figure 78), *Oryba kadeni* (Figure 83), *Pachylioides resumens* (Figure 84), *Madoryx plutonius* (Figure 85) and *Enyo lugubris* (Figure 92), and only in females of *Pachylia darceta* (Figure 77) and *Eumorpha obliquus* (Figure 93), and males of *Aellopos fadus* (Figure 82) and *Hemeroplanes ornatus* (Figure 86). However, bent tip is more frequent than the other type.

[19] Dilatation tip (**): (a) regular (Figure 11A); (b) dilated (Figure 11B); (c) well-dilated (Figures 11C-D)

Regular tip is more common that the other character states in the analyzed species. Dilated tip occurs in both sexes of *Eumorpha obliquus* (Figure 93), and only in females of *Hemaris diffinis* (Figure 76) and *Callionima parce* (Figure 78), in males of *Nyceryx nictitans nictitans* (Figure 79), *Hemeroplanes ornatus* (Figure 86) and *Erinnyis oenotrus* (Figure 87). Well-dilated tip occurs only in males of *Eupyrrhoglossum sagra* (Figure 81) and *Pseudosphinx tetrio* (Figure 89)

[20] Dentiform projections (**): (a) vestigial (Figure 11A); (b) serrated (Figure 11B); (c) markedly serrated (Figures 11C-D).

Vestigial dentiform projection is typical of both sexes of *Oryba kadeni* (Figure 83) and females of *Pachylioides resumens* (Figure 84). Most of the species analyzed have serrated projections. We considered the condition “serrated” when the projections were separated from each other, and markedly sawed when these projections were very close.

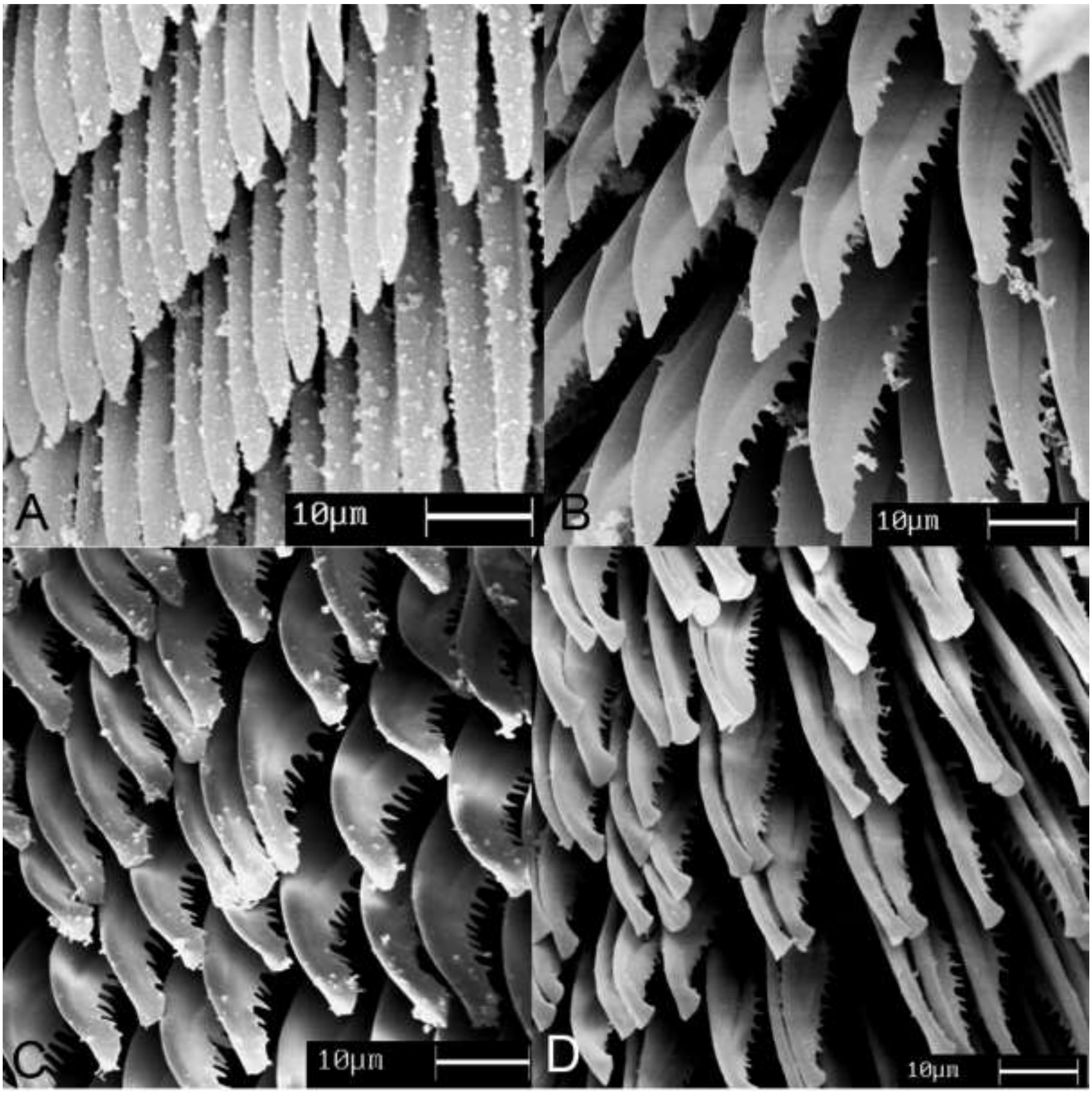


Figure 11. Acanthae. (A) Straight not narrowed towards the tip. (B) Curved narrowed towards the tip. (C, D) well-dilated tip and markedly serrated projection.

[21] Macula in the outer margin of the epiphysis (*): (a) restricted to the upper area; (b) macula extending over the entire margin until it reaches the middle of the epiphysis.

Most of the species analyzed have a macula restricted to the upper area. See Figure 16 for example of macula extending over the entire margin until it reaches the middle of the epiphysis and Figures 19-21 for example of macula restricted to the upper area.

[22] Color of lower posterior region of the epiphysis (*): (a) single color; (b) half-black apical; (c) black apex.

Most of the species analyzed have a single color in the entire epiphysis, however the presence of half-black apical is observed in *Aellopos titan* (Figure 38) and black apex in male of *Nyceryx continua continua* (Figure 27), *Perigonia passerina*, *P. pallida* (Figures 31-32) and *Aellopos fadus*, and in the female of *Aellopos tantalus* (Figures 36-37).

3.1.2. Measurements

The sizes of the epiphyses differ among tribe, genera and species. For the average of the tribes, all the specimens were considered. Epiphyses of Dilophonotini average 2.213 ± 0.486 mm long and 0.453 ± 0.182 mm wide (n = 444). Epiphyses of Philampelini average 3.073 ± 0.391 mm long and 0.737 ± 0.186 mm wide (n = 120). Foretibia length in Dilophonotini averages 4.715 ± 1.140 mm (n = 444) and in Philampelini averages 5.697 ± 0.710 mm (n = 120). In relation to the position on the foretibia, in Dilophonotini averages 1.417 ± 0.332 mm (n = 444) and in Philampelini averages 1.865 ± 0.250 mm (n = 120).

Considering the length and width of the epiphyses, *Pseudosphinx* is distinguished by having the largest epiphyses (3.399 ± 0.154 mm long and 0.788 ± 0.093 mm wide), while *Hemaris* is the opposite, their epiphyses are the smallest (1.540 ± 0.119 mm long and 0.175 ± 0.068 mm wide), and both genera belong to the tribe Dilophonotini (Table 5, Figure 12 and Figure 13). Additionally, *Pachylia*, *Oryba* and *Hemeroplanes* also have large epiphyses in opposition to those with small epiphyses such as *Aellopos*, *Perigonia* and *Cephonodes* (Table 5, Figure 12 and Figure 13).

Species with the longest epiphyses in Dilophonotini are: *Pachylia ficus* (3.081 ± 0.317 mm)*, Oryba achemenides* (2.890 ± 0.028 mm), *Oryba kadeni* (2.838 ± 0.176 mm), *Erinnyis lassauxii* (2.779 ± 0.155 mm) and *Pachylia syces* (2.767 ± 0.27 mm). Species with the shortest epiphyses in Dilophonotini are: *Aellopos tantalus* (1.46 ± 0.085 mm), *Hemaris croatica* (1.485 ± 0.163 mm), *Aellopos ceculus* (1.565 ± 0.183 mm), *Perigonia pallida* (1.580 ± 0.082 mm), *Perigonia stulta* (1.583 ± 0.092 mm) and *Hemaris diffinis* (1.595 ± 0.064 mm) (Table 6). In

Philampelini, *Eumorpha anchemolus* and *Eumorpha vitis* have the largest (3.711 ± 0.223 mm long and 1.033 ± 0.215 mm wide) and smallest epiphyses (2.566 ± 0.179 mm long and 0.509 ± 0.059 mm wide), respectively (Table 6).

Pseudosphinx has the longest foretibia, *Hemaris* the shortest (Table 5, Figure 14), and both belong to Dilophonotini. Other genera of Dilophonotini with long foretibia are *Oryba* (6.752 ± 0.414 mm), *Pachylia* (5.722 ± 0.556 mm) and *Erinnyis* (5.355 ± 0.752 mm). In addition, species with the longest foretibia in Dilophonotini are: *Oryba achemenides* (7.005 ± 0.106 mm), *Oryba kadeni* (6.625 ± 0.466 mm), *Erinnyis lassauxii* (6.192 ± 0.309 mm), *Erinnyis alope* (6.13 ± 0.409 mm) and *Pachylia ficus* (6.007 ± 0.500 mm).

Other genera of Dilophonotini with short foretibia are *Nyceryx* (3.387 ± 0.187 mm), *Unzela* (3.355 ± 0.140 mm) and *Perigonia* (3.314 ± 0.255 mm). Species with the shortest foretibia in Dilophonotini are: *Hemaris croatica* (2.625 ± 0.134 mm), *Hemaris diffinis* (2.690 ± 0.410 mm), *Perigonia pallida* (3.105 ± 0.18 mm), *Nyceryx alophus* (3.183 ± 0.143 mm) and *Perigonia passerina* (3.265 ± 0.361 mm) (Table 6).

In Philampelini, *Eumorpha anchemolus* has the longest foretibia (7.125 ± 0.413 mm) and *Eumorpha vitis*, the shortest (4.885 ± 0.294 mm) (Table 6).

The position of the epiphyses on the foretibia may be more proximal or more distal on the foretibia, considered proximal when epiphyses are close to femur and distal when they are close to the first tarsomere. In Dilophonotini, *Oryba* has the epiphysis more distal (2.150 ± 0.124 mm) and *Hemaris* more proximal (0.655 ± 0.115 mm) (Figure 15). In Philampelini, the position coincides with the length of the foretibia, thus, epiphyses of *Eumorpha anchemolus* are positioned more distally (2.356 ± 0.162 mm) and *Eumorpha vitis* more proximal on the foretibia (1.647 ± 0.118 mm).

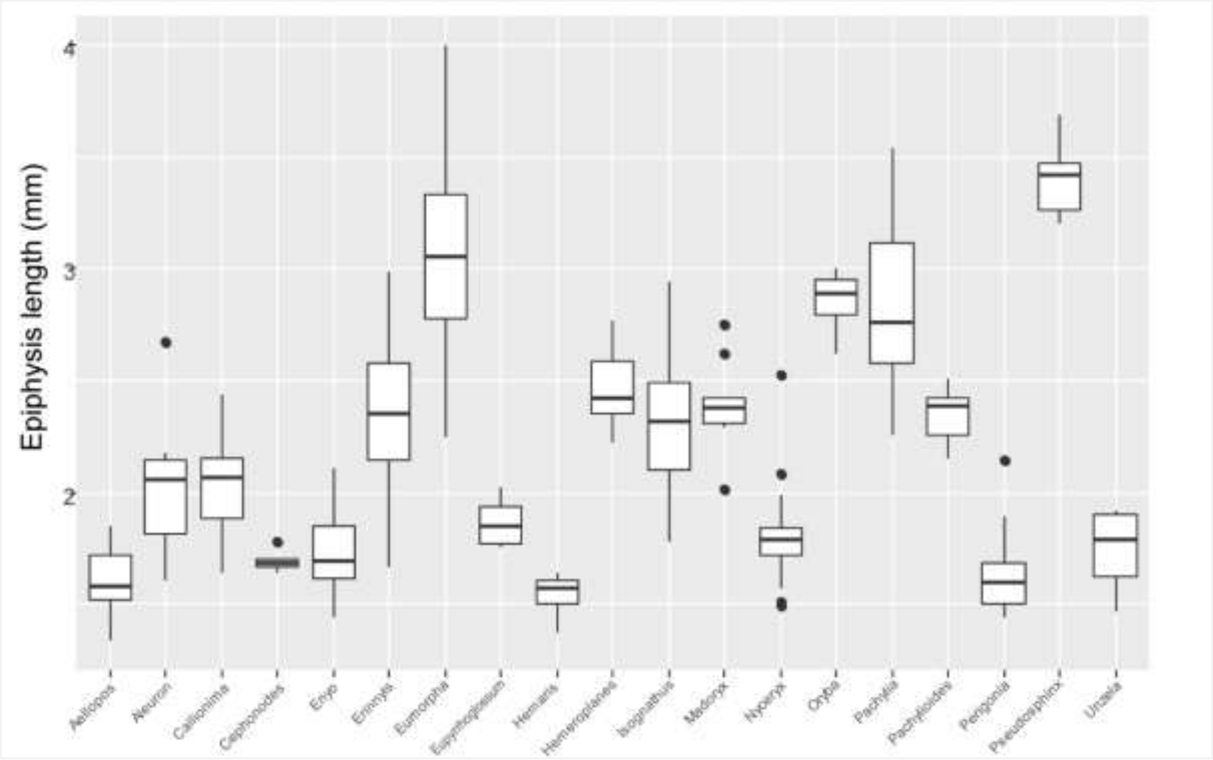


Figure 12. Boxplot of epiphysis length by genus. Dots indicate outliers.

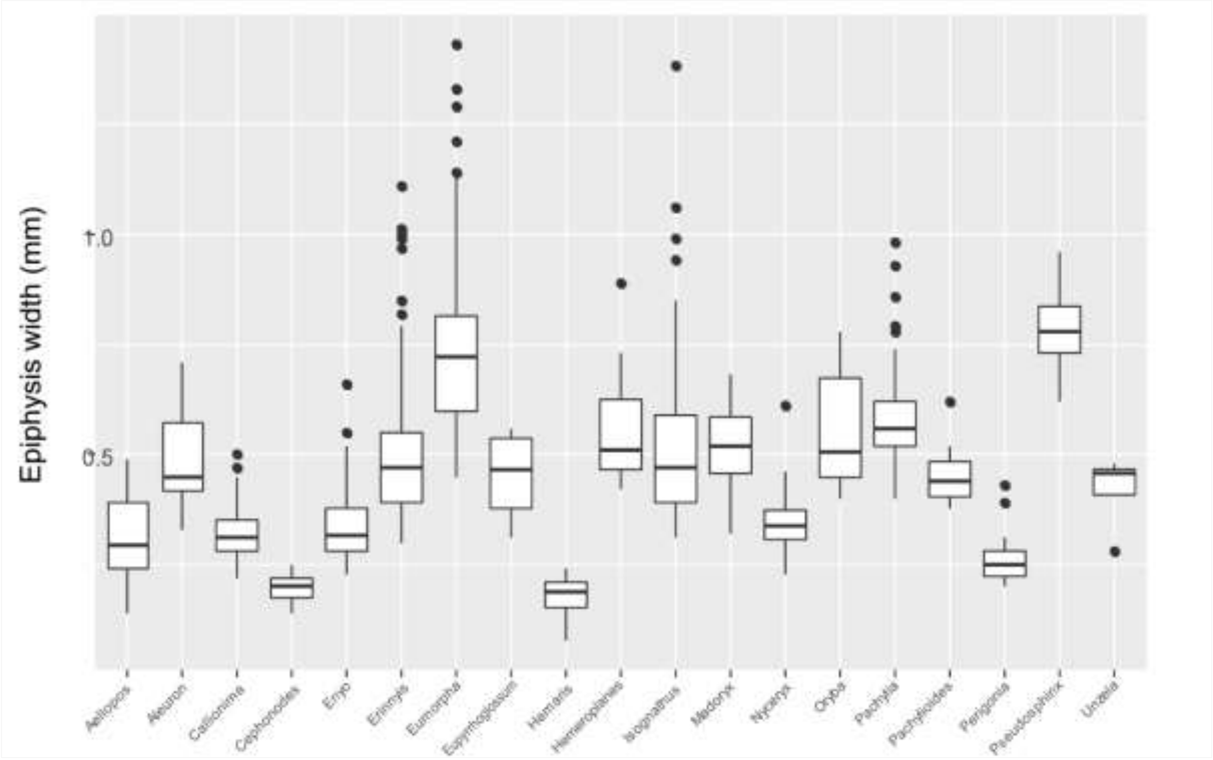


Figure 13. Boxplot of epiphysis width by genus. Dots indicate outliers.

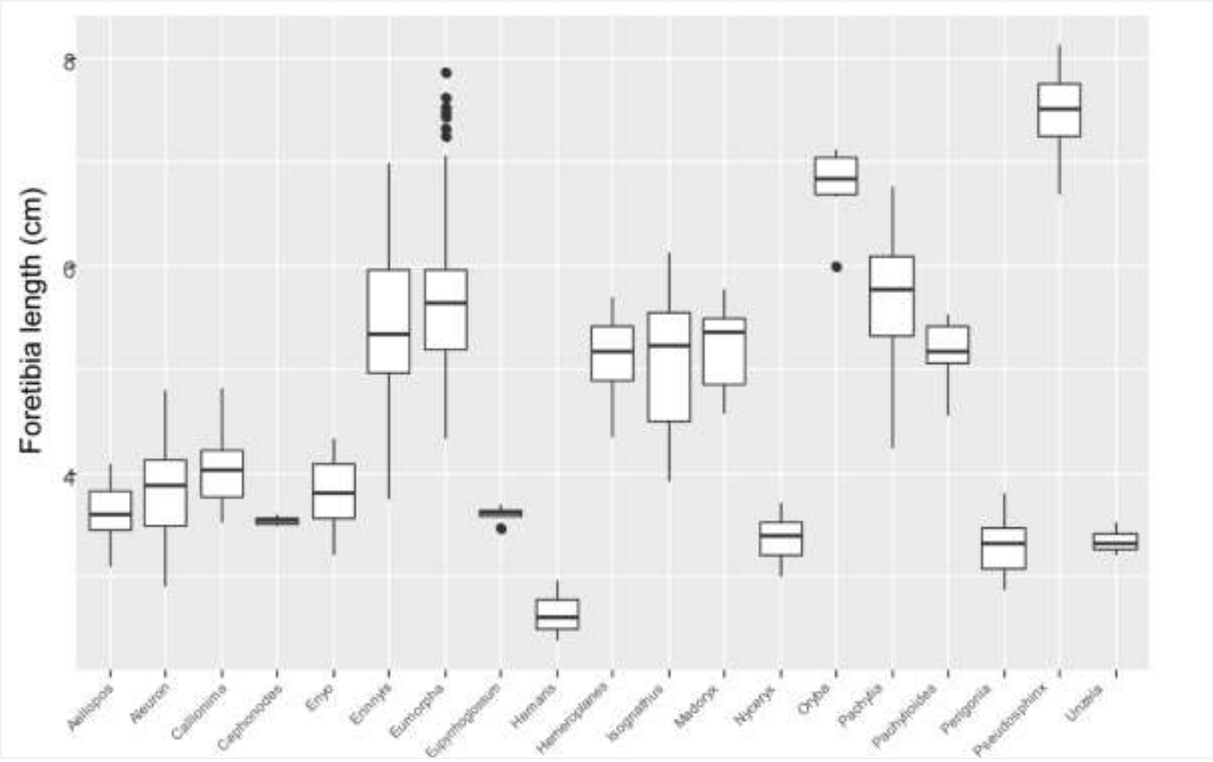


Figure 14. Boxplot of foretibia length by genus. Dots indicate outliers.

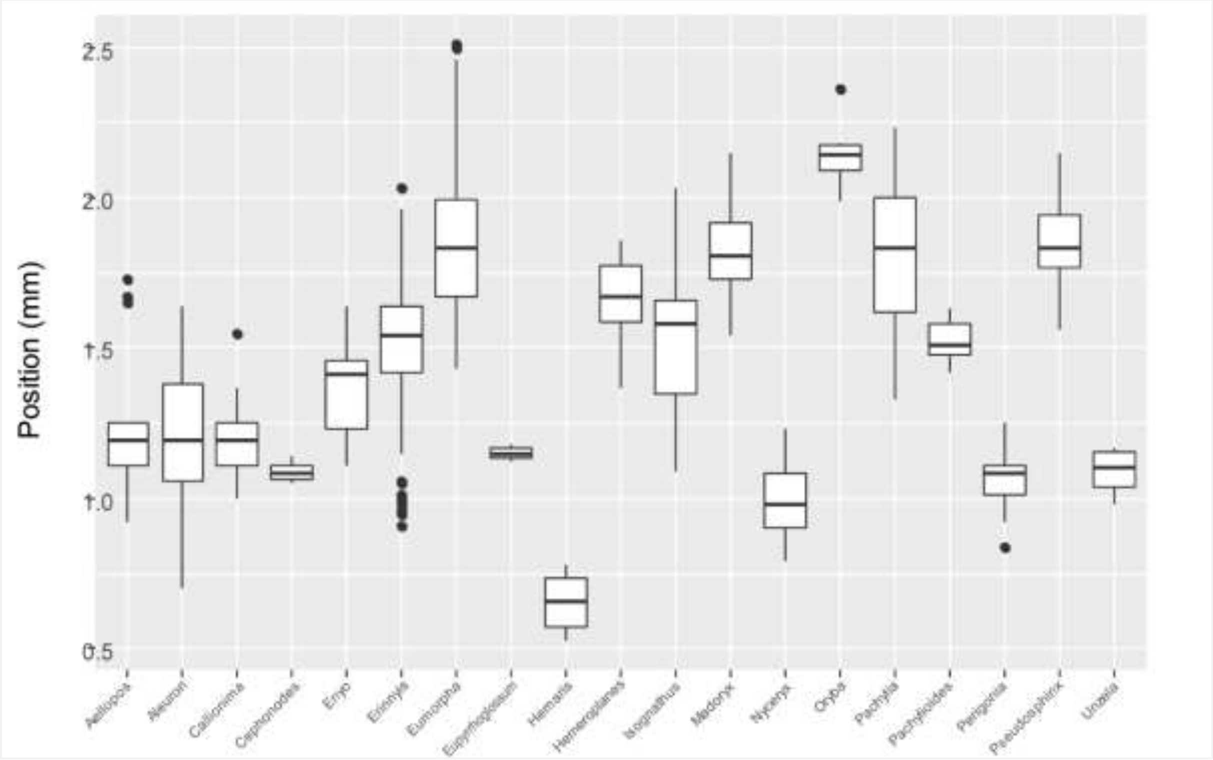


Figure 15. Boxplot of position on the foretibia by genus. Dots indicate outliers.

Table 5. Measurements by genera.

Genus	n	Epiphysis length (mm)		Epiphysis width (mm)		Position (mm)		Foretibia length (mm)	
		mean	sd	mean	sd	mean	sd	mean	sd
Cephonodes	4	1.695	0.060	0.198	0.046	1.090	0.039	3.548	0.048
Hemaris	4	1.540	0.119	0.175	0.068	0.655	0.115	2.658	0.252
Pachylia	45	2.817	0.329	0.589	0.124	1.812	0.239	5.722	0.556
Callionima	60	2.043	0.195	0.320	0.060	1.195	0.105	4.036	0.287
Nyceryx	36	1.791	0.187	0.345	0.070	0.985	0.119	3.387	0.187
Perigonia	23	1.622	0.158	0.266	0.061	1.057	0.088	3.314	0.255
Eupyrrhoglossum	4	1.865	0.124	0.450	0.116	1.150	0.026	3.605	0.097
Aellopos	14	1.590	0.164	0.314	0.103	1.250	0.253	3.620	0.293
Oryba	6	2.855	0.140	0.558	0.157	2.150	0.124	6.752	0.414
Pachylioides	15	2.349	0.109	0.455	0.066	1.525	0.065	5.170	0.290
Madoryx	10	2.363	0.230	0.517	0.101	1.820	0.169	5.223	0.406
Hemeroplanes	10	2.458	0.188	0.566	0.148	1.655	0.158	5.116	0.412
Erinnyis	105	2.364	0.316	0.512	0.169	1.503	0.231	5.355	0.752
Isognathus	45	2.301	0.274	0.544	0.226	1.510	0.226	5.079	0.582
Pseudosphinx	15	3.399	0.154	0.788	0.093	1.857	0.174	7.483	0.413
Aleuron	10	2.013	0.311	0.485	0.124	1.189	0.275	3.863	0.564
Unzela	4	1.743	0.212	0.418	0.093	1.090	0.088	3.355	0.140
Enyo	34	1.717	0.164	0.339	0.096	1.368	0.156	3.792	0.312
Eumorpha	120	3.073	0.391	0.737	0.186	1.865	0.250	5.697	0.710

Table 6. Measurements by species.

Species	n	Epiphysis length (mm)		Epiphysis width (mm)		Position (mm)		Foretibia length (mm)	
		mean	sd	mean	sd	mean	sd	mean	sd
Cephonodes hylas	4	1.695	0.060	0.198	0.046	1.090	0.039	3.548	0.048
Hemaris croatica	2	1.485	0.163	0.220	0.028	0.750	0.042	2.625	0.134
Hemaris diffinis	2	1.595	0.064	0.130	0.071	0.560	0.042	2.690	0.410
Pachylia darceta	15	2.604	0.204	0.601	0.147	1.726	0.163	5.748	0.443
Pachylia ficus	15	3.081	0.317	0.561	0.071	1.941	0.234	6.007	0.500
Pachylia syces	15	2.767	0.270	0.604	0.143	1.767	0.265	5.410	0.578
Callionima guiarti	15	1.869	0.119	0.293	0.033	1.134	0.073	3.759	0.109
Callionima innus	15	2.068	0.130	0.320	0.040	1.220	0.066	4.066	0.183
Callionima nomius	15	2.241	0.138	0.391	0.055	1.160	0.109	4.087	0.290
Callionima parce	15	1.993	0.178	0.277	0.036	1.267	0.115	4.230	0.302
Nyceryx alophus	4	1.693	0.136	0.270	0.045	0.960	0.041	3.183	0.143
Nyceryx continua continua	15	1.839	0.228	0.345	0.085	0.886	0.083	3.283	0.120
Nyceryx nictitans nictitans	15	1.769	0.159	0.368	0.046	1.063	0.070	3.521	0.138
Nyceryx stuarti	2	1.800	0.042	0.320	0.028	1.190	0.057	3.565	0.191
Perigonia lusca	2	1.820	0.099	0.340	0.071	1.170	0.113	3.765	0.078
Perigonia pallida	4	1.580	0.082	0.298	0.072	1.003	0.129	3.105	0.180
Perigonia passerina	2	1.800	0.481	0.350	0.113	1.055	0.092	3.265	0.361
Perigonia stulta	15	1.583	0.092	0.237	0.024	1.057	0.066	3.316	0.208
Eupyrrhoglossum sagra	4	1.865	0.124	0.450	0.116	1.150	0.026	3.605	0.097
Aellopos ceculus	4	1.565	0.183	0.250	0.037	1.085	0.079	3.368	0.278
Aellopos fadus	4	1.675	0.160	0.288	0.082	1.198	0.071	3.595	0.031
Aellopos tantalus	2	1.460	0.085	0.395	0.007	1.060	0.198	3.485	0.262
Aellopos titan	4	1.610	0.181	0.363	0.155	1.563	0.244	3.965	0.119
Oryba achemenides	2	2.890	0.028	0.660	0.170	2.035	0.064	7.005	0.106
Oryba kadeni	4	2.838	0.176	0.508	0.145	2.208	0.105	6.625	0.466
Pachylioides resumens	15	2.349	0.109	0.455	0.066	1.525	0.065	5.170	0.290
Madoryx bubastus	4	2.173	0.191	0.500	0.148	1.785	0.087	5.083	0.400

Table 6. Continuation.

Species	n	Epiphysis length (mm)		Epiphysis width (mm)		Position (mm)		Foretibia length (mm)	
		mean	sd	mean	sd	mean	sd	mean	sd
Madoryx oiclus	2	2.370	0.000	0.575	0.049	1.655	0.163	5.075	0.361
Madoryx plutonius	4	2.550	0.165	0.505	0.071	1.938	0.176	5.438	0.436
Hemeroplanes longistriga	2	2.435	0.092	0.810	0.113	1.640	0.057	5.115	0.276
Hemeroplanes ornatus	4	2.533	0.252	0.548	0.073	1.788	0.088	5.465	0.214
Hemeroplanes triptolemus	4	2.395	0.162	0.463	0.042	1.530	0.148	4.768	0.338
Erinnyis alope	15	2.689	0.196	0.657	0.164	1.647	0.115	6.130	0.409
Erinnyis crameri	15	2.244	0.123	0.503	0.135	1.615	0.121	5.278	0.287
Erinnyis ello	15	2.209	0.171	0.471	0.072	1.526	0.183	5.425	0.509
Erinnyis impunctata	15	2.234	0.196	0.407	0.060	1.449	0.112	5.028	0.280
Erinnyis lassauxii	15	2.779	0.155	0.689	0.239	1.689	0.134	6.192	0.309
Erinnyis obscura	15	1.942	0.139	0.367	0.033	1.072	0.137	4.055	0.237
Erinnyis oenotrus	15	2.455	0.151	0.490	0.084	1.525	0.104	5.381	0.366
Isognathus allamandae	15	1.988	0.115	0.375	0.038	1.244	0.130	4.357	0.223
Isognathus caricae	15	2.528	0.201	0.728	0.187	1.622	0.076	5.406	0.267
Isognathus menechus	15	2.388	0.118	0.529	0.239	1.664	0.152	5.475	0.322
Pseudosphinx tetrio	15	3.399	0.154	0.788	0.093	1.857	0.174	7.483	0.413
Aleuron carinata	2	2.415	0.361	0.615	0.021	1.550	0.127	4.625	0.247
Aleuron chloroptera	2	1.900	0.141	0.575	0.191	0.945	0.346	3.475	0.785
Aleuron iphis	4	1.945	0.245	0.395	0.065	1.195	0.210	3.850	0.349
Aleuron neglectum	2	1.860	0.354	0.445	0.049	1.060	0.014	3.515	0.332
Unzela japix discrepans	4	1.743	0.212	0.418	0.093	1.090	0.088	3.355	0.140
Enyo gorgon	4	1.968	0.132	0.328	0.041	1.375	0.058	3.898	0.184
Enyo lugubris	15	1.708	0.151	0.340	0.102	1.465	0.139	3.873	0.321
Enyo ocypete	15	1.659	0.124	0.341	0.105	1.268	0.127	3.683	0.311
Eumorpha analis	15	3.177	0.319	0.702	0.089	1.883	0.165	5.802	0.524
Eumorpha anchemolus	15	3.711	0.223	1.033	0.215	2.356	0.162	7.125	0.413
Eumorpha fasciatus	15	2.719	0.183	0.765	0.113	1.766	0.127	5.344	0.370

Table 6. Continuation.

Species	n	Epiphysis length (mm)		Epiphysis width (mm)		Position (mm)		Foretibia length (mm)	
		mean	sd	mean	sd	mean	sd	mean	sd
Eumorpha labruscae	15	3.019	0.203	0.614	0.068	1.923	0.118	5.613	0.303
Eumorpha megaeacus	15	2.947	0.150	0.755	0.139	1.815	0.156	5.495	0.379
Eumorpha obliquus	15	3.349	0.161	0.823	0.091	1.864	0.175	5.775	0.380
Eumorpha translineatus	15	3.093	0.178	0.695	0.113	1.669	0.111	5.539	0.346
Eumorpha vitis	15	2.566	0.179	0.509	0.059	1.647	0.118	4.885	0.294

3.1.3. Description of the epiphyses

All the representatives of Dilophonotini and Philampelini here studied have an epiphysis on each foretibia; all of them are covered by acanthae on its surface. Epiphyses are well developed and bear a strong comb on the inner margin (im). Despite having these general characteristics, they may be either sexually dimorphic and show variation among genera and species. All the characters and measurements are available in Appendices C and D, respectively.

3.1.3.1. *Cephonodes hylas* (Linnaeus, 1771)

(Figures 16, 75)

Average length and width of the epiphysis in males: 1.660 ± 0.025 mm long and 0.220 ± 0.043 mm wide (n = 2), in females: 1.725 ± 0.071 mm long and 0.174 ± 0.053 mm wide (n = 2). Elongated in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia straight, lobeless, and without invagination. Inner margin spineless, lacking tubercles. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the medial of the epiphysis.

The epiphyses are sexually dimorphic considered the following features: i) outer margin surface with spinules in male, and with erect spines in female; ii) inner margin surface smooth in male, and striated in female.

In relation to the acanthae, they are curve-shaped, narrowed towards the tip, bent and regular tip, showing projections serrated.

Average foretibiae length in: (♂) 3.511 ± 0.029 mm, (♀) 3.582 ± 0.022 mm.

3.1.3.2. *Hemaris diffinis* (Boisduval, 1836)

(Figs. 17, 76)

Average length and width of the epiphysis in male: 1.643 mm long and 0.080 mm wide (n = 1), in female: 1.552 mm long and 0.176 mm wide (n = 1). Elongated in both sexes and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, without lower lobe and invagination. Outer margin with spinules. Inner margin lacking tubercles. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) upper lobe rounded in male, and subtriangular in female; ii) inner margin surface smooth in male, and striated in female; iii) inner margin lacking spines in male, and with spines in female.

In relation to the acanthae, there is sexual dimorphism. They have regular tip in male, and dilated tip in female.

Average foretibiae length in: (♂) 2.984 mm, (♀) 2.401 mm.

3.1.3.3. *Hemaris croatica* (Esper, 1800)

(Fig. 18)

Average length and width of the epiphysis in male: 1.604 mm long and 0.196 mm wide (n = 1), in female: 1.372 mm long and 0.237 mm wide (n = 1). Elongated in in both sexes, and apically placed at about two sevenths of the foretibia length**.** Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Invagination “v-notched” and slightly accentuated. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) lower lobe subtriangular in male, and rounded in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 2.715 mm, (♀) 2.532 mm.

3.1.3.4. *Pachylia darceta* Druce, 1881

(Figs. 19, 77)

Average length and width of the epiphysis in males: 2.491 ± 0.139 mm long and 0.531 ± 0.051 mm wide (n = 8), in females: 2.732 ± 0.198 mm long and 0.680 ± 0.182 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes straight in males. Lower lobe rounded, sometimes rounded with crested margin in males. Lower lobe spineless. Invagination “v-notched” or “u-notched”. Invagination slightly accentuated. Invagination spineless. Outer margin surface spiny with erect spines. Inner margin smooth and lacking tubercles. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) inner margin surface striated in males, and smooth in females.

In relation to the acanthae, there is sexual dimorphism. They are curved with bent tip in male, and straight with straight tip in female.

Average foretibiae length in: (♂) 5.459 ± 0.281 mm, (♀) 6.081 ± 0.354 mm.

3.1.3.5. *Pachylia ficus* (Linnaeus, 1758)

(Fig. 20)

Average length and width of the epiphysis in males: 3.328 ± 0.140 mm long and 0.605 ± 0.067 mm wide (n = 8), in females: 2.794 ± 0.186 mm long and 0.512 ± 0.032 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length.

Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe truncated, sometimes with crested margin in females or presenting two lobes in males. Invagination strongly accentuated, sometimes slightly accentuated in females. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following feature: i) invagination "v-notched" in males, and "u-notched" in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 6.068 ± 0.627 mm, (♀) 5.936 ± 0.337 mm.

3.1.3.6. *Pachylia syces* (Hübner, [1819])

(Fig. 21)

Average length and width of the epiphysis in males: 2.818 ± 0.338 mm long and 0.569 ± 0.107 mm wide (n = 8), in females: 2.705 ± 0.643 mm long and 0.643 ± 0.175 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes straight in females. Lower lobe rounded, sometimes rounded with crested margin in males or truncated in females. Lower lobe spineless. Invagination "v-notched", sometimes "u-notched" in females. Invagination slightly or strongly accentuated. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.106 ± 0.492 mm, (♀) 5.756 ± 0.482 mm.

3.1.3.7. *Callionima guiarti* (Debauche, 1934)

(Fig. 22)

Average length and width of the epiphysis in males: 1.959 ± 0.099 mm long and 0.308 ± 0.014 mm wide (n = 8), in females: 1.776 ± 0.059 mm long and 0.278 ± 0.042 mm wide (n = 7). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes subtriangular in females. Lower lobe truncated or rounded. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in males, and one third of the foretibia length in females; ii) invagination "u-notched" in males, and "v-notched" in females; iii) slightly accentuated invagination in males, strongly accentuated invagination in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.758 ± 0.142 mm, (♀) 3.758 ± 0.067 mm.

3.1.3.8. *Callionima innus* Rothschild & Jordan, 1903

(Fig. 23)

Average length and width of the epiphysis in males: 2.083 ± 0.139 mm long and 0.328 ± 0.040 mm wide (n = 9), in females: 2.049 ± 0.133 mm long and 0.306 ± 0.040 mm wide (n = 6). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Invagination "v-notched". Invagination slightly accentuated. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following feature: i) epiphyses apically placed at about two sevenths of the foretibia length in males, and one third of the foretibia length in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.120 ± 0.146 mm, (♀) 3.987 ± 0.217 mm.

3.1.3.9. *Callionima nomius* (Walker, 1856)

(Fig. 24)

Average length and width of the epiphysis in males: 2.207 ± 0.144 mm long and 0.372 ± 0.042 mm wide (n = 8), in females: 2.280 ± 0.130 mm long and 0.410 ± 0.065 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Invagination “u-notched”. Invagination strongly accentuated, sometimes slightly in females. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.926 ± 0.246 mm, (♀) 4.270 ± 0.228 mm.

3.1.3.10. *Callionima parce* (Fabricius, 1775)

(Figs. 25, 78)

Average length and width of the epiphysis in males: 2.131 ± 0.066 mm long and 0.291 ± 0.039 mm wide (n = 8), in females: 1.838 ± 0.125 mm long and 0.262 ± 0.022 mm wide (n = 7). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe truncated or rounded. Lower lobe spineless. Invagination “u-notched”, sometimes “v-notched” in females. Invagination slightly or strongly accentuated. Invagination spineless. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in males, and one third of the foretibia length in females; ii) outer margin surface with spatulate projection in male, and spiny with erect spines in female; iii) inner margin surface smooth in male, and spiny plates in female; iv) inner margin smooth in male, and with spines in female; v) inner margin lacking tubercles in male, and with tubercles in female.

In relation to the acanthae, there is sexual dimorphism. They have regular tip in male and, they have dilated tip in female.

Average foretibiae length in: (♂) 4.329 ± 0.164 mm, (♀) 4.115 ± 0.391 mm.

3.1.3.11. *Nyceryx alophus* (Boisduval, [1875])

(Fig. 26)

Average length and width of the epiphysis in males: 1.757 ± 0.110 mm long and 0.305 ± 0.037 mm wide (n = 2), in females: 1.633 ± 0.168 mm long and 0.238 ± 0.007 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded, sometimes truncated in males. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) invagination “u-notched” in males, “v-notched” in females; ii) invagination slightly accentuated in males, and strongly accentuated in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.183 ± 0.002 mm, (♀) 3.183 ± 0.251 mm.

3.1.3.12. *Nyceryx continua continua* (Walker, 1856)

(Fig. 26)

Average length and width of the epiphysis in males: 1.890 ± 0.257 mm long and 0.325 ± 0.028 mm wide (n = 10), in females: 1.734 ± 0.107 mm long and 0.385 ± 0.144 mm wide (n = 5). Lanceolate in both sexes, and apically placed at about one quarter of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes straight in males. Invagination "u-notched", sometimes "v-notched" in males. Invagination slightly accentuated, sometimes strongly accentuated in males. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) lower lobe rounded in males, and straight in females; ii) color of lower posterior region half-black apical in males, and uniformly colored in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.269 ± 0.107 mm, (♀) 3.311 ± 0.152 mm.

3.1.3.13. *Nyceryx nictitans nictitan*s Boisduval, [1875]

(Figs. 28, 79)

Average length and width of the epiphysis in males: 1.854 ± 0.080 mm long and 0.377 ± 0.046 mm wide (n = 10), in females: 1.595 ± 0.136 mm long and 0.350 ± 0.048 mm wide (n = 5). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Lower lobe rounded, sometimes straight in males. Lower lobe spineless. Invagination "u-notched", sometimes "v-notched" in males. Invagination slightly accentuated. Invagination spineless. Inner margin with spiny plates and lacking tubercles. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in males, and one third of the foretibia length in females; ii) upper lower rounded in males, and straight or subtriangular in females; iii) outer margin surface spiny with erect spines in male, and spiny with decumbent spines in female.

In relation to the acanthae, there is sexual dimorphism. They are narrowed towards the tip, with dilated tip and markedly serrated projections in male, and not narrowed towards the tip, regular tip and serrated projections in female.

Average foretibiae length in: (♂) 3.562 ± 0.120 mm, (♀) 3.439 ± 0.148 mm.

3.1.3.14. *Nyceryx stuarti* (Rothschild, 1894)

(Fig. 29)

Average length and width of the epiphysis in male: 1.834 mm long and 0.298 mm wide (n = 1), in female: 1.775 mm long and 0.337 mm wide (n = 1). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe subtriangular. Lower lobe rounded. Invagination slightly accentuated. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) invagination “u-notched” in males, and “v-notched” in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.699 mm, (♀) 3.431 mm.

3.1.3.15. *Perigonia lusca* (Fabricius, 1777)

(Fig. 30)

Average length and width of the epiphysis in male: 1.889 mm long and 0.386 mm wide (n = 1), in female: 1.750 mm long and 0.291 mm wide (n = 1). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Invagination “v-notched”. Invagination slightly accentuated. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) epiphyses apically placed at about two sevenths of the foretibia length in males, and one third of the foretibia length in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.710 mm, (♀) 3.815 mm.

3.1.3.16. *Perigonia pallida* Rothschild & Jordan, 1903

(Fig. 31)

Average length and width of the epiphysis in males: 1.631 ± 0.081 mm long and 0.290 ± 0.022 mm wide (n = 2), in females: 1.530 ± 0.057 mm long and 0.309 ± 0.120 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Lower lobe rounded. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) upper lobe subtriangular, and straight in females; ii) invagination “u-notched” in males, and “v-notched” in females; iii) invagination slightly accentuated in males, and strongly accentuated in females; iv) color of lower posterior half-black apical in male, and uniformly colored in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 2.967 ± 0.131 mm, (♀) 3.246 ± 0.029 mm.

3.1.3.17. *Perigonia passerina* Boisduval, [1875]

(Fig. 32)

Average length and width of the epiphysis in male: 2.141 mm long and 0.434 mm wide (n = 1), in female: 1.456 mm long and 0.269 mm wide (n = 1). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Invagination strongly accentuated. The macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and three eighths of the foretibia length in female; ii) lower lobe truncated in male, and curved in female; iii) invagination “v-notched” in males, and “u-notched” in females; iv) color of lower posterior with black apex in male, and uniformly colored in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.524 mm, (♀) 3.007 mm.

3.1.3.18. *Perigonia stulta* Herrich-Schäffer, [1854]

(Figs. 33, 80)

Average length and width of the epiphysis in males: 1.617 ± 0.073 mm long and 0.299 ± 0.019 mm wide (n = 10), in females: 1.515 ± 0.096 mm long and 0.248 ± 0.030 mm wide (n = 5). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes subtriangular in males. Lower lobe rounded or truncated, sometimes rounded lobe with crested margin in females. Lower lobe spineless. Invagination “u-notched” or “v-notched”. Invagination slightly or strongly accentuated. Invagination spineless. Outer margin spiny with erect spines. Inner margin striated and lacking tubercles. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis or restrict to the upper region.

The epiphyses are sexually dimorphic considering the following feature: i) inner margin surface spineless in male, and with spines in female.

In relation to the acanthae, there is sexual dimorphism. They are straight in male, and curved in female.

Average foretibiae length in: (♂) 3.341 ± 0.177 mm, (♀) 3.262 ± 0.278 mm.

3.1.3.19. *Eupyrrhoglossum sagra* (Poey, 1832)

(Figs. 34, 81)

Average length and width of the epiphysis in males: 1.967 ± 0.080 mm long and 0.479 ± 0.114 mm wide (n = 2), in females: 1.1763 ± 0.017 mm long and 0.420 ± 0.161 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes subtriangular in males. Lower lobe spineless. Invagination “v-notched”. Invagination spineless. Inner margin striated. Inner margin smooth and lacking tubercles. Uniformly colored. Macula situated on the outer is restrict to the upper region.

The epiphyses are sexually dimorphic considering the following features: i) lower lobe truncated in males, and straight in females; ii) invagination strongly accentuated in males, and slightly accentuated in females; iii) outer margin surface striated in male, and spiny with decumbent spines in female.

In relation to the acanthae, there is sexual dimorphism. They are narrowed towards the tip, dilated tip and markedly-serrated projections in male, and not narrowed towards the tip, regular tip and serrated projections in female.

Average foretibiae length in: (♂) 3.661 ± 0.057 mm, (♀) 3.548 ± 0.117 mm.

3.1.3.20. *Aellopos ceculus* (Cramer, 1777)

(Figure 35)

Average length and width of the epiphysis in males: 1.696 ± 0.137 mm long and 0.272 ± 0.036 mm wide (n = 2), in females: 1.530 ± 0.057 mm long and 0.309 ± 0.120 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe straight. Lower lobe rounded. Invagination "u-notched". Invagination slightly accentuated. Uniformly colored. Macula situated on the outer is restrict to the upper region.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.470 ± 0.373 mm, (♀) 3.266 ± 0.236 mm.

3.1.3.21. *Aellopos fadus* (Cramer, 1775)

(Figs. 36, 82)

Average length and width of the epiphysis in males: 1.685 ± 0.228 mm long and 0.341 ± 0.073 mm wide (n = 2), in females: 1.668 ± 0.147 mm long and 0.236 ± 0.060 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe truncated. Invagination slightly accentuated. Invagination with spines. Outer margin spiny with erect spines. Inner margin with spiny projections. Inner margin with spines and lacking tubercles. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) lower lobe with spines in male, and spineless in female; ii) invagination “v-notched” in males, and “u-notched” in females; iii) color of lower posterior region with black apex in males, and uniformly colored in females.

In relation to the acanthae, there is sexual dimorphism. They are straight, narrowed towards the tip and straight tip in male, and curved, not narrowed towards the tip and bent tip in female.

Average foretibiae length in: (♂) 3.578 ± 0.039 mm, (♀) 3.610 ± 0.015 mm.

3.1.3.22. *Aellopos tantalus* (Linnaeus, 1758)

(Fig. 37)

Average length and width of the epiphysis in male: 1.518 mm long and 0.398 mm wide (n = 1), in female: 1.402 mm long and 0.386 mm wide (n = 1). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Invagination “u-notched”. Invagination slightly accentuated. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one third of the foretibia length in female; ii) color of lower posterior region uniformly colored in male, and with black apex in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.301 mm, (♀) 3.665 mm.

3.1.3.23. *Aellopos titan* (Cramer, 1777)

(Fig. 38)

Average length and width of the epiphysis in males: 1.716 ± 0.012 mm long and 0.466 ± 0.032 mm wide (n = 2), in females: 1.504 ± 0.235 mm long and 0.261 ± 0.173 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about three sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Invagination slightly accentuated. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following feature: i): invagination "v-notched" in males, and "u-notched" in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.984 ± 0.157 mm, (♀) 3.944 ± 0.121 mm.

3.1.3.24. *Oryba achemenides* (Cramer, 1779)

(Fig. 39)

Average length and width of the epiphysis in male: 2.909 mm long and 0.777 mm wide (n = 1), in female: 2.866 mm long and 0.536 mm wide (n = 1). Spoon-shaped in both sexes, and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) invagination "u-notched" in male, "v-notched" in female; ii) invagination strongly accentuated in male, and slightly accentuated in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 7.080 mm, (♀) 6.930 mm.

3.1.3.25. *Oryba kadeni* (Schaufuss, 1870)

(Figs. 40, 83)

Average length and width of the epiphysis in males: 2.885 ± 0.165 mm long and 0.592 ± 0.175 mm wide (n = 2), in females: 2.790 ± 0.247 mm long and 0.416 ± 0.028 mm wide (n = 2). Epiphysis apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes subtriangular in females. Lower lobe spineless. Invagination "u-notched", sometimes "v-notched" in females. Invagination strongly accentuated. Invagination spineless. Outer margin spiny with decumbent spines. Inner margin striated. Inner margin spineless and lacking tubercles. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) epiphysis spoon-shaped in males, and lanceolate in females; ii) lower lobe truncated in males, and rounded in females.

In relation to the acanthae; they are straight, not narrowed towards the tip, straight and regular tip, and almost without projections.

Average foretibiae length in: (♂) 6.701 ± 0.040mm, (♀) 6.551 ± 0.790 mm.

3.1.3.26. *Pachylioides resumens* (Walker, 1856)

(Figs. 41, 84)

Average length and width of the epiphysis in males: 2.389 ± 0.064 mm long and 0.434 ± 0.041 mm wide (n = 8), in females: 2.302 ± 0.137 mm long and 0.481 ± 0.083 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded, sometimes truncated in females. Lower lobe spineless. Invagination “u-notched”. Invagination slightly or strongly accentuated. Invagination spineless. Invagination spineless. Outer margin spiny with erect spines. Inner margin striated. Inner margin lacking tubercles. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following feature: i) inner margin surface with spines in male, and smooth in female.

In relation to the acanthae, they are curved with serrated projections in male, and straight with vestigial projections in female.

Average foretibiae length in: (♂) 5.277 ± 0.311, (♀) 5.104 ± 0.271 mm.

3.1.3.27. *Madoryx bubastus* (Cramer, 1777)

(Fig. 42)

Average length and width of the epiphysis in males: 2.194 ± 0.265 mm long and 0.579 ± 0.137 mm wide (n = 2), in females: 2.150 ± 0.198 mm long and 0.424 ± 0.141 mm wide (n = 2). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Lower lobe rounded or truncated. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about one third of the foretibia length in male, and three eighths of the foretibia length in female; ii) upper lobe rounded in males, straight in females; iii) invagination “v-notched” in males, and “u-notched” in females; iv) invagination strongly accentuated in males, and slightly accentuated in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.982 ±0.576, (♀) 5.188 ±0.317 mm.

3.1.3.28. *Madoryx plutonius* (Hübner, [1819])

(Figs. 43, 85)

Average length and width of the epiphysis in males: 2.683 ± 0.092 mm long and 0.559 ± 0.056 mm wide (n = 2), in females: 2.418 ± 0.010 mm long and 0.452 ± 0.004 mm wide (n = 2). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes straight in males. Lower lobe rounded. Lower lobe spineless. Invagination “u-notched”. Invagination slightly accentuated, sometimes strongly accentuated in males. Invagination spineless. Outer margin spiny with erect spines. Inner margin smooth and lacking tubercles. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about one third of the foretibia length in male, and three eighths of the foretibia length in female; ii) inner margin surface striated in male, and scaled surface forming irregular processes in female.

In relation to the acanthae, they are straight, narrowed towards the tip, straight and regular tip, and with serrated projections.

Average foretibiae length in: (♂) 4.824 mm, (♀) 5.327 mm.

3.1.3.29. *Madoryx oiclus* (Cramer, 1779)

(Fig. 44)

Average length and width of the epiphysis in male: 2.366 mm long and 0.540 mm wide (n = 1), in female: 2.373 mm long and 0.612 mm wide (n =1). Lanceolate in both sexes, and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Invagination “u-notched.” Invagination slightly accentuated. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) lower lobe rounded in males, and truncated in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.651 ± 0.166, (♀) 5.226 ± 0.606 mm.

3.1.3.30. *Hemeroplanes longistriga* (Rothschild & Jordan, 1903)

(Fig. 45)

Average length and width of the epiphysis in male: 2.366 mm long and 0.540 mm wide (n = 1), in female: 2.373 mm long and 0.612 mm wide (n =1). Lanceolate in both sexes, and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Invagination “u-notched”. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) lower lobe rounded in males, and truncated in females; ii) invagination strongly accentuated in male, and slightly accentuated in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.311, (♀) 4.919 mm.

3.1.3.31. *Hemeroplanes ornatus* Rothschild, 1894

(Figs. 46, 86)

Average length and width of the epiphysis in males: 2.735 ± 0.050 mm long and 0.605 ± 0.052 mm wide (n = 2), in females: 2.329 ± 0.156 mm long and 0.487 ± 0.015 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about one third of the foretibia length.

Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe truncated, sometimes rounded in males. Lowe lobe spineless. Invagination "u-notched". Invagination strongly accentuated, sometimes slightly accentuated in females. Invagination spineless. Outer margin spiny with erect spines. Inner margin scaled forming hexagons. Inner margin smooth and lacking tubercles. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

In relation to the acanthae, they are straight and dilated tip in male, and bent and regular tip in female.

Average foretibiae length in: (♂) 5.498 ± 0.066, (♀) 5.432 ± 0.361 mm.

3.1.3.32. *Hemeroplanes triptolemus* (Cramer, 1779)

(Fig. 47)

Average length and width of the epiphysis in males: 2.480 ± 0.181 mm long and 0.487 ± 0.045 mm wide (n = 2), in females: 2.309 ± 0.121 mm long and 0.432 ± 0.021 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded, sometimes truncated in males. Invagination "v-notched". Invagination strongly accentuated. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.914 ± 0.345, (♀) 4.620 ± 0.371 mm.

3.1.3.33. *Erinnyis alope* (Drury, 1773)

(Fig. 48)

Average length and width of the epiphysis in males: 2.806 ± 0.098 mm long and 0.659 ± 0.188 mm wide (n = 8), in females: 2.556 ± 0.199 mm long and 0.653 ± 0.146 mm wide (n = 7). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded, sometimes truncated in females. Invagination “u-notched”, sometimes “v-notched” in males. Invagination strongly accentuated, sometimes slightly accentuated in females. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis, sometimes is restricted to the upper area in males.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about one quarter of the foretibia length in male, and two sevenths of the foretibia length in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 6.162 ± 0.200, (♀) 6.093 ± 0.584 mm.

3.1.3.34. *Erinnyis crameri* (Schaus, 1898)

(Fig. 49)

Average length and width of the epiphysis in males: 2.311 ± 0.084 mm long and 0.580 ± 0.135 mm wide (n = 8), in females: 2.168 ± 0.116 mm long and 0.416 ± 0.059 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded, sometimes subtriangular in females. Lower lobe rounded sometimes with crested margin. Invagination “v-notched”, sometimes “u-notched” in males. Invagination strongly accentuated, sometimes slightly accentuated in females. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.247 ± 0.333, (♀) 5.315 ± 0.249 mm.

3.1.3.35. *Erinnyis ello* (Linnaeus, 1758)

(Fig. 50)

Average length and width of the epiphysis in males: 2.275 ± 0.165 mm long and 0.468 ± 0.056 mm wide (n = 8), in females: 2.128 ± 0.154 mm long and 0.474 ± 0.092 mm wide (n = 7). Lanceolate in both sexes. Margin of the foretibia sinuous, with both lobes. Upper lobe rounded. Invagination "v-notched", sometimes u-notched in males. Invagination strongly accentuated, sometimes slightly accentuated in females. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis, sometimes is restricted to the upper area in males. Medial macula with little sclerotization.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about one quarter of the foretibia length in male, and two sevenths of the foretibia length in female; ii) lower lobe rounded in males, and truncated in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.413 ± 0.452, (♀) 5.437 ± 0.604 mm.

3.1.3.36. *Erinnyis impunctata* Rothschild & Jordan, 1903

(Fig. 51)

Average length and width of the epiphysis in males: 2.339 ± 0.163 mm long and 0.446 ± 0.047 mm wide (n = 8), in females: 2.112 ± 0.164 mm long and 0.361 ± 0.039 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about two sevenths of the foretibia length. Margin of the foretibia sinuous, with both lobes. Invagination "v-notched", sometimes "u-notched" in males. Invagination slightly accentuated, sometimes strongly accentuated in males. Uniformly colored.

The epiphyses are sexually dimorphic considering the following features: i) upper lobe rounded in males, and straight in females; ii) lower lobe rounded in males, and subtriangular in females; iii) macula situated on the outer margin is restricted to the upper area in males, and it extending over the entire margin until it reaches the middle of the epiphysis in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.010 ± 0.221, (♀) 5.050 ± 0.354 mm.

3.1.3.37. *Erinnyis lassauxii* (Boisduval, 1859)

(Fig. 52)

Average length and width of the epiphysis in males: 2.856 ± 0.140 mm long and 0.731 ± 0.234 mm wide (n = 9), in females: 2.664 ± 0.095 mm long and 0.627 ± 0.253 mm wide (n = 6). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe rounded, sometimes straight in females. Lower lobe rounded, sometimes rounded with crested margin in females. Invagination "v-notched" or "u-notched". Invagination slightly accentuated, sometimes strongly accentuated in males. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis, sometimes is restricted to the upper area in males.

The epiphyses are sexually dimorphic considering the following feature: i) epiphyses apically placed at about one quarter of the foretibia length in male, and two sevenths of the foretibia length in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 6.176 ± 0.366, (♀) 6.215 ± 0.225 mm.

3.1.3.38. *Erinnyis obscura* (Fabricius, 1775)

(Fig. 53)

Average length and width of the epiphysis in males: 2.043 ± 0.087 mm long and 0.387 ± 0.024 mm wide (n = 8), in females: 1.827 ± 0.086 mm long and 0.346 ± 0.032 mm wide (n = 7). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded, sometimes truncated in males. Invagination “v-notched”, sometimes “u-notched” in females. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about one quarter of the foretibia length in male, and two sevenths of the foretibia length in female, ii) invagination slightly accentuated in males, and strongly accentuated in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.025 ± 0.115, (♀) 4.088 ± 0.337 mm.

3.1.3.39. *Erinnyis oenotrus* (Cramer, 1780)

(Figs. 54, 87)

Average length and width of the epiphysis in males: 2.493 ± 0.106 mm long and 0.530 ± 0.081 mm wide (n = 8), in females: 2.409 ± 0.190 mm long and 0.442 ± 0.062 mm wide (n = 7). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded, sometimes truncated in males. Lowe lobe spineless. Invagination “u-notched”, sometimes “v-notched” in males. Invagination strongly accentuated, sometimes slightly accentuated in females. Invagination spineless. Outer margin spiny with erect spines. Inner margin scaled forming irregular processes. Inner margin smooth and lacking tubercles. Uniformly colored. Macula situated on the outer margin is restricted to the upper area, sometimes it extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one third of the foretibia length in female.

In relation to the acanthae, there is sexual dimorphism. They have dilated tip and markedly-serrated projections in male, and regular tip and serrated projections in female.

Average foretibiae length in: (♂) 5.421 ± 0.354, (♀) 5.335 ± 0.400 mm.

3.1.3.40. *Isognathus allamandae* Clark, 1920

(Fig. 55)

Average length and width of the epiphysis in males: 2.069 ± 0.044 mm long and 0.399 ± 0.029 mm wide (n = 8), in females: 1.895 ± 0.101 mm long and 0.349 ± 0.023 mm wide (n = 7). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded, sometimes truncated in males. Invagination "u-notched", sometimes v-notched in females. Invagination strongly accentuated, sometimes slightly accentuated in females. Uniformly colored. Macula situated on the outer margin is restricted to the upper area, sometimes it extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one third of the foretibia length in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.256 ± 0.204, (♀) 4.469 ± 0.197 mm.

3.1.3.41. *Isognathus caricae* (Linnaeus, 1758)

(Fig. 56)

Average length and width of the epiphysis in males: 2.654 ± 0.168 mm long and 0.691 ± 0.154 mm wide (n = 8), in females: 2.384 ± 0.128 mm long and 0.771 ± 0.224 mm wide (n = 7). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded, sometimes rounded with crested margin in males. Invagination “v-notched”, sometimes “u-notched” in males. Invagination strongly accentuated, sometimes slightly accentuated in males. Uniformly colored. Macula situated on the outer margin is restricted to the upper area, sometimes it extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one third of the foretibia length in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.525 ± 0.274, (♀) 5.270 ± 0.195 mm.

3.1.3.42. *Isognathus menechus* (Boisduval, [1875])

(Figs. 57, 88)

Average length and width of the epiphysis in males: 2.387 ± 0.095 mm long and 0.488 ± 0.023 mm wide (n = 8), in females: 2.391 ± 0.148 mm long and 0.573 ± 0.059 mm wide (n = 7). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Lowe lobe spineless. Invagination “u-notched”, sometimes “v-notched” in females. Invagination strongly accentuated. Invagination spineless. Inner margin scaled forming irregular processes. Inner margin smooth and lacking tubercles. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one third of the foretibia length in female, ii) outer margin surface spiny with erect spines in male, and spiny with decumbent spines in female.

In relation to the acanthae, they are curved, not narrowed towards the tip, bent and regular tip, and markedly-serrated projections.

Average foretibiae length in: (♂) 5.410 ± 0.333, (♀) 5.547 ± 0.314 mm.

3.1.3.43. *Pseudosphinx tetrio* (Linnaeus, 1771)

(Figs. 58, 89)

Average length and width of the epiphysis in males: 3.436 ± 0.190 mm long and 0.808 ± 0.075 mm wide (n = 8), in females: 3.356 ± 0.097 mm long and 0.765 ± 0.114 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one quarter of the foretibia length. Margin of the foretibia sinuous, with both lobes. Lower lobe truncated, sometimes rounded in males. Lower lobe spineless. Invagination "u-notched", sometimes "v-notched" in males. Invagination strongly accentuated and spineless. Outer margin spiny with erect spines. Inner margin scaled forming irregular processes. Inner margin smooth and lacking tubercles. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) upper lobe rounded and sometimes subtriangular in males, and straight in females

In relation to the acanthae. There is sexual dimorphism. They are narrowed towards the tip, well-dilated tip and markedly-serrated projections in male, and not narrowed towards the tip, regular tip and serrated projections in female.

Average foretibiae length in: (♂) 7.378 ± 0.364, (♀) 7.603 ± 0.464 mm.

3.1.3.44. *Aleuron carinata* (Walker, 1856)

(Fig. 59)

Average length and width of the epiphysis in male: 2.671 mm long and 0.598 mm wide (n = 1), in female: 2.162 mm long and 0.633 mm wide (n = 1). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about one third of the foretibia length in male, and three eighths of the foretibia length in female; ii) upper lobe straight in male, and rounded in female; iii) lower lobe subtriangular in male, and rounded in female; iv) invagination “u-notched” in male, and “v-notched” in female; v) invagination strongly accentuated in male, and slightly accentuated in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.796 mm, (♀) 4.453 mm.

3.1.3.45. *Aleuron chloroptera* (Perty, [1833])

(Fig. 60)

Average length and width of the epiphysis in male: 1.995 mm long and 0.708 mm wide (n = 1), in female: 1.803 mm long and 0.437 mm wide (n = 1). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded. Invagination “v-notched”. Invagination strongly accentuated. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following feature: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one quarter of the foretibia length in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.034 mm, (♀) 2.920 mm.

3.1.3.46. *Aleuron iphis* (Walker, 1856)

(Figs. 61, 90)

Average length and width of the epiphysis in males: 2.143 ± 0.045 mm long and 0.488 ± 0.023 mm wide (n = 2), in females: 1.745 ± 0.137 mm long and 0.342 ± 0.011 mm wide (n = 2). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Lower lobe with spines. Invagination "u-notched". Invagination strongly accentuated. Invagination spineless. Outer margin spiny with erect spines. Inner margin with spines. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one quarter of the foretibia length in female; ii) upper lobe rounded in males, straight in females; iii) lower lobe subtriangular in males, and rounded in females; iv) inner margin surface with tubercles in male, and striated in female; v) inner margin with tubercles in male, and lacking tubercles in female.

In relation to the acanthae, they are straight shape, not narrowed towards the tip, bent and non-dilated tip, and serrated projections.

Average foretibiae length in: (♂) 3.774 ± 0.508 mm, (♀) 3.929 ± 0.285 mm.

3.1.3.47. *Aleuron neglectum* Rothschild & Jordan, 1903

(Fig. 62)

Average length and width of the epiphysis in male: 2.108 mm long and 0.480 mm wide (n = 1), in female: 1.611 mm long and 0.408 mm wide (n = 1). Lanceolate in both sexes.

Margin on foretibia sinuous, with both lobes. Lower lobe rounded. Invagination “v-notched”. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one quarter of the foretibia length in female; ii) upper lobe rounded in male, straight in female; iii) invagination strongly accentuated in male, and slightly accentuated in female.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.753 mm, (♀) 3.277 mm.

3.1.3.48. *Unzela japix discrepans* Walker, 1856

(Figs. 63, 91)

Average length and width of the epiphysis in males: 1.911 ± 0.017 mm long and 0.470 ± 0.020 mm wide (n = 2), in females: 1.574 ± 0.152 mm long and 0.365 ± 0.120 mm wide (n = 2). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded, sometimes straight in females. Lower lobe rounded. Lower lobe with spines. Invagination spineless. Inner margin striated. Inner margin spineless no tubercles. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) invagination “u-notched” in males, and “v-notched” in females; ii) invagination strongly accentuated in males, and slightly accentuated in females; iii) outer margin surface spiny with erect spines in male, and spiny with decumbent spines in female.

In relation to the acanthae, there is sexual dimorphism. They have dilated tip in male, and regular tip in female.

Average foretibiae length in: (♂) 3.256 ± 0.070 mm, (♀) 3.455 ± 0.123 mm.

3.1.3.49. *Enyo gorgon* (Cramer, 1777)

(Fig. 64)

Average length and width of the epiphysis in males: 2.080 ± 0.045 mm long and 0.357 ± 0.036 mm wide (n = 2), in females: 1.855 ± 0.022 mm long and 0.302 ± 0.031 mm wide (n = 2). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe straight. Invagination slightly accentuated. Uniformly colored.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about one third of the foretibia length in male, and three eighths of the foretibia length in female; ii) lower lobe rounded in male, truncated in female; iii) invagination “u-notched” in male, and “v-notched” in female; iv) macula situated on the outer margin is restricted to the upper area in males, and it extending over the entire margin until it reaches the middle of the epiphysis in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.049 ± 0.106 mm, (♀) 3.749 ± 0.054 mm.

3.1.3.50. *Enyo lugubris* (Linnaeus, 1771)

(Figs. 65, 92)

Average length and width of the epiphysis in males: 1.790 ± 0.100 mm long and 0.361 ± 0.135 mm wide (n = 8), in females: 1.613 ± 0.148 mm long and 0.319 ± 0.048 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about three eighths of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded or straight. Lower lobe rounded or rounded with crested margin. Lower lobe spineless. Invagination “v-notched”, sometimes “u-notched” in females. Invagination with spines. Outer margin spiny with erect spines. Inner margin spineless and lacking tubercles. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) invagination slightly accentuated in males, and strongly accentuated in females; ii) inner margin surface striated in male, and smooth in female.

In relation to the acanthae, they are straight shape, not narrowed towards the tip, straight and regular tip, and serrated projections.

Average foretibiae length in: (♂) 3.976 ± 0.336 mm, (♀) 3.755 ± 0.278 mm.

3.1.3.51. *Enyo ocypete* (Linnaeus, 1758)

(Fig. 66)

Average length and width of the epiphysis in males: 1.728 ± 0.101 mm long and 0.393 ± 0.096 mm wide (n = 8), in females: 1.579 ± 0.104 mm long and 0.280 ± 0.085 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe rounded with crested margin, sometimes without crested margin in males. Invagination v-notched or u-notched. Invagination slightly or strongly accentuated. Uniformly colored. Macula situated on the outer margin is restricted to the upper area. Medial macula with little sclerotization.

There is no information about the acanthae.

Average foretibiae length in: (♂) 3.874 ± 0.251 mm, (♀) 3.462 ± 0.214 mm.

3.1.3.52. *Eumorpha analis* (Rothschild & Jordan, 1903)

(Fig. 67)

Average length and width of the epiphysis in males: 3.355 ± 0.210 mm long and 0.739 ± 0.069 mm wide (n = 8), in females: 2.974 ± 0.310 mm long and 0.657 ± 0.092 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Invagination “u-notched”, sometimes “v-notched” in females. Invagination strongly accentuated, sometimes slightly accentuated in females. Uniformly colored. Macula situated on the outer margin is restricted to the upper area, sometimes it extending over the entire margin until it reaches the middle of the epiphysis in females.

The epiphyses are sexually dimorphic considering the following feature: i) lower lobe truncated or truncated with crested margin in males, and rounded in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 6.050 ± 0.476 mm, (♀) 5.518 ± 0.448 mm.

3.1.3.53. *Eumorpha anchemolus* (Cramer, 1779)

(Fig. 68)

Average length and width of the epiphysis in males: 3.874 ± 0.118 mm long and 0.890 ± 0.108 mm wide (n = 8), in females: 3.526 ± 0.156 mm long and 1.195 ± 0.191 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) lower lobe rounded with crested margin in males, and rounded in females; ii) invagination “v-notched” in males, and “u-notched” in females; iii) invagination strongly accentuated in males, and slightly accentuated in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 7.442 ± 0.246 mm, (♀) 6.764 ± 0.211 mm.

3.1.3.54. *Eumorpha fasciatus* (Sulzer, 1776)

(Fig. 69)

Average length and width of the epiphysis in males: 2.806 ± 0.163 mm long and 0.800 ± 0.141 mm wide (n = 8), in females: 2.618 ± 0.157 mm long and 0.726 ± 0.057 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe truncated, sometimes with crested margin. Invagination “v-notched”, sometimes “u-notched” in males. Invagination strongly accentuated. Uniformly colored. Macula situated on the outer margin is restricted to the upper area or it extending over the entire margin until it reaches the middle of the epiphysis.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.330 ± 0.314 mm, (♀) 5.359 ± 0.453 mm.

3.1.3.55. *Eumorpha labruscae* (Linnaeus, 1758)

(Fig. 70)

Average length and width of the epiphysis in males: 3.111 ± 0.178 mm long and 0.656 ± 0.062 mm wide (n = 8), in females: 2.914 ± 0.187 mm long and 0.567 ± 0.035 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Invagination “u-notched”. Invagination slightly accentuated. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis.

The epiphyses are sexually dimorphic considering the following feature: i) lower lobe with shapes different (subtriangular, truncated, rounded, rounded with crested margin), and only rounded in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.679 ± 0.293 mm, (♀) 5.359 ± 0.319 mm.

3.1.3.56. *Eumorpha megaeacus* (Hübner, [1819])

(Fig. 71)

Average length and width of the epiphysis in males: 2.976 ± 0.127 mm long and 0.685 ± 0.114 mm wide (n = 8), in females: 2.914 ± 0.180 mm long and 0.833 ± 0.125 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded, sometimes straight in females. Lower lobe truncated and rounded with crested margin. Invagination “u-notched” or “v-notched”. Invagination slightly accentuated, sometimes strongly accentuated in males. Uniformly colored. Macula situated on the outer margin extending over the entire margin until it reaches the middle of the epiphysis, sometimes it is restricted to the upper area in males.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.597 ± 0.154 mm, (♀) 5.380 ± 0.526 mm.

3.1.3.57. *Eumorpha obliquus* Rothschild & Jordan, 1903

(Figs. 72, 93)

Average length and width of the epiphysis in males: 3.414 ± 0.187 mm long and 0.833 ± 0.062 mm wide (n = 8), in females: 3.276 ± 0.091 mm long and 0.809 ± 0.121 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Lower lobe truncated with crested margin. Lower lobe spineless. Invagination “u-notched” or “v-notched”. Invagination strongly accentuated. Invagination spineless. Outer margin spiny with erect spines. Inner margin striated. Inner margin with spines and lacking tubercles. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

The epiphyses are sexually dimorphic considering the following features: i) lower lobe truncated with threes lobes in males, and truncated with two lobes in females.

In relation to the acanthae, there is sexual dimorphism. They are curved, narrowed towards the tip, bent tip and serrated markedly in male, and straight, not narrowed towards the tip, straight tip and serrated projections in female.

Average foretibiae length in: (♂) 5.775 ± 0.354 mm, (♀) 5.776 ± 0.437 mm.

3.1.3.58. *Eumorpha translineatus* (Rothschild, 1895)

(Fig. 73)

Average length and width of the epiphysis in males: 3.149 ± 0.214 mm long and 0.622 ± 0.048 mm wide (n = 8), in females: 3.029 ± 0.109 mm long and 0.778 ± 0.107 mm wide (n = 7). Lanceolate in both sexes. Margin on foretibia sinuous, with both lobes. Upper lobe rounded. Invagination "u-notched" or "v-notched". Invagination strongly accentuated, sometimes slightly accentuated in females. Uniformly colored.

The epiphyses are sexually dimorphic considering the following features: i) epiphyses apically placed at about two sevenths of the foretibia length in male, and one third of the foretibia length in female; ii) lower lobe truncated with crested margin in males, and truncated with crested margin in females; iii) macula situated on the outer margin is restricted to the upper area in males, and it extending over the entire margin until it reaches the middle of the epiphysis in females.

There is no information about the acanthae.

Average foretibiae length in: (♂) 5.470 ± 0.408 mm, (♀) 5.620 ± 0.263 mm.

3.1.3.59. *Eumorpha vitis* (Linnaeus, 1758)

(Fig. 74)

Average length and width of the epiphysis in males: 2.582 ± 0.184 mm long and 0.530 ± 0.062 mm wide (n = 8), in females: 2.549 ± 0.191 mm long and 0.486 ± 0.047 mm wide (n = 7). Lanceolate in both sexes, and apically placed at about one third of the foretibia length. Margin on foretibia sinuous, with both lobes. Upper lobe rounded, sometimes subtriangular in females. Lower lobe rounded or rounded with crested margin. Invagination "u-notched", sometimes v-notched in males. Invagination strongly or slightly accentuated. Uniformly colored. Macula situated on the outer margin is restricted to the upper area.

There is no information about the acanthae.

Average foretibiae length in: (♂) 4.779 ± 0.288 mm, (♀) 5.008 ± 0.267 mm.

3.1.4. Sexual dimorphism

Most males have longer epiphyses than females (54 species), however, there are five species - *Cephonodes hylas*, *Pachylia darceta*, *Callionima nomius*, *Madoryx oiclus* and *Isognathus menechus* - with females having longer epiphyses than males (Table 7, Appendix D).

Most males have wider epiphyses than females (42 species). However, 17 species in which females have wider epiphyses than males, fourteen species from the Dilophonotini tribe and three from Philampelini (Table 7, Appendix D).

With regard to the length of the foretibia, males of 35 species have foretibia longer than females. However, there are 24 species where females have longer foretibia than males (Table 7, Appendix D).

In 50 species of our study group (45 species of Dilophonotini, 5 species of Philampelini), sexual dimorphism was observed in the proposed characters, except in the species *Pachylia* *syces*, *Callionima nomius*, *Aellopos ceculus*, *Hemeroplanes triptolemus*, *Erinnyis crameri*, *Enyo ocypete*, *Eumorpha fasciatus*, *Eumorpha megaecus*, *Eumorpha vitis* (9 species).

Of the 22 proposed characters, only 4 did not present sexual dimorphism (Character 3: shape of the margin of the foretibia; Character 4: presence or absence of the upper lobe; Character 6: presence or absence of the lower lobe; Character 11: presence or absence of spines in invagination), the character 2 (position of the epiphysis on the foretibia) was the most frequent difference between males and females.

The species *Callionima parce*, *Nyceryx nictitans nictitans*, *Eupyrrhoglossum sagra* and *Aellopos fadus* showed sexual dimorphism in more characters (six characters); *Oryba kadeni* was the only species that presented sexual dimorphism in the shape of the epiphysis, and *Aellopos fadus* was the only species that presented sexual dimorphism in character 8 (presence or absent of spines in the lower lobe).

Table 7. Summary of sexual dimorphism in species. EL = Epiphysis length; EW = Epiphysis width; P = Position; FL = Foretibia length; SD = Number of sexual dimorphism by species. light gray: Epiphysis' characters; dark gray: Acanthae's characters. ♀: means that females showed higher average; ♂: means that males showed higher average.

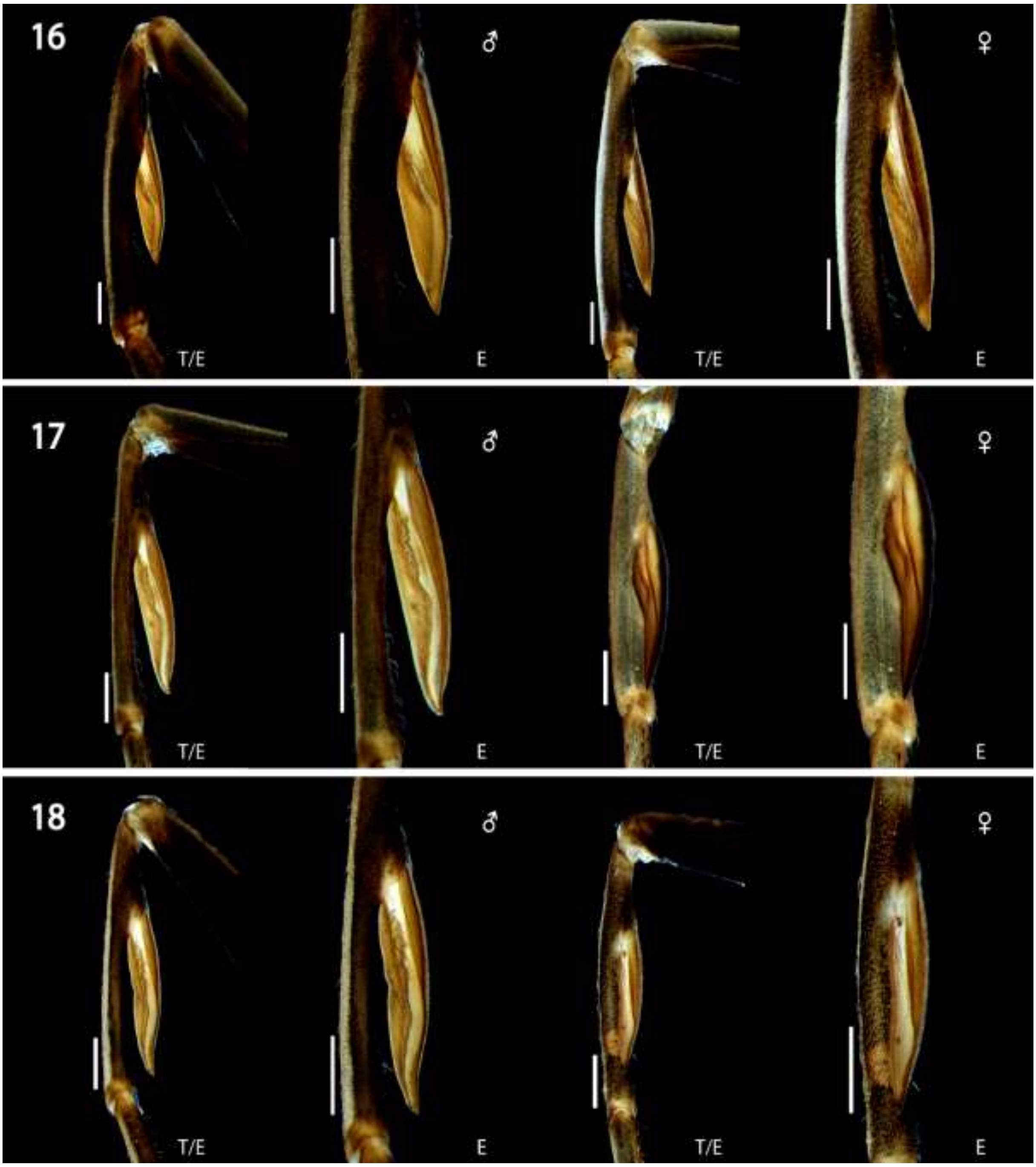
Species	EL	EW	P	FL	Characters																						SD
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Cephonodes hylas (Linnaeus, 1771)	♀	♂	♀	♀												x	x										2
Hemaris diffinis (Boisduval, 1836)	♂	♀	♂	♂					x								x	x					x				4
Hemaris croatica (Esper, 1800)	♂	♀	♂	♂							x																1
Pachylia darceta Druce, 1882	♀	♀	♀	♀													x										1
Pachylia ficus (Linnaeus, 1758)	♂	♂	♀	♂									x														1
Pachylia syces (Hübner, [1819])	♂	♀	♀	♀																							0
Callionima guiarti (Debauche, 1934)	♂	♂	♀	-		x							x	x													3
Callionima innus Rothschild & Jordan, 1904	♂	♂	♂	♂		x																					1
Callionima nomius (Walker, 1856)	♀	♀	♀	♀																							0
Callionima parce (Fabricius, 1775)	♂	♂	♀	♂		x										x	x	x	x				x				6
Nyceryx alophus (Boisduval, [1875])	♂	♂	♂	-									x	x													2
Nyceryx continua continua (Walker, 1856)	♂	♀	♀	♀							x															x	2
Nyceryx nictitans nictitans Boisduval, [1875]	♂	♂	♀	♂		x			x							x					x		x	x			6
Nyceryx stuarti (Rothschild, 1894)	♂	♀	♂	♂									x														1
Perigonia lusca (Fabricius, 1777)	♂	♂	♀	♀		x																					1
Perigonia pallida Rothschild & Jordan, 1904	♂	♀	♀	♀					x				x	x												x	4
Perigonia passerina Boisduval, [1875]	♂	♂	♀	♂		x					x		x													x	4
Perigonia stulta Herrich-Schäffer, [1854]	♂	♀	♀	♂														x		x							2
Eupyrrhoglossum sagra (Poey, 1832)	♂	♂	♂	♂							x			x		x					x		x	x			6
Aellopos ceculus (Cramer, 1777)	♂	♂	♀	♂																							0
Aellopos fadus (Cramer, 1775)	♂	♂	♀	♀								x	x							x	x	x				x	6
Aellopos tantalus (Linnaeus, 1758)	♂	♂	♀	♀		x																				x	2

Table 7. Continuation.

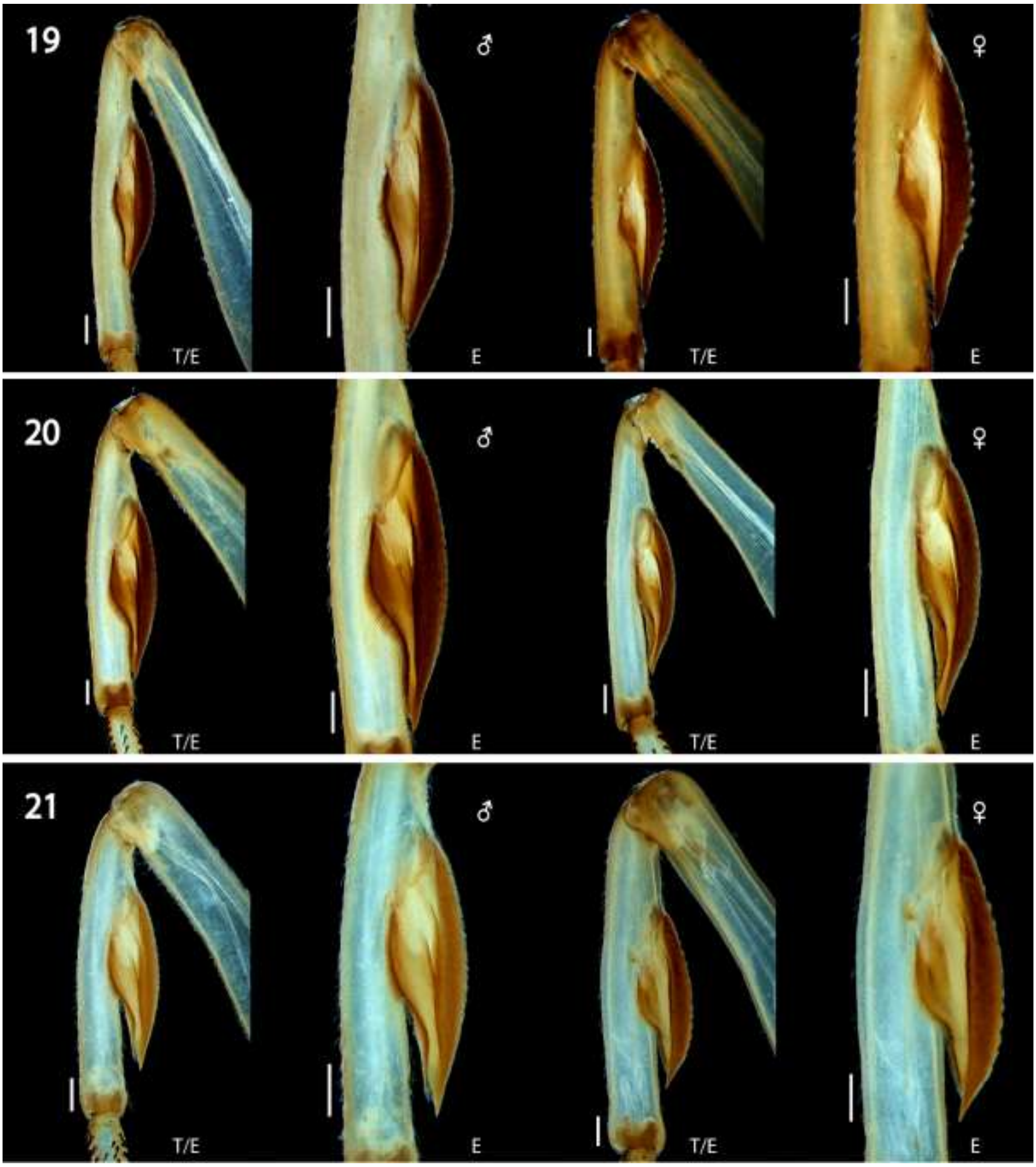
Species	EL	EW	P	FL	Characters																						
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	SD
Aellopos titan (Cramer, 1777)	♂	♂	♀	♂									x														1
Oryba achemenides (Cramer, 1779)	♂	♂	♂	♂									x	x													2
Oryba kadeni (Schaufuss, 1870)	♂	♂	♀	♂	x						x																2
Pachylioides resumens (Walker, 1856)	♂	♀	♂	♂														x		x				x			3
Madoryx bubastus (Cramer, 1777)	♂	♂	♀	♀		x			x				x	x													4
Madoryx plutonius (Hübner, [1819])	♂	♂	♂	♂		x											x										2
Madoryx oiclus (Cramer, 1779)	♀	♀	♀	♀							x																1
Hemeroplanes longistriga (Rothschild & Jordan, 1903)	♂	♂	♀	♂							x			x													2
Hemeroplanes ornatus Rothschild, 1894	♂	♂	♀	♂																		x	x				2
Hemeroplanes triptolemus (Cramer, 1779)	♂	♂	♂	♂																							0
Erinnyis alope (Drury, 1773)	♂	♂	♀	♂		x																					1
Erinnyis crameri (Schaus, 1898)	♂	♂	♀	♀																							0
Erinnyis ello (Linnaeus, 1758)	♂	♀	♀	♀		x					x																2
Erinnyis impunctata Rothschild & Jordan, 1904	♂	♂	♀	♀					x		x														x		3
Erinnyis lassauxii (Boisduval, 1859)	♂	♂	♀	♀		x																					1
Erinnyis obscura (Fabricius, 1775)	♂	♂	♀	♀		x								x													2
Erinnyis oenotrus (Cramer, 1780)	♂	♂	♀	♂		x																	x	x			3
Isognathus allamandae Clark, 1919	♂	♂	♀	♀		x																					1
Isognathus caricae (Linnaeus, 1758)	♂	♂	♀	♂		x																					1
Isognathus menechus (Boisduval, [1875])	♀	♀	♀	♀		x										x											2
Pseudosphinx tetrio (Linnaeus, 1771)	♂	♂	♀	♀					x												x		x	x			4
Aleuron carinata (Walker, 1856)	♂	♀	♀	♂		x			x		x		x	x													5
Aleuron chloroptera (Perty, [1833])	♂	♂	♂	♂		x																					1
Aleuron iphis (Walker, 1856)	♂	♂	♀	♀		x			x		x						x		x								5
Aleuron neglectum Rothschild & Jordan, 1902	♂	♂	♂	♂		x			x					x													3

Table 7. Continuation.

Species	EL	EW	P	FL	Characters																						
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	SD
Unzela japix discrepans Walker, 1855	♂	♂	♀	♀									x			x		x					x				4
Enyo gorgon (Cramer, 1777)	♂	♂	♀	♂		x					x		x												x		4
Enyo lugubris (Linnaeus, 1771)	♂	♂	♂	♂										x			x										2
Enyo ocypete (Linnaeus, 1758)	♂	♂	♂	♂																							0
Eumorpha analis (Rothschild & Jordan, 1903)	♂	♂	♂	♂							x																1
Eumorpha anchemolus (Cramer, 1779)	♂	♀	♂	♂							x		x	x													3
Eumorpha fasciatus (Sulzer, 1776)	♂	♂	♀	♀																							0
Eumorpha labruscae (Linnaeus, 1758)	♂	♂	♀	♂							x																1
Eumorpha megaeacus (Hübner, [1819])	♂	♀	♂	♂																							0
Eumorpha obliquus Rothschild & Jordan, 1903	♂	♂	♀	♀																x	x	x		x			4
Eumorpha translineatus (Rothschild, 1895)	♂	♀	♀	♀		x					x														x		3
Eumorpha vitis (Linnaeus, 1758)	♂	♂	♀	♀																							0
Characters by species	-	-	-	-	1	23	0	0	9	0	16	1	14	12	0	6	7	5	2	4	5	3	8	6	3	5	50



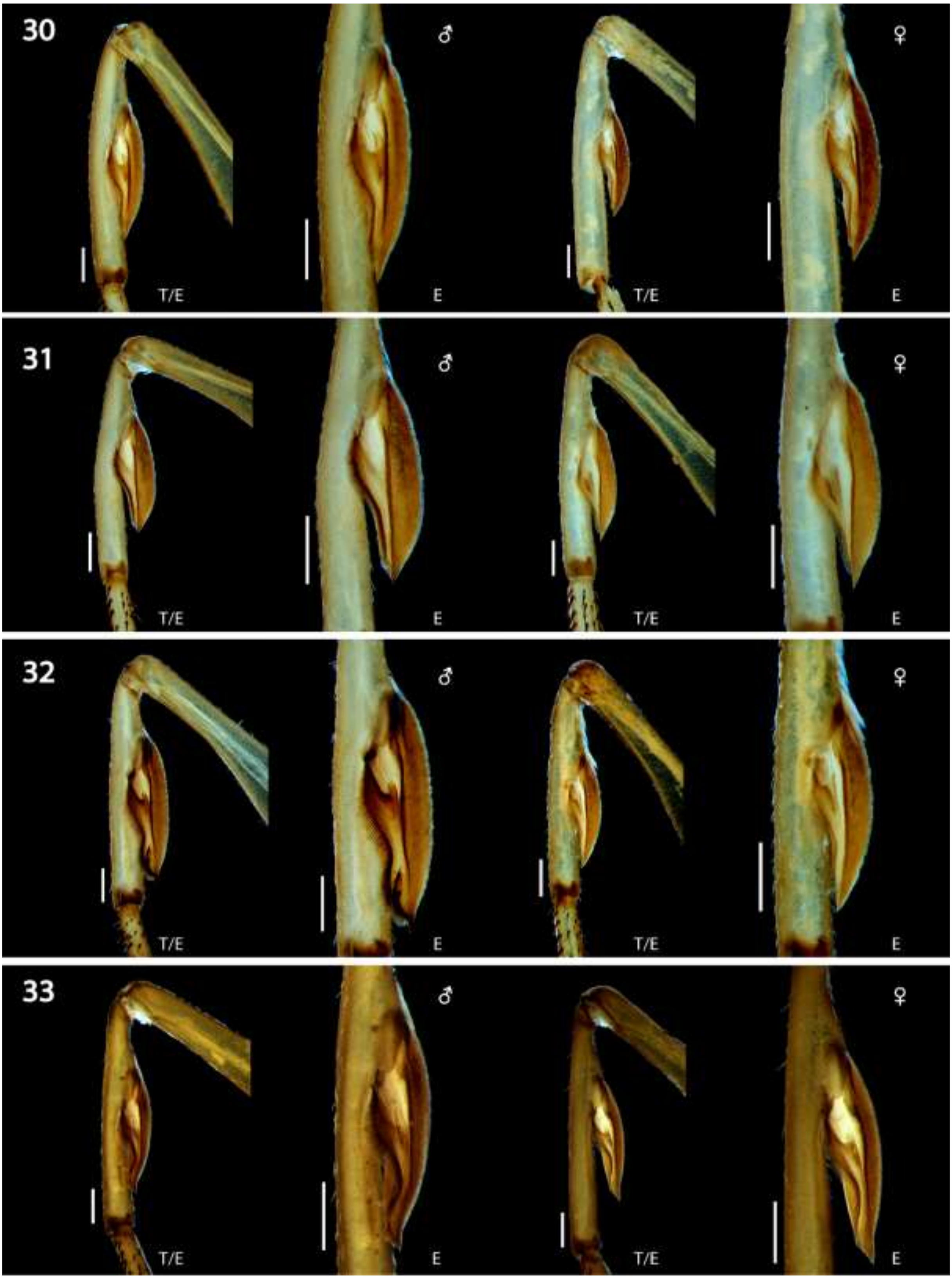
Figures 16-18. Morphology of the epiphyses in *Cephonodes* and *Hemaris*. 16. *Cephonodes hylas, 17*. *Hemaris diffinis*, 18. *Hemaris croatica.* Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



Figures 19-21. Morphology of the epiphyses in *Pachylia*. 19. *Pachylia darceta*, 20. *Pachylia ficus*, 21. *Pachylia syces*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

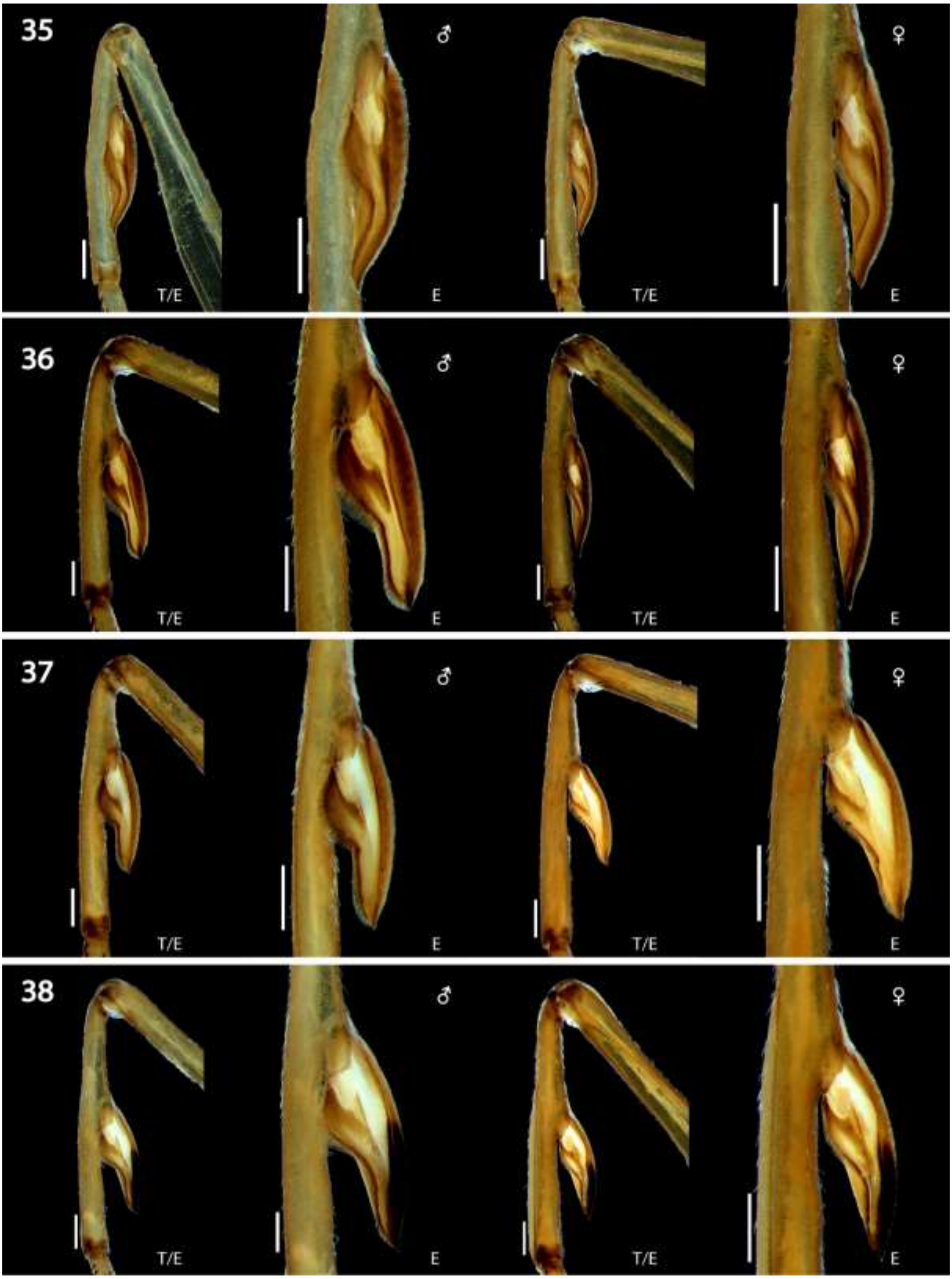
Figures 22-25. Morphology of the epiphyses in *Callionima*. 22. *Callionima guiarti*, 23. *Callionima innus*, 24. *Callionima nomius*, 25. *Callionima parce*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

Figures 26-29. Morphology of the epiphyses in *Nyceryx*. 26. *Nyceryx alophus*, 27. *Nyceryx continua continua*, 28. *Nyceryx nictitans nictitans*, 29. *Nyceryx stuarti*. Scale bar: 0.5 mm. In anterolateral view (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

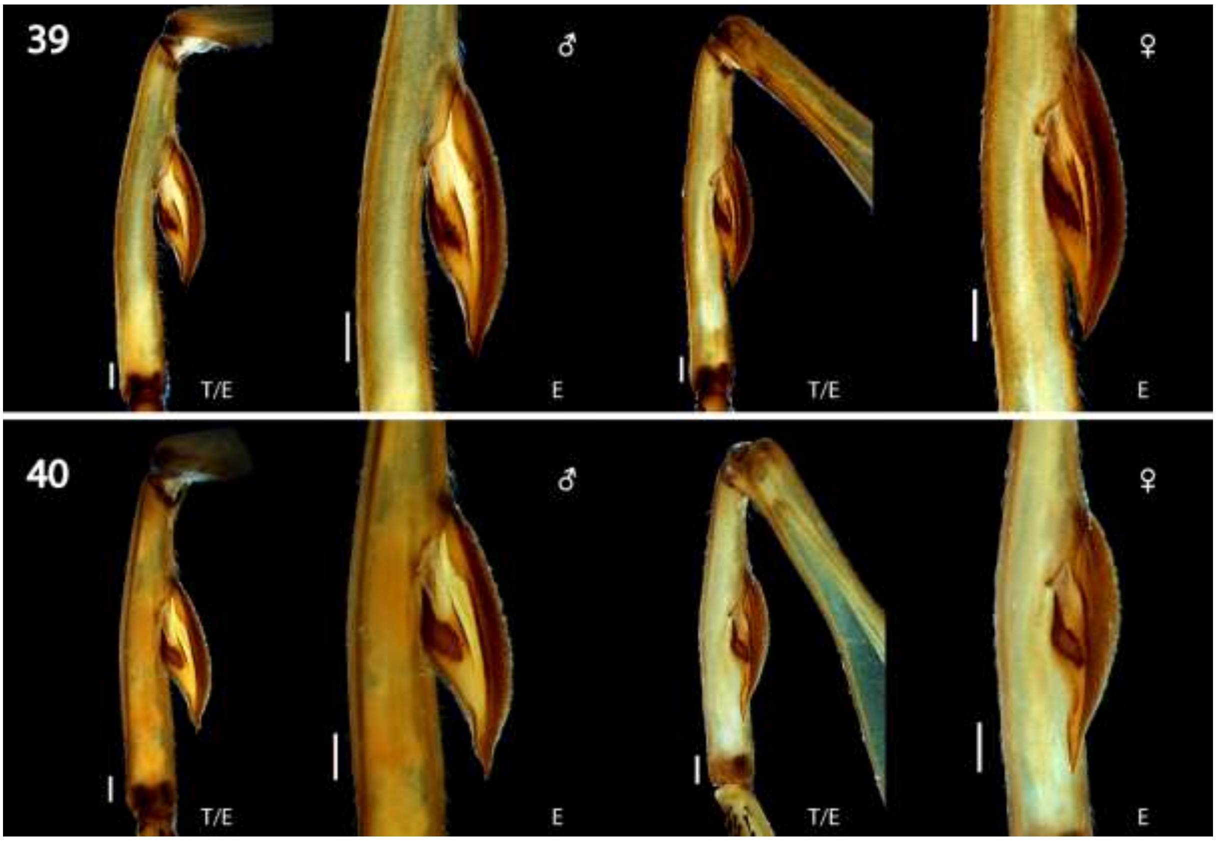


Figures 30-33. Morphology of the epiphyses in *Perigonia*. 30. *Perigonia lusca*, 31. *Perigonia pallida*, 32. *Perigonia passerina*, 33. *Perigonia stulta*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

Figure 34. Morphology of the epiphyses in *Eupyrrhoglossum*. 34. *Eupyrrhoglossum sagra*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

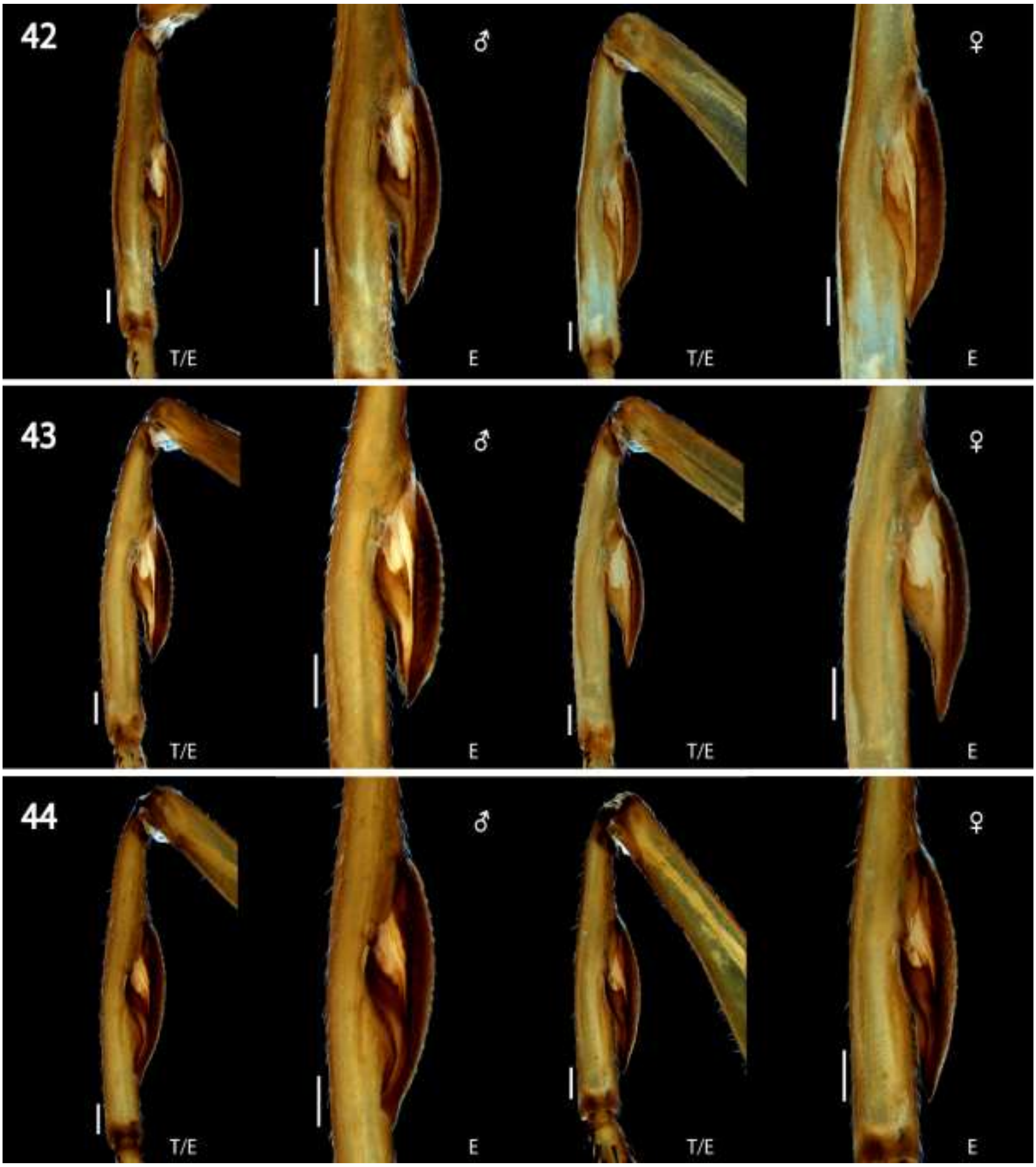


Figures 35-38. Morphology of the epiphyses in *Aellopos*. 35. *Aellopos ceculus*, 36. *Aellopos fadus*, 37. *Aellopos tantalus*, 38. *Aellopos titan*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



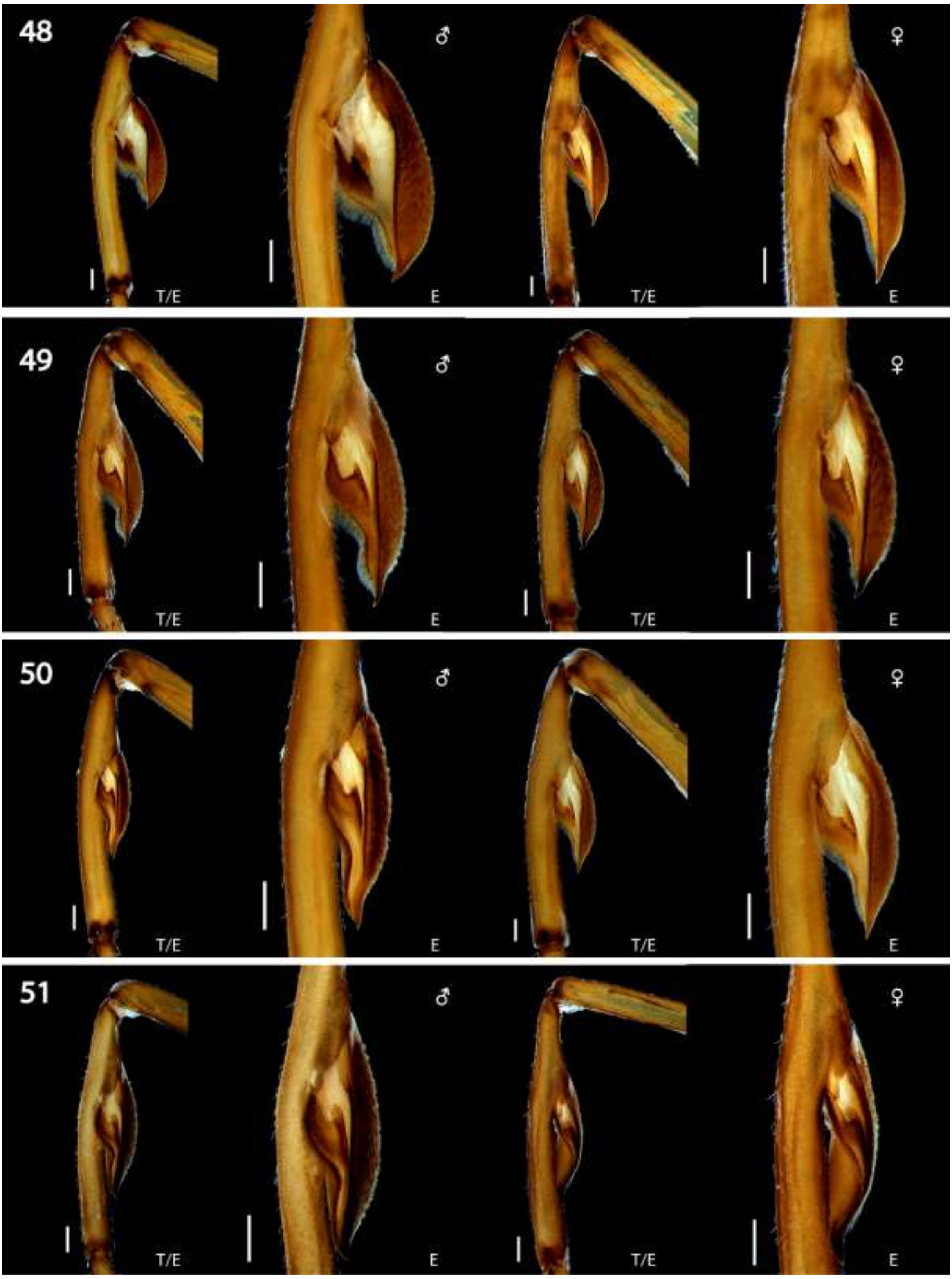
Figures 39-40. Morphology of the epiphyses in *Oryba*. 39. *Oryba achemenides*, 40. *Oryba kadeni*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

Figure 41. Morphology of the epiphyses in *Pachylioides*. 41. *Pachylioides resumens*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

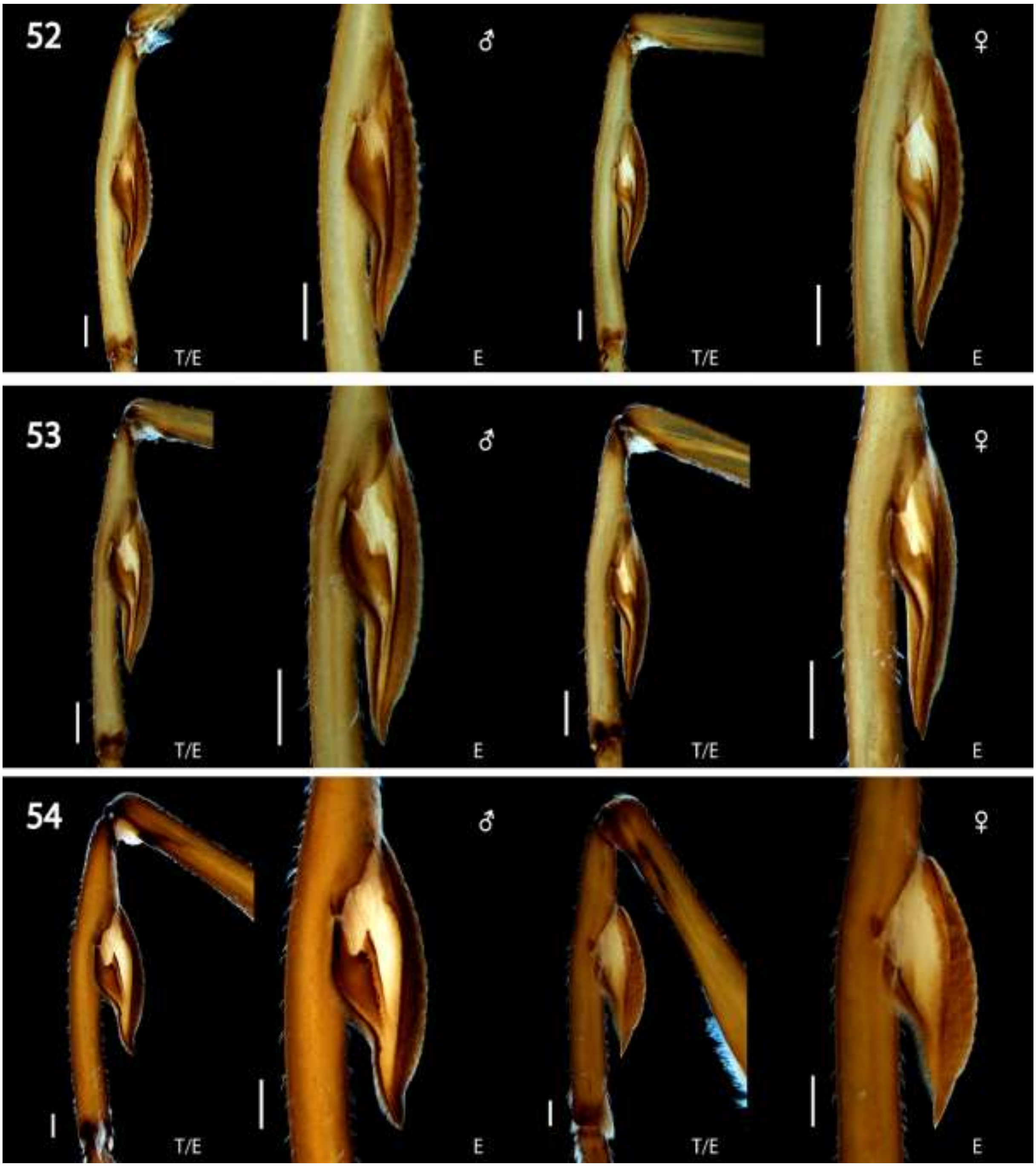


Figures 42-44. Morphology of the epiphyses in *Madoryx*. 42. *Madoryx bubastus*, 43. *Madoryx plutonius*, 44. *Madoryx oiclus.* Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

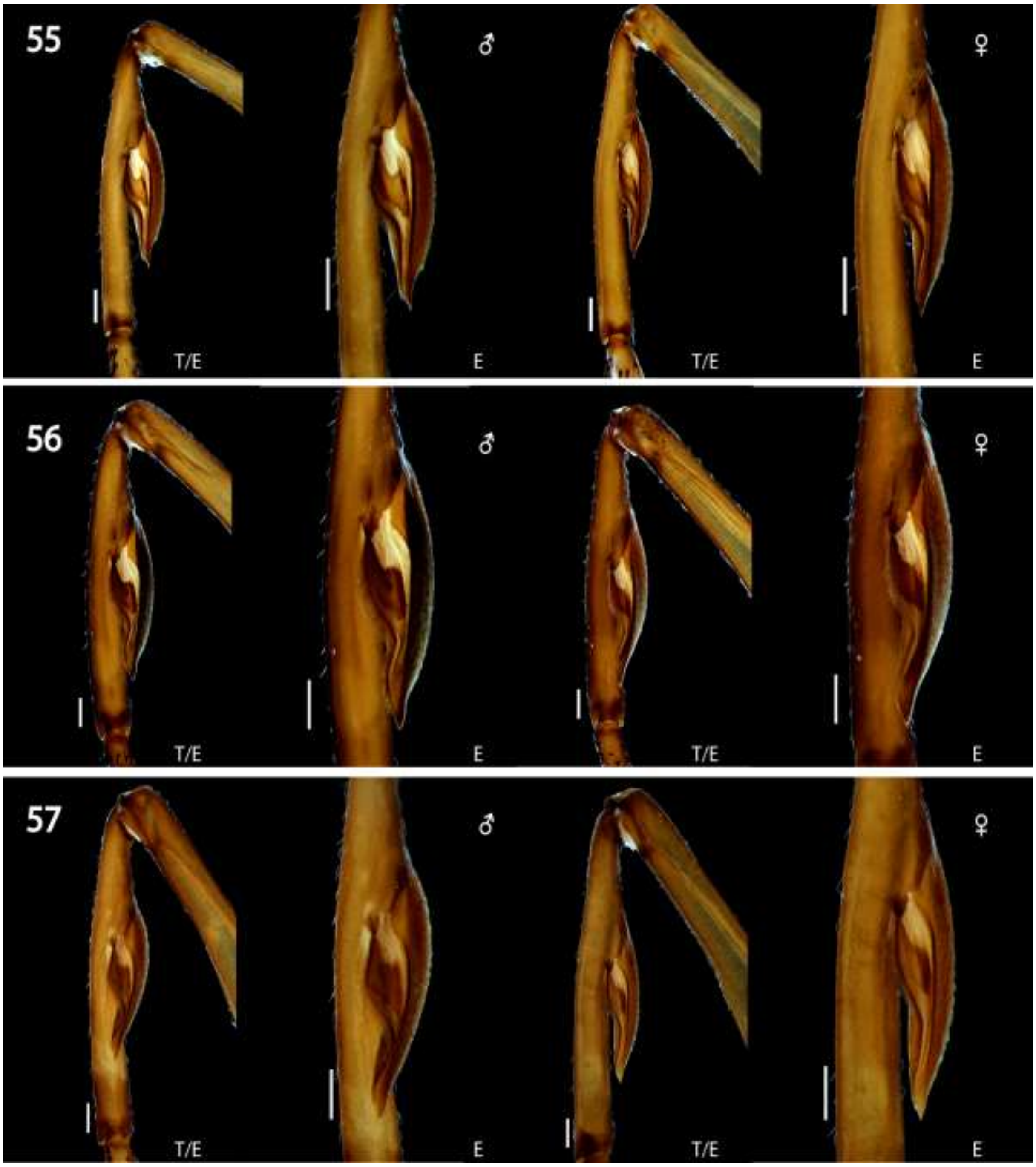
Figures 45-47. Morphology of the epiphyses in *Hemeroplanes*. 45. *Hemeroplanes longistriga*, 46. *Hemeroplanes ornatus*, 47. *Hemeroplanes triptolemus.* Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



Figures 48-51. Morphology of the epiphyses in *Erinnyis*. 48. *Erinnyis alope*, 49. *Erinnyis crameri*, 50. *Erinnyis ello*, 51. *Erinnyis impunctata*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



Figures 52-54. Morphology of the epiphyses in *Erinnyis. 52*. *Erinnyis lassauxii*, 53. *Erinnyis obscura*, 54. *Erinnyis oenotrus*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



Figures 55-57. Morphology of the epiphyses in *Isognathus. 55*. *Isognathus allamandae*, 56. *Isognathus caricae*, 57. *Isognathus menechus*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

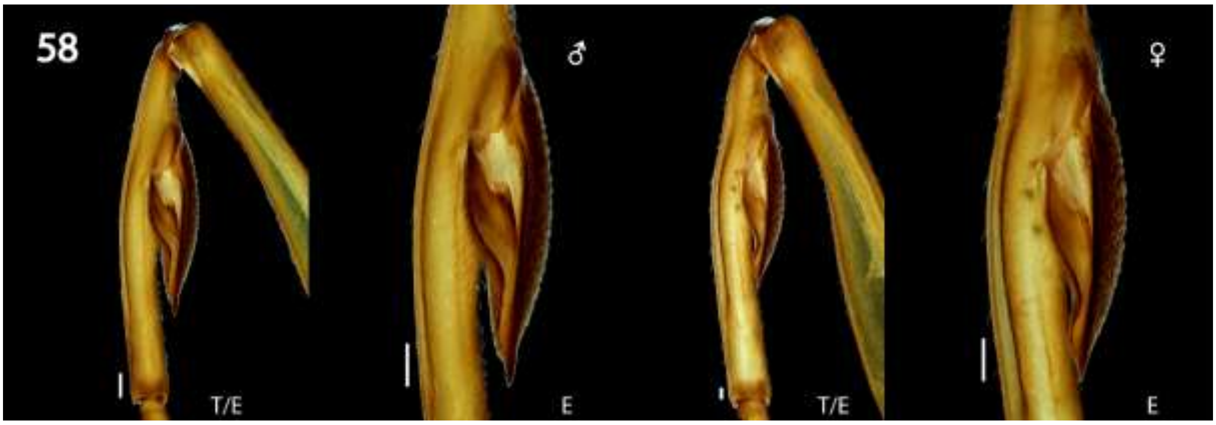
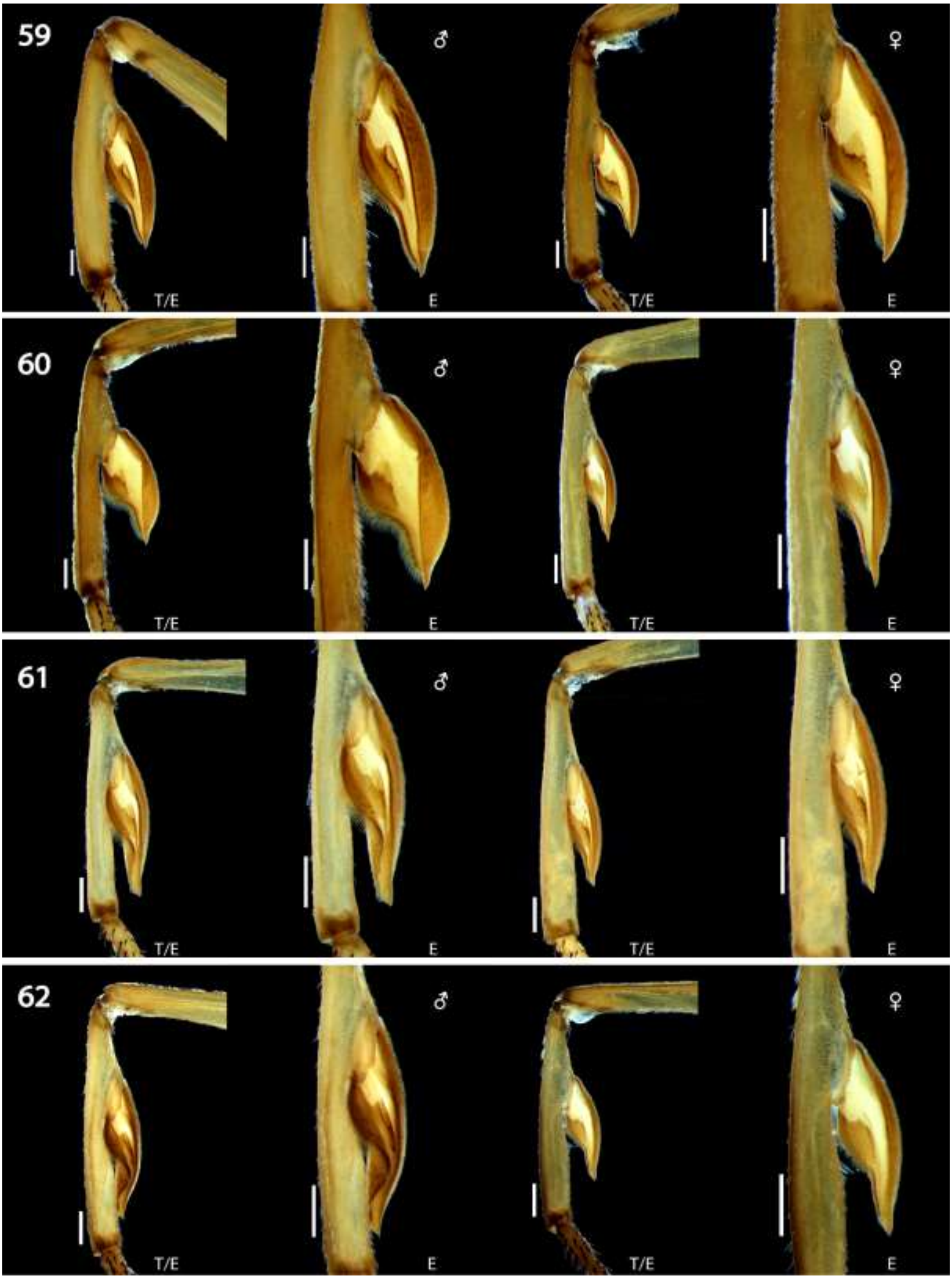


Figure 58. Morphology of the epiphyses in *Pseudosphinx*. 58. *Pseudosphinx tetrio*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



Figures 59-62. Morphology of the epiphyses in *Aleuron*. 59. *Aleuron carinata*, 60. *Aleuron chloroptera*, 61. *Aleuron iphis*, 62. *Aleuron neglectum*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

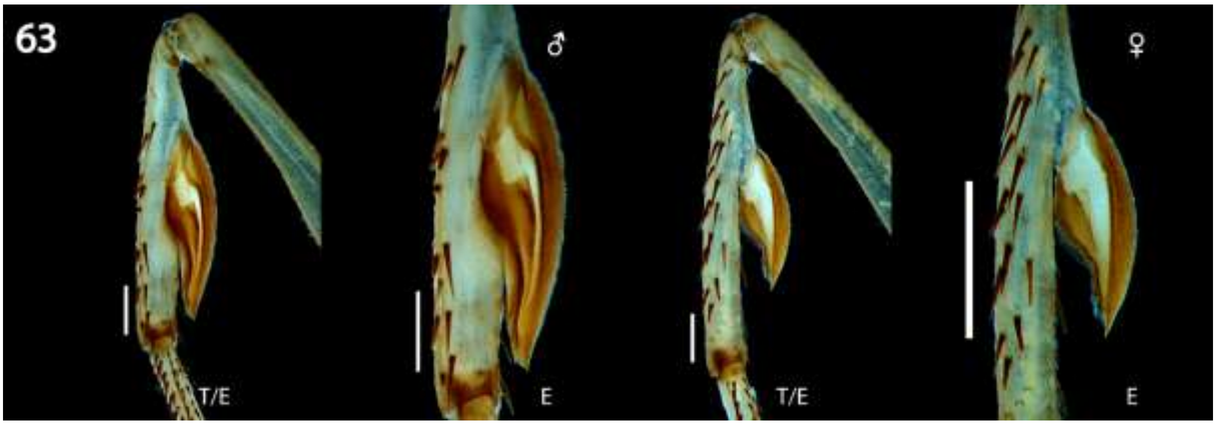
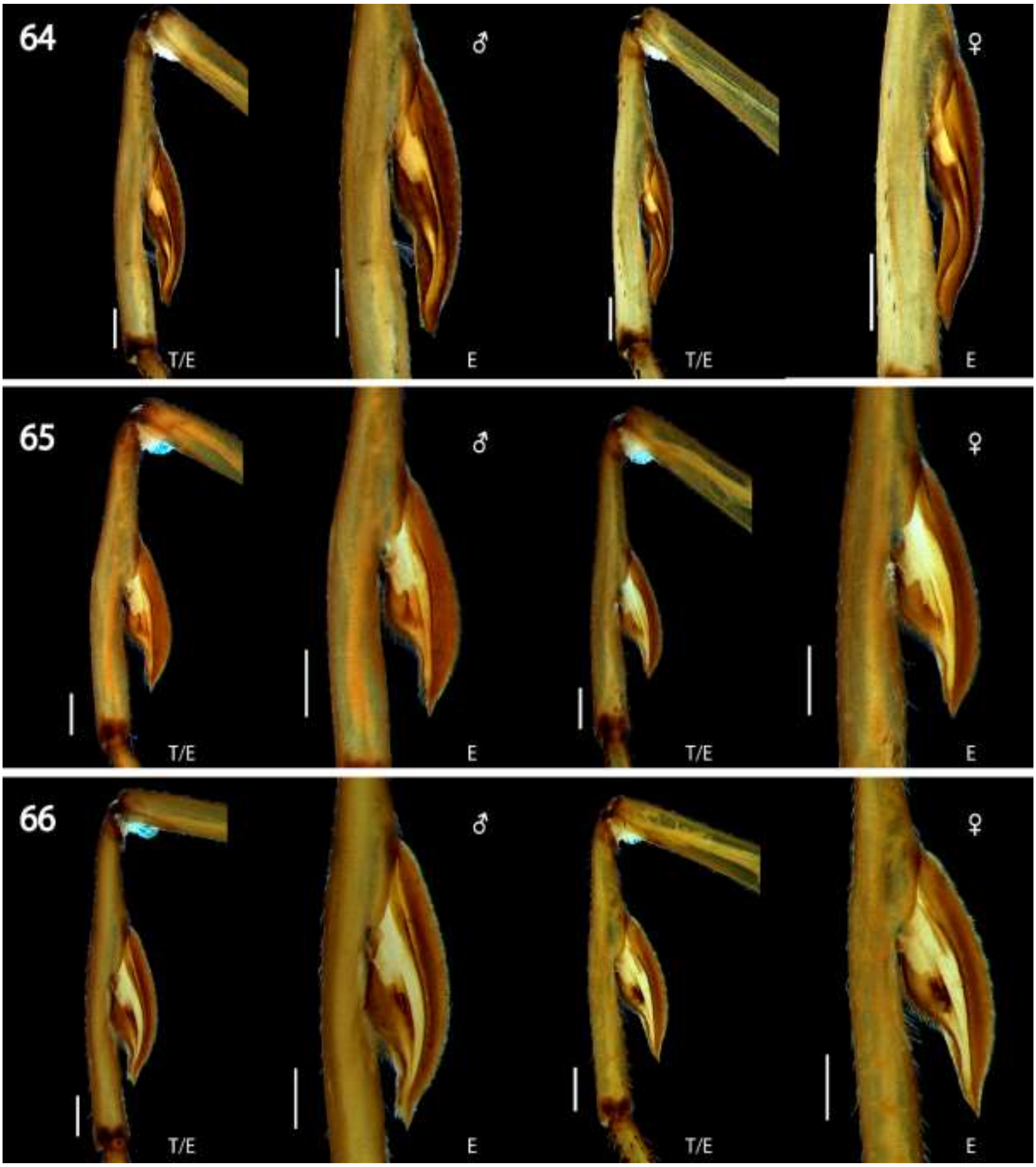
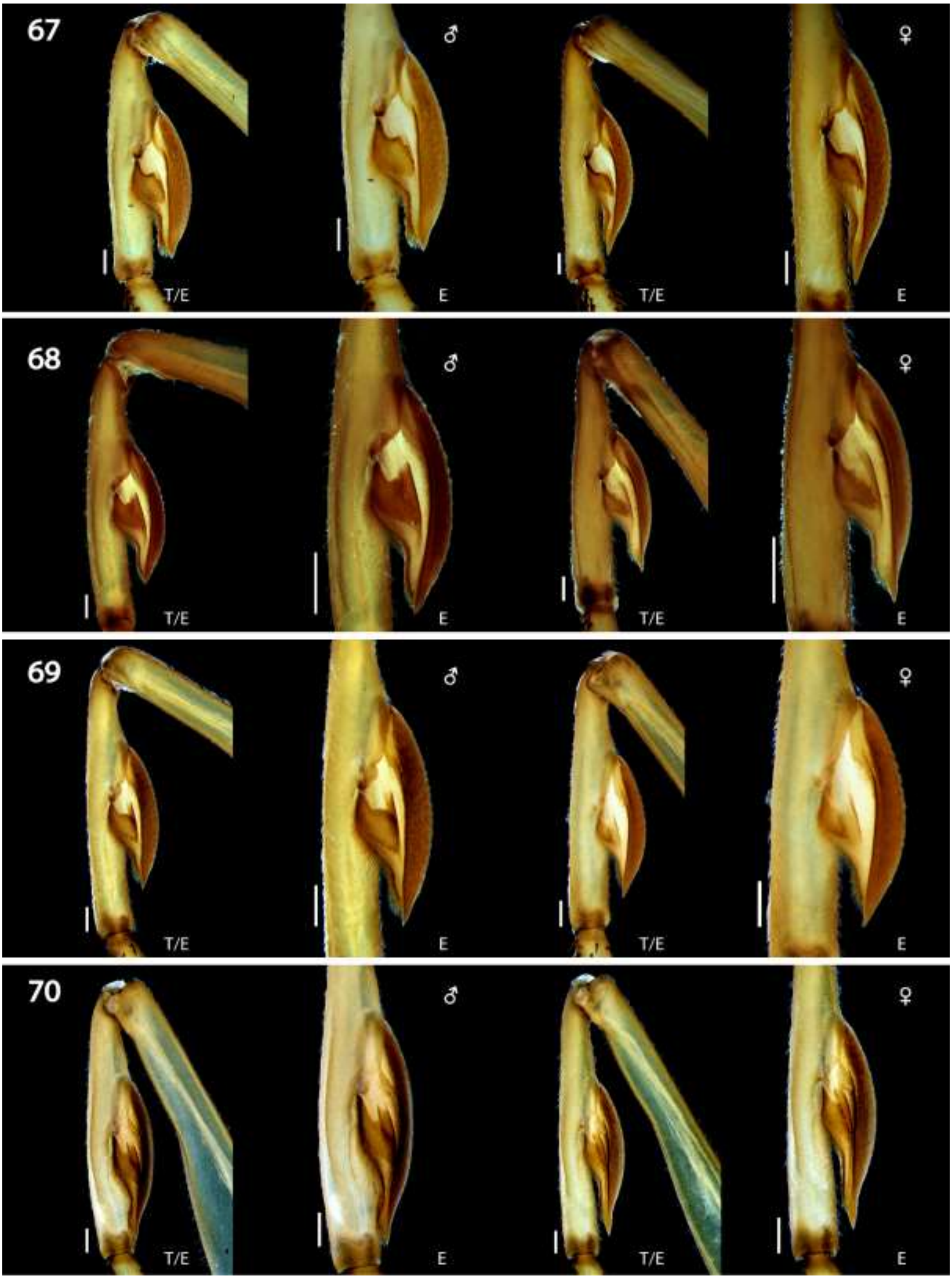


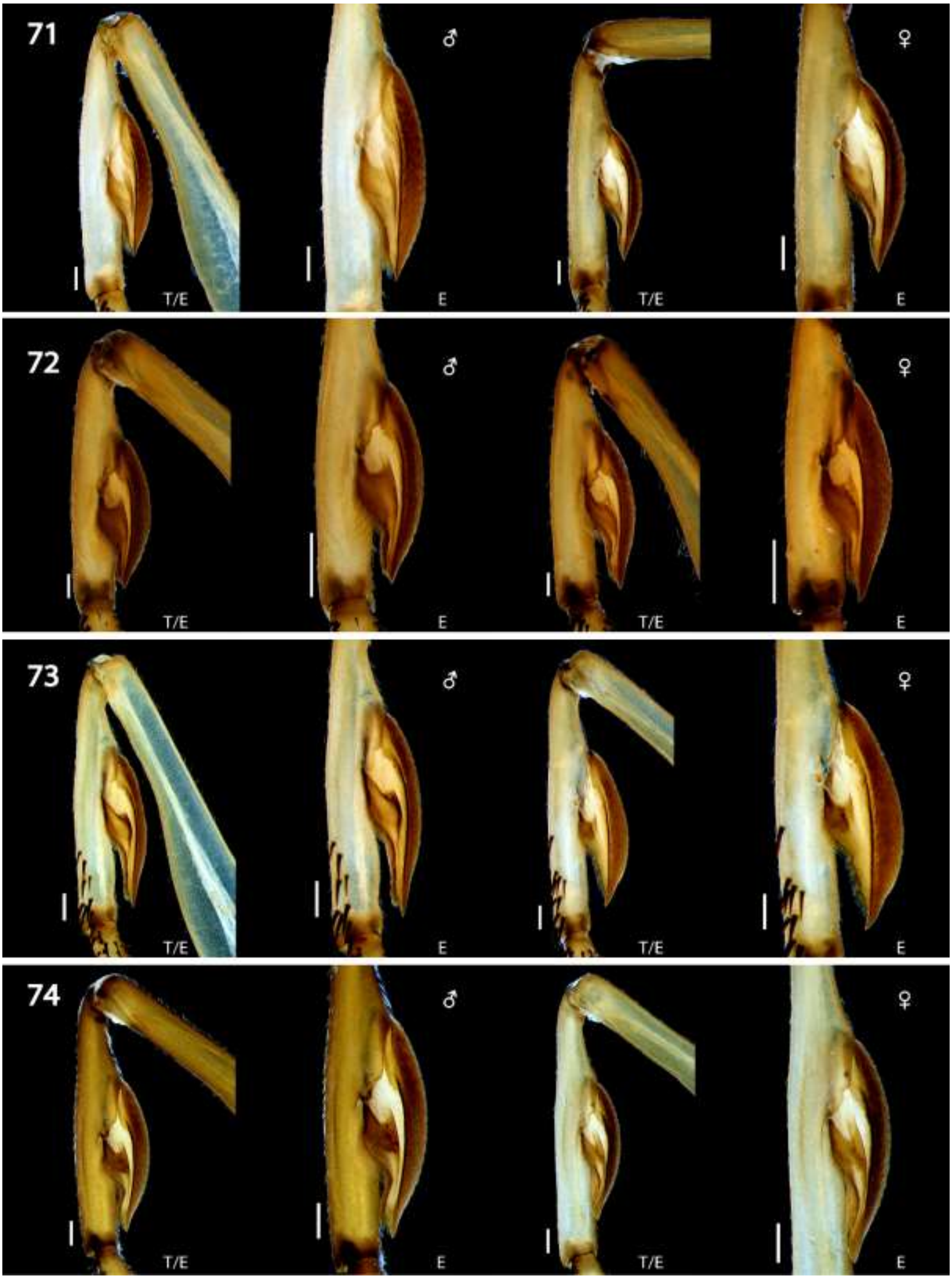
Figure 63. Morphology of the epiphyses in *Unzela*. 63*. Unzela japix discrepans*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



Figures 64-66. Morphology of the epiphyses in *Enyo. 64*. *Enyo gorgon*, 65. *Enyo lugubris*, 66. *Enyo ocypete.* Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



Figures 67-70. Morphology of the epiphyses in *Eumorpha*. 67. *Eumorpha analis*, 68. *Eumorpha anchemolus*, 69. *Eumorpha fasciatus*, 70. *Eumorpha labruscae*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).



Figures 71-74. Morphology of the epiphyses in *Eumorpha*. 71. *Eumorpha megaecus*, 72. *Eumorpha obliquus*, 73. *Eumorpha translineatus*, 74. *Eumorpha vitis*. Scale bar: 0.5 mm. In anterolateral view. (T/E = Position of the epiphysis on the foretibia, E = Detail of the epiphysis).

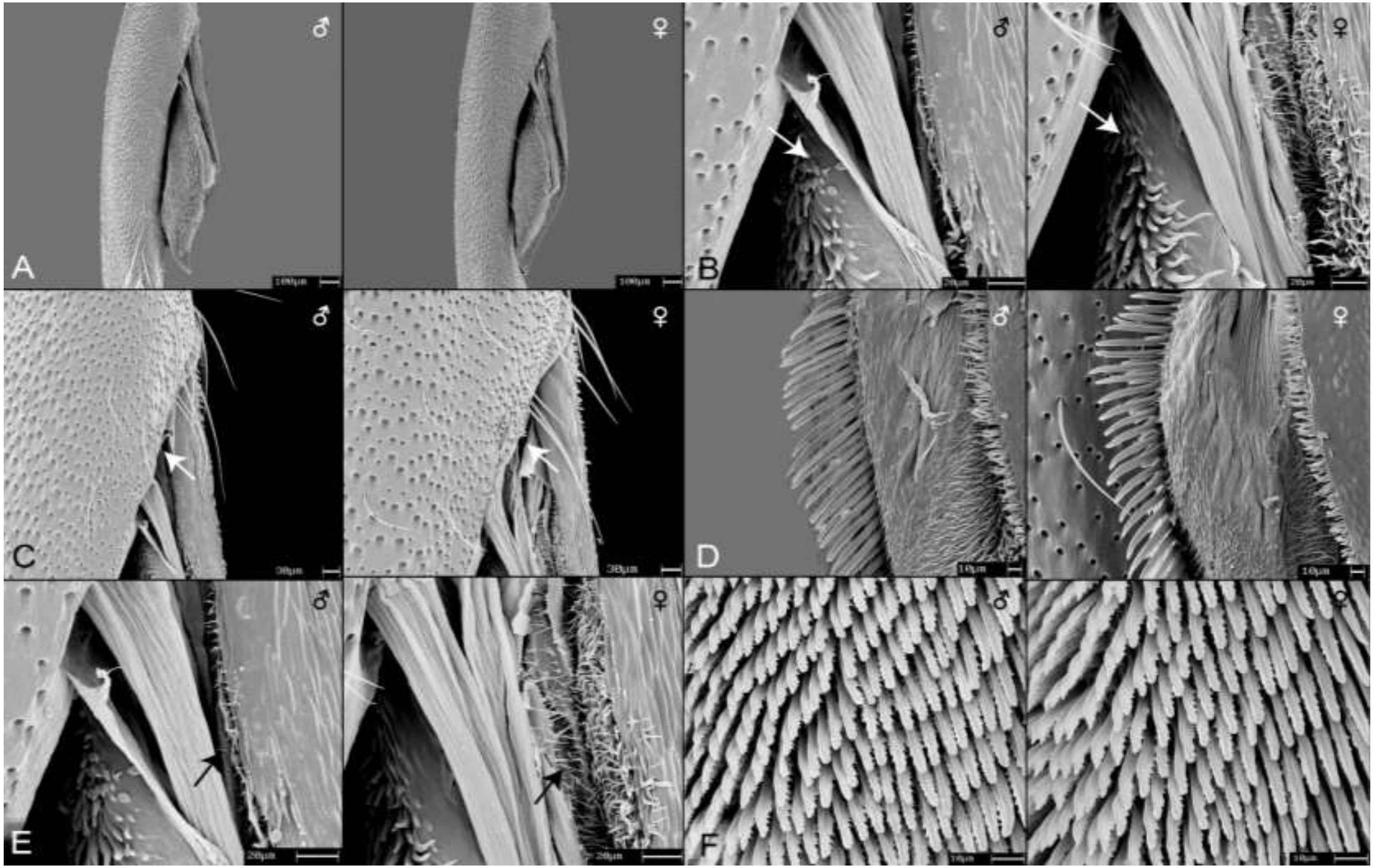


Figure 75. Ultrastructure of the epiphysis of *Cephonodes hylas*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin, F. Acanthae.

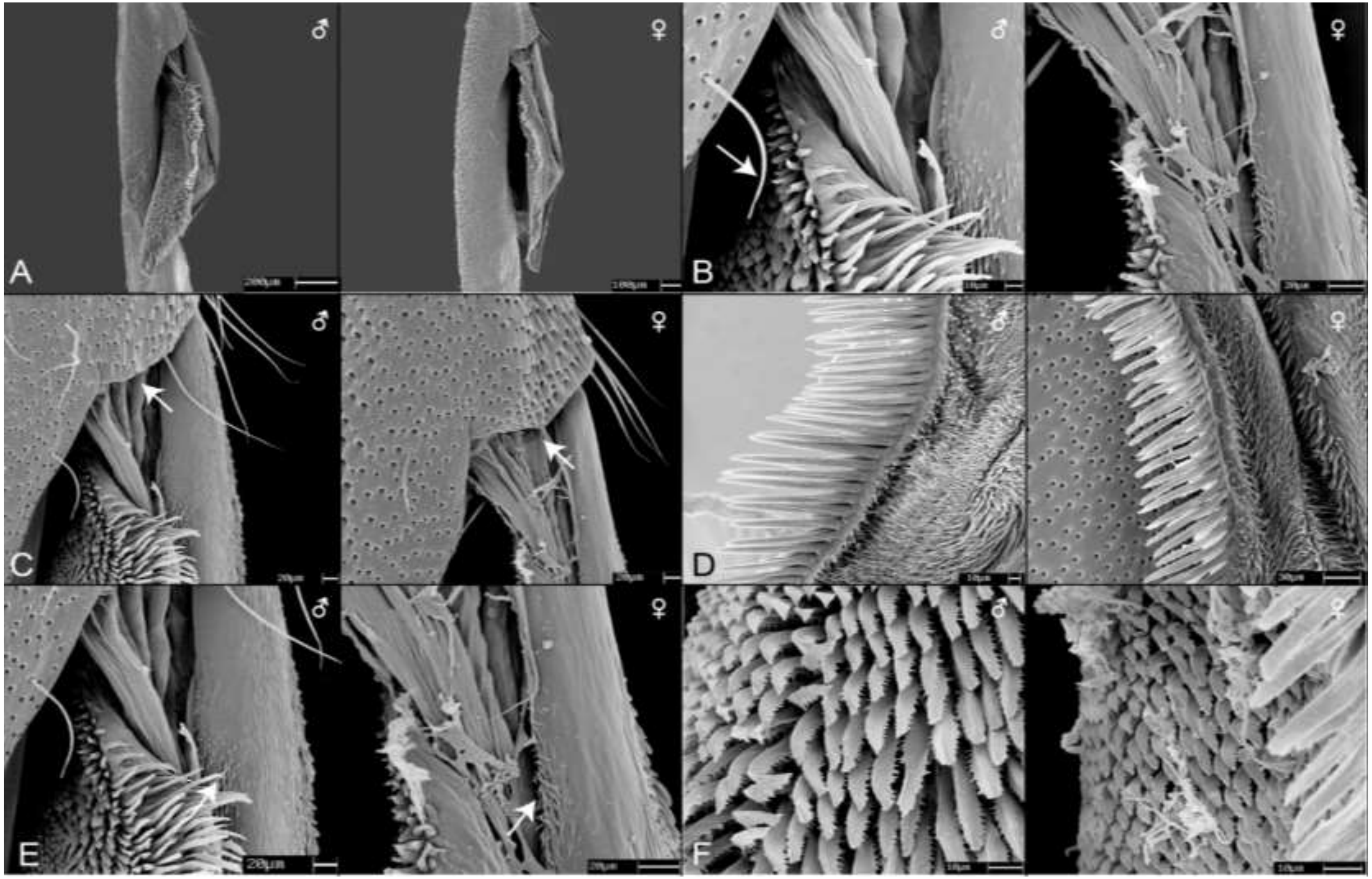


Figure 76. Ultrastructure of the epiphysis of *Hemaris diffinis*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin, F. Acanthae.

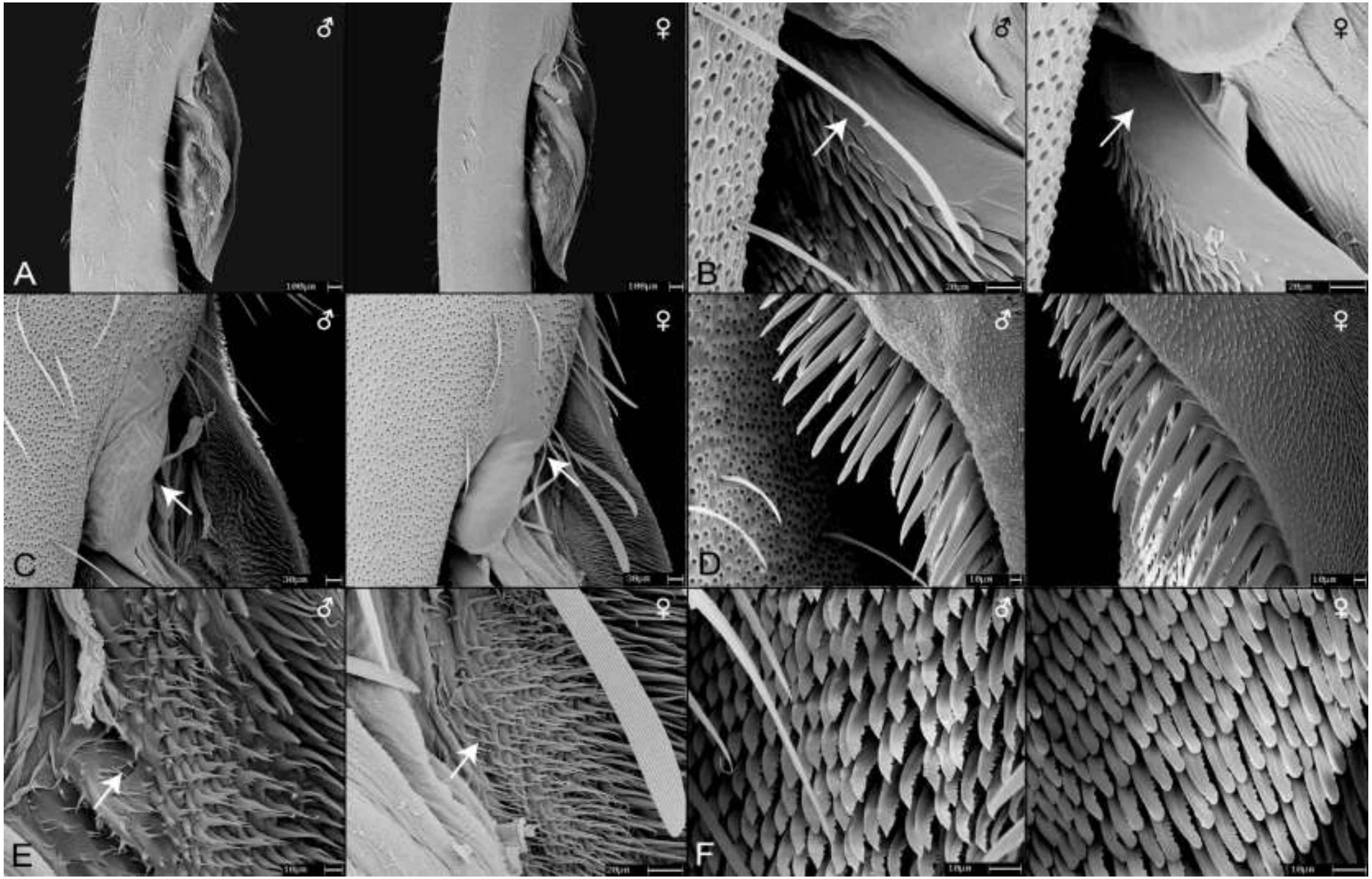


Figure 77. Ultrastructure of the epiphysis of *Pachylia darceta*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin, F. Acanthae.

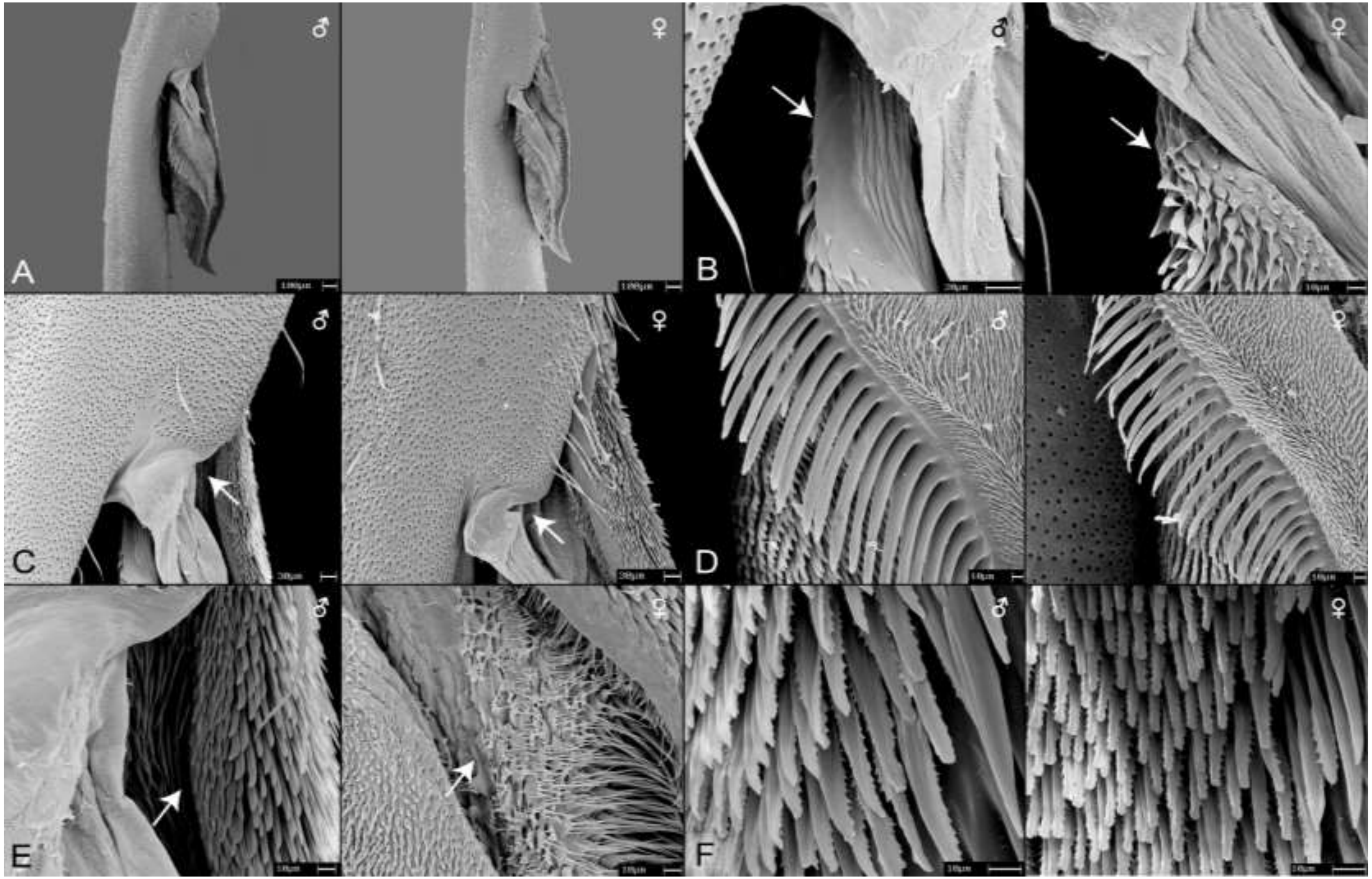


Figure 78. Ultrastructure of the epiphysis of *Callionima parce*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin, F. Acanthae.

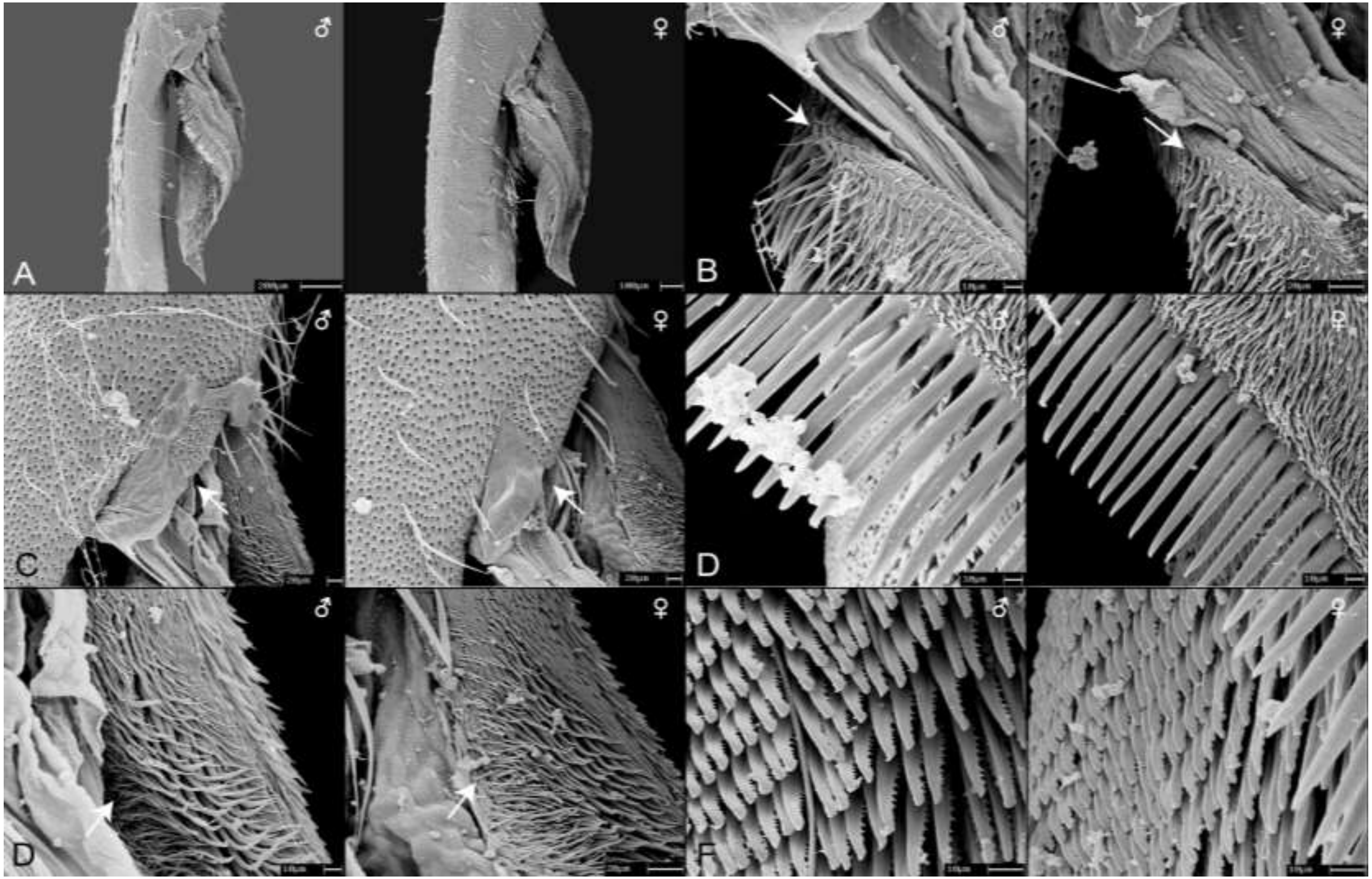


Figure 79. Ultrastructure of the epiphysis of *Nyceryx nictitans*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

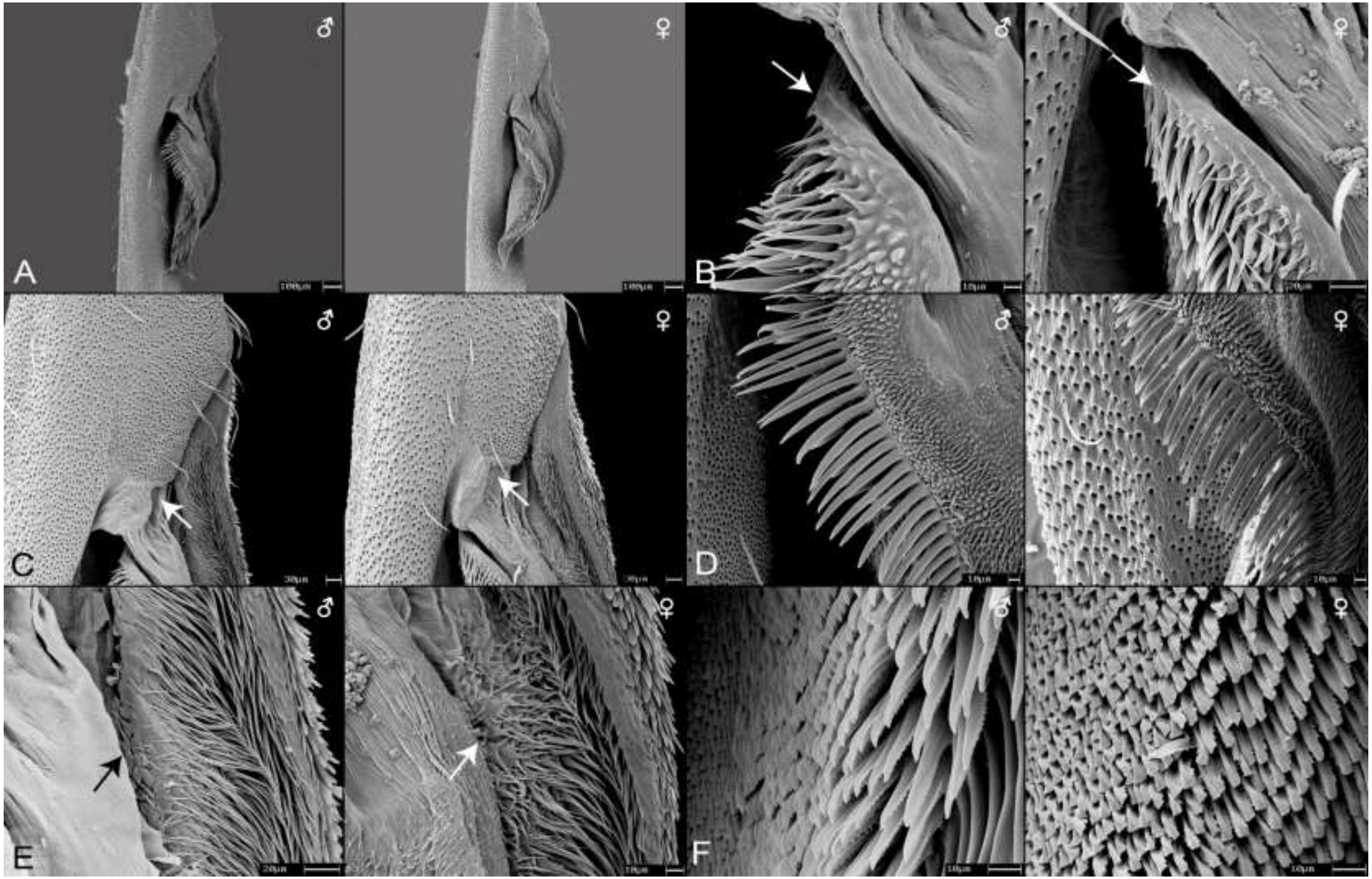


Figure 80. Ultrastructure of the epiphysis of *Perigonia stulta*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

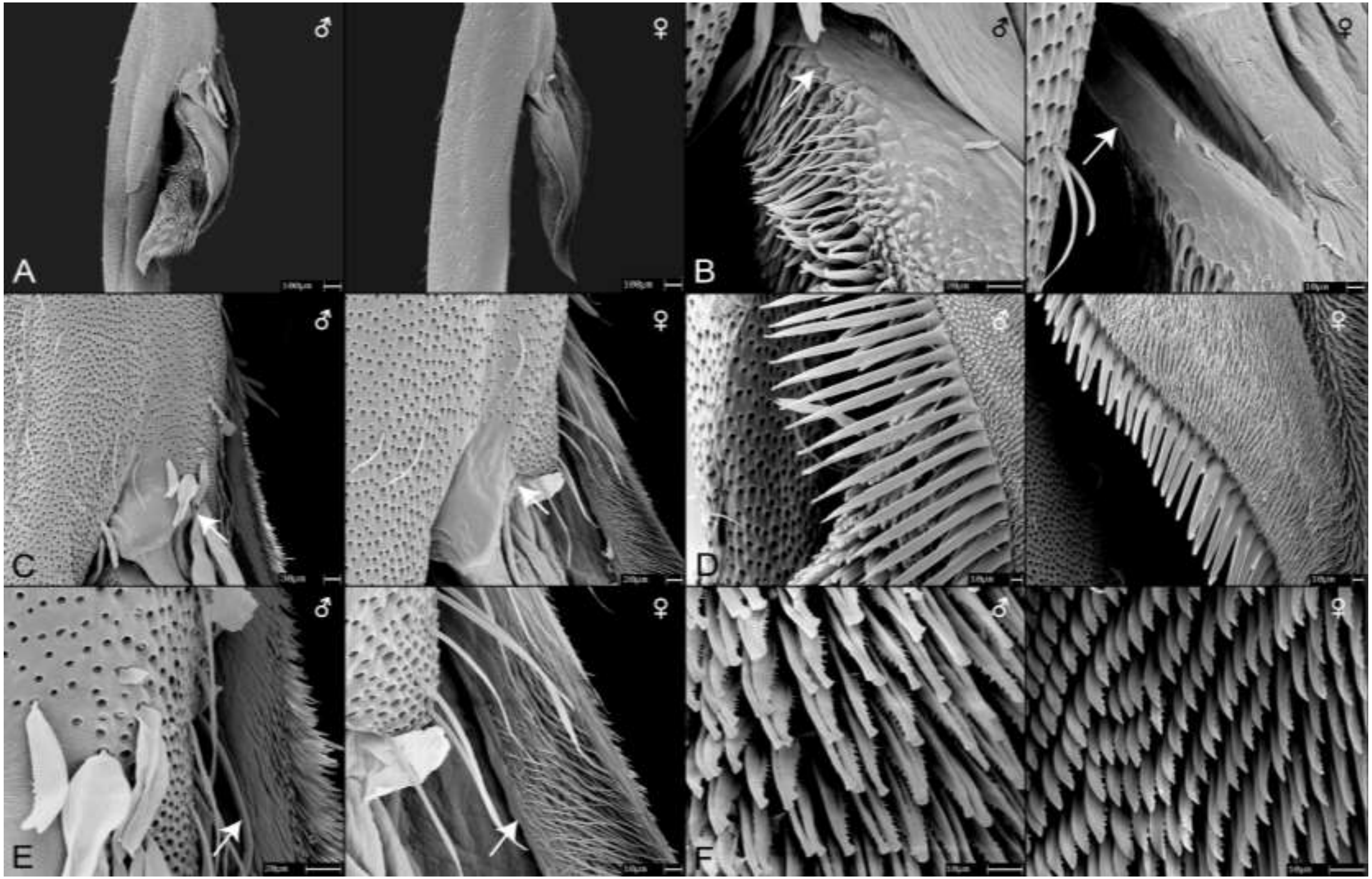


Figure 81. Ultrastructure of the epiphysis of *Eupyrrhoglossum sagra*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

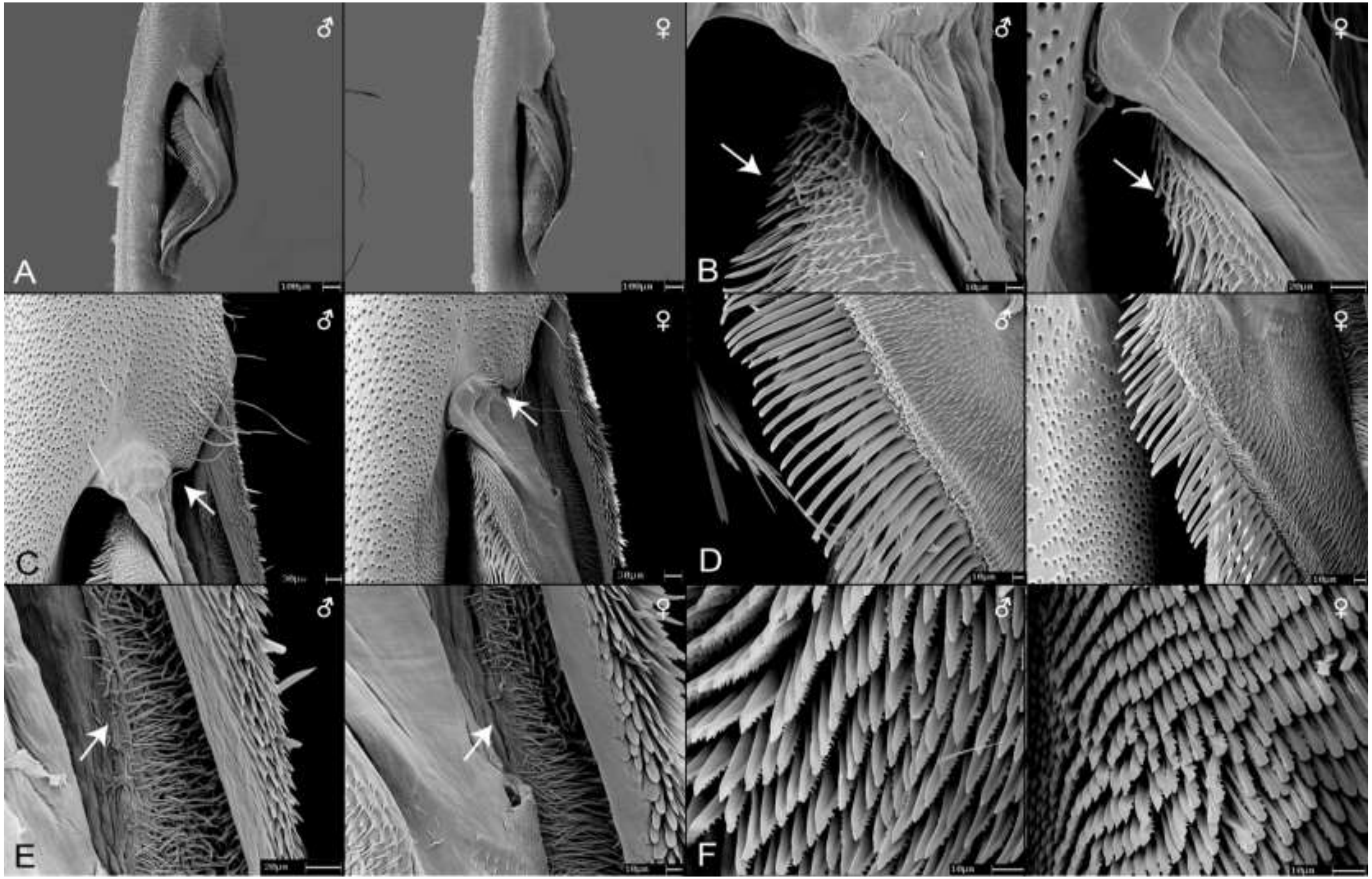


Figure 82. Ultrastructure of the epiphysis of *Aellopos fadus*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

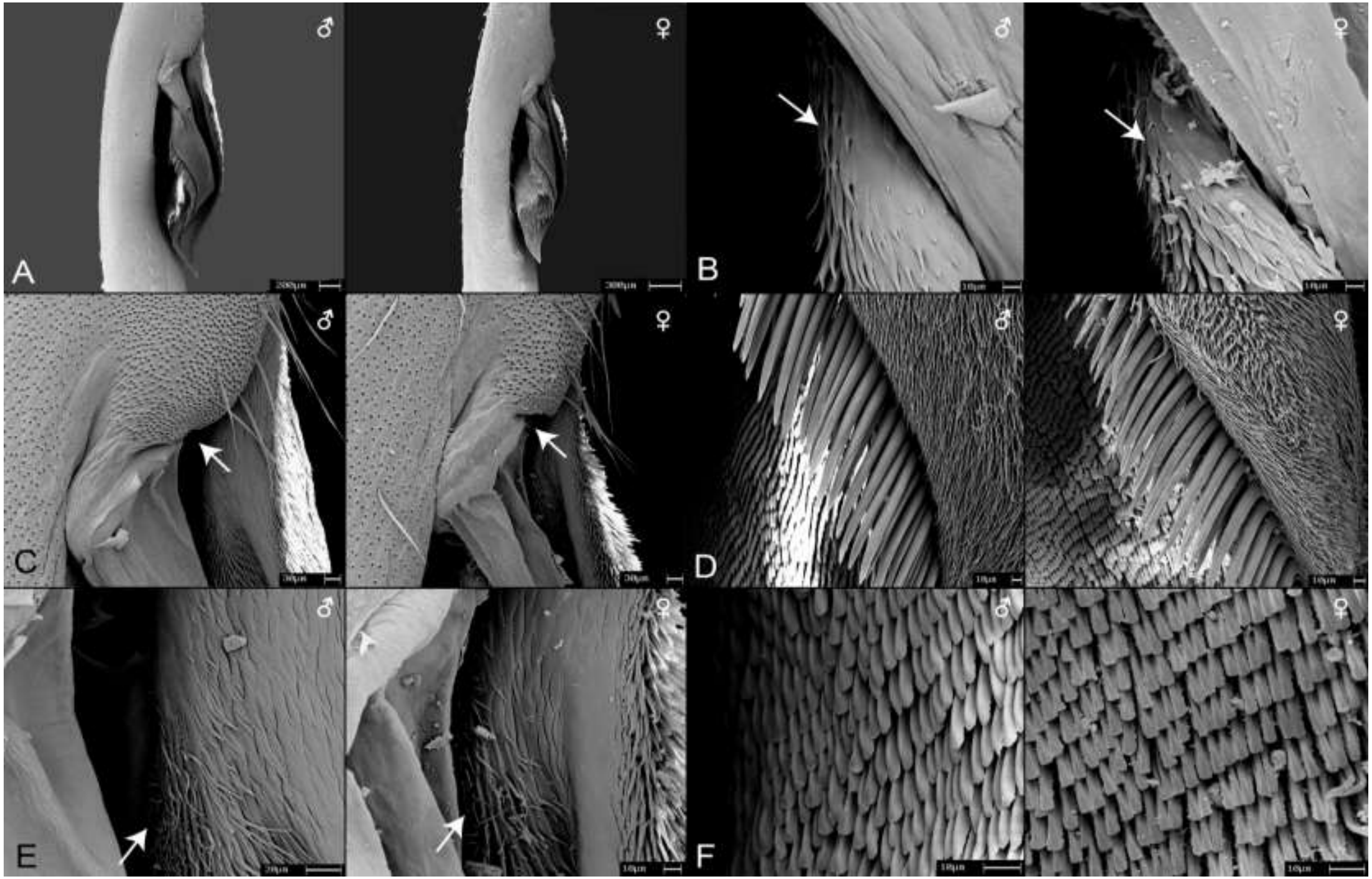


Figure 83. Ultrastructure of the epiphysis of *Oryba kadeni*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

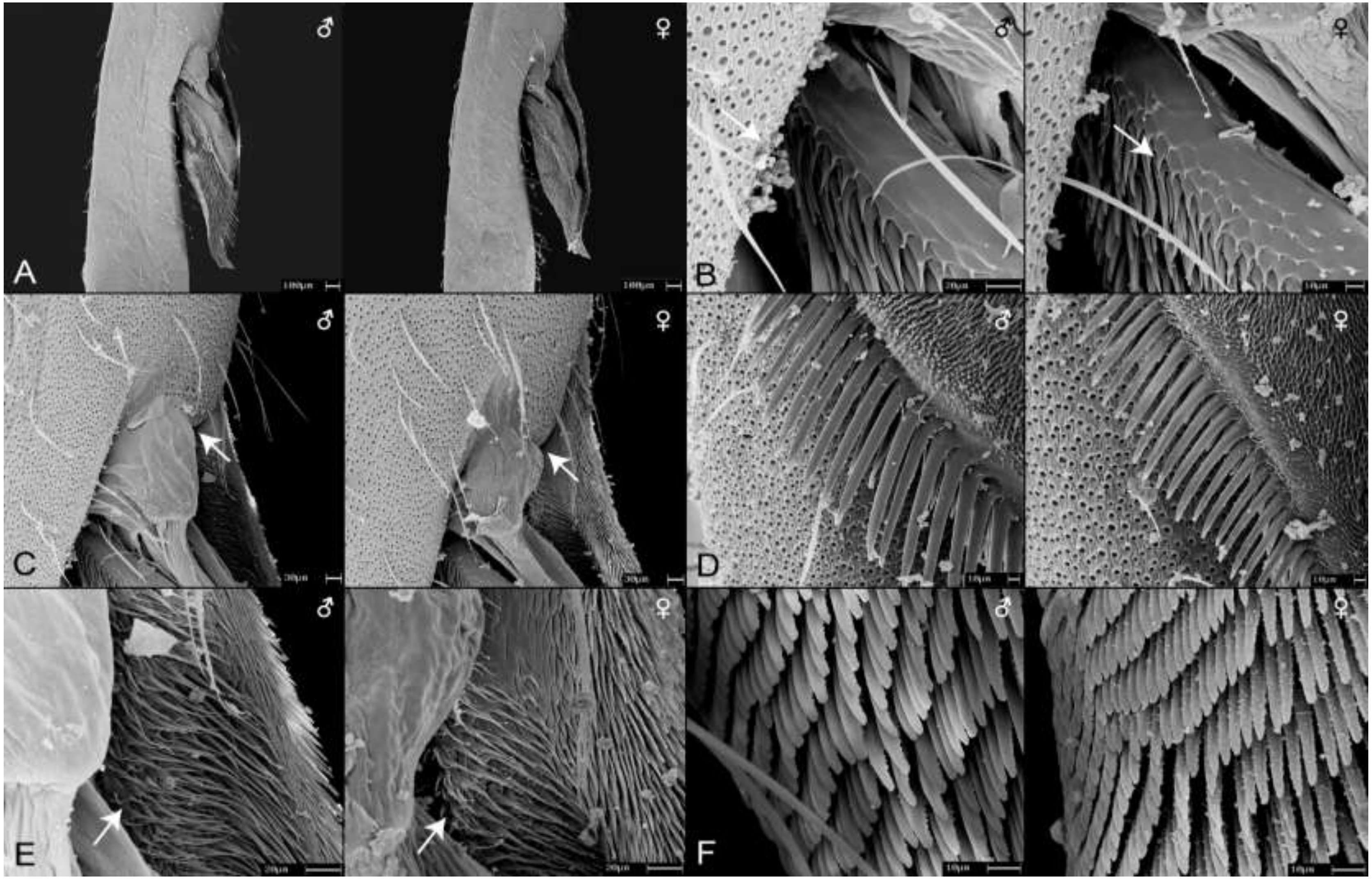


Figure 84. Ultrastructure of the epiphysis of *Pachylioides resumens*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

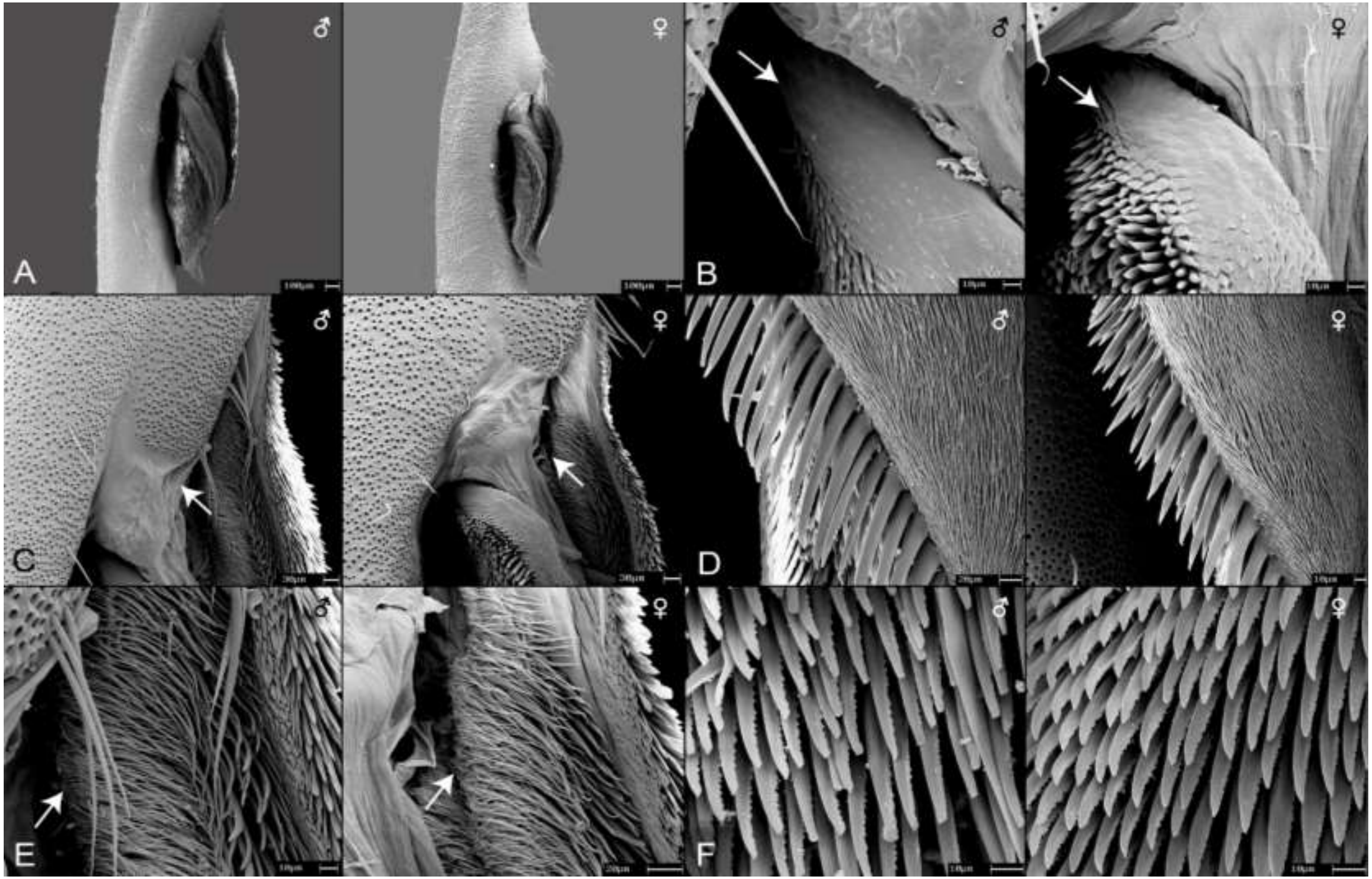


Figure 85. Ultrastructure of the epiphysis of *Madoryx plutonius*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

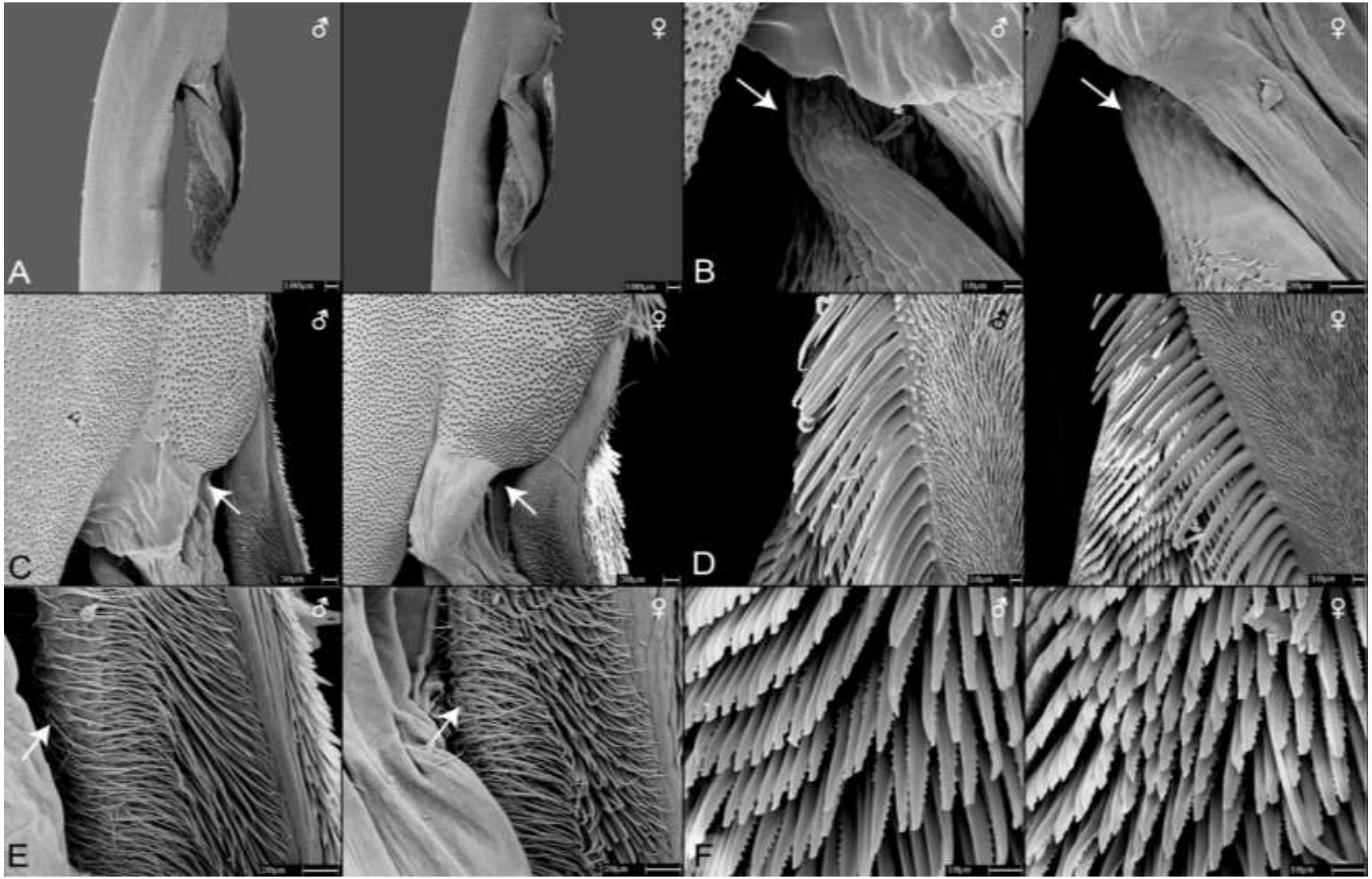


Figure 86. Ultrastructure of the epiphysis of *Hemeroplanes ornatus*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

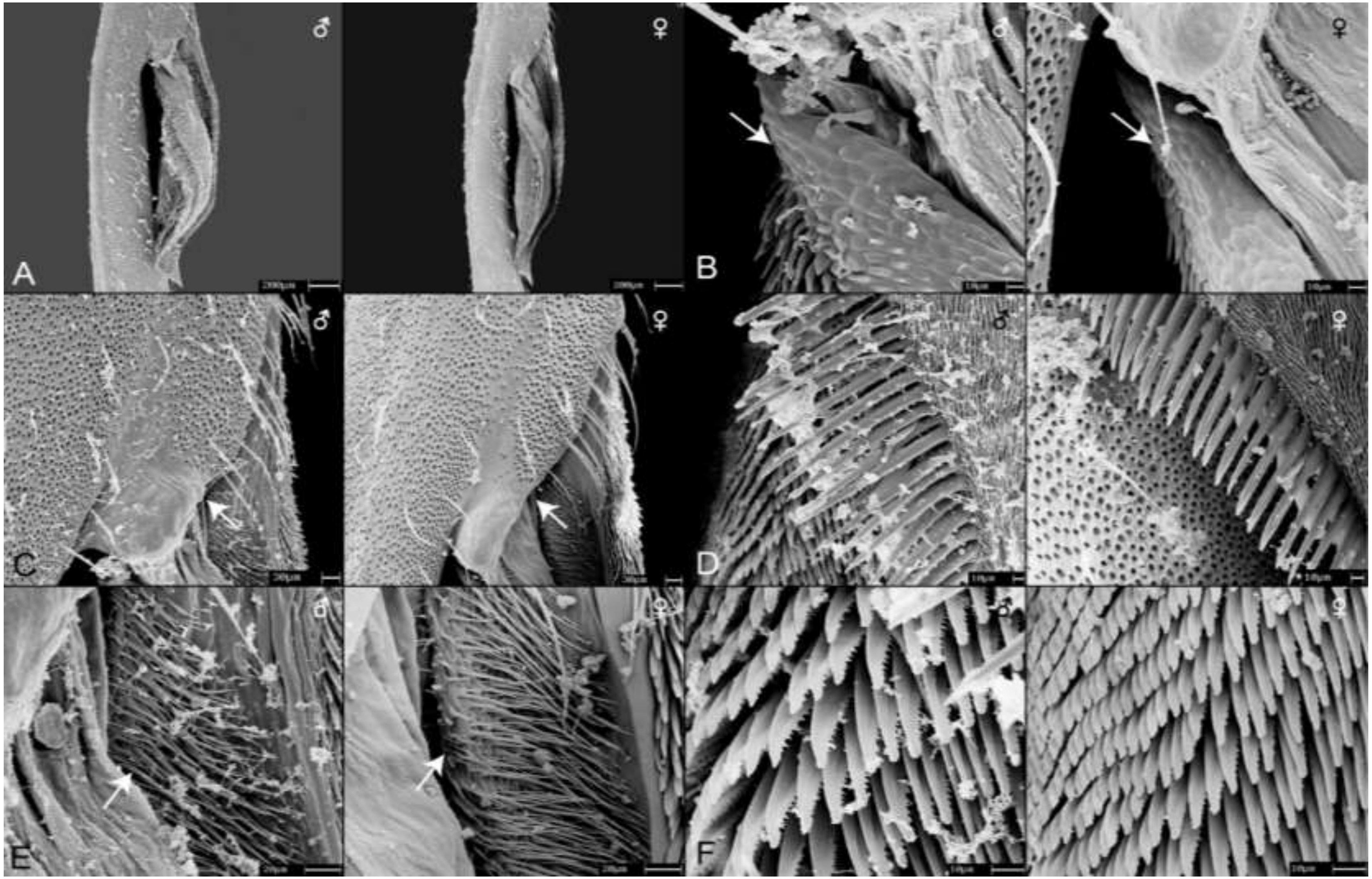


Figure 87. Ultrastructure of the epiphysis of *Erinnyis oenotrus*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin, F. Acanthae.

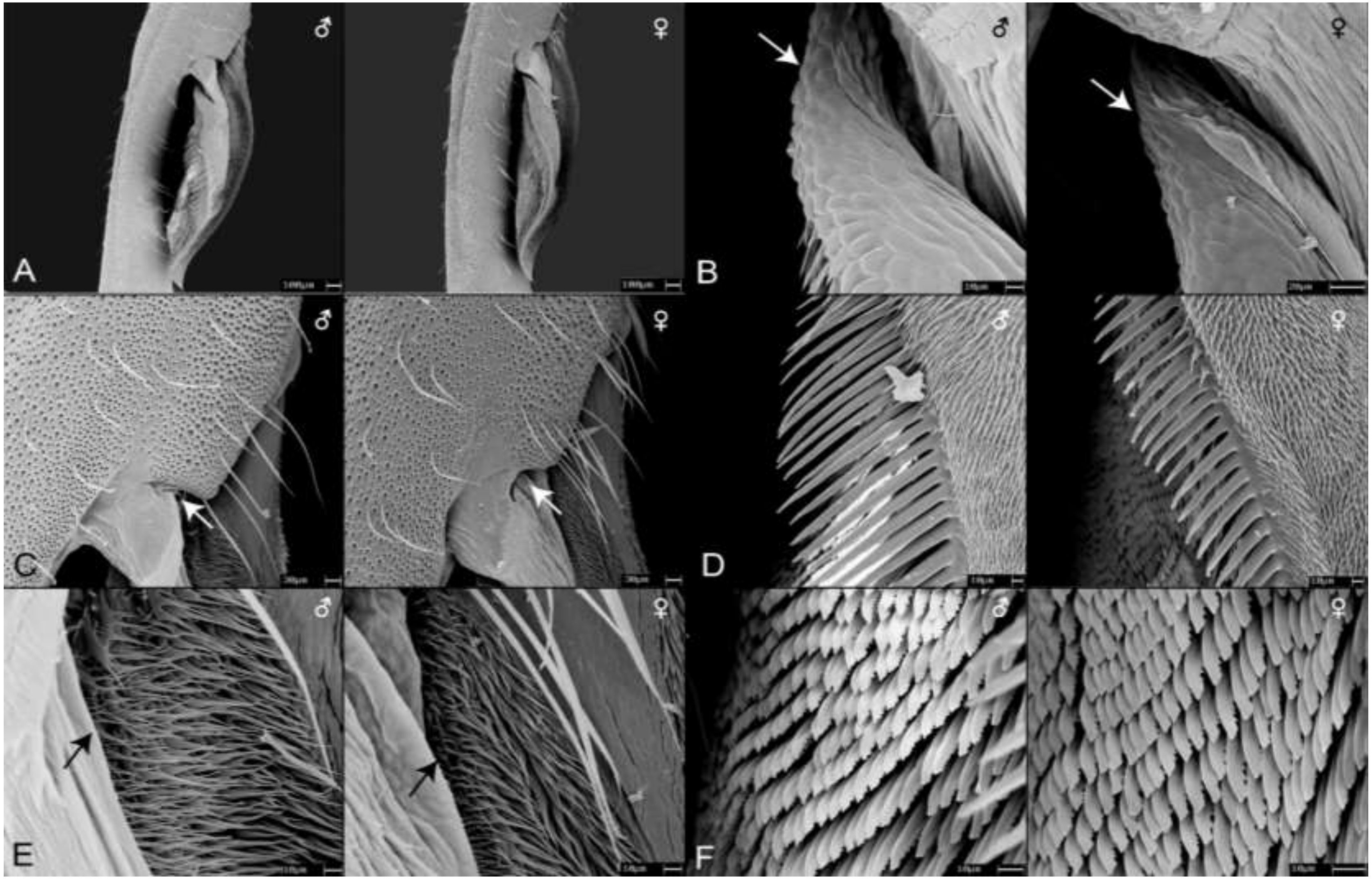


Figure 88. Ultrastructure of the epiphysis of *Isognathus menechus*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin, F. Acanthae.

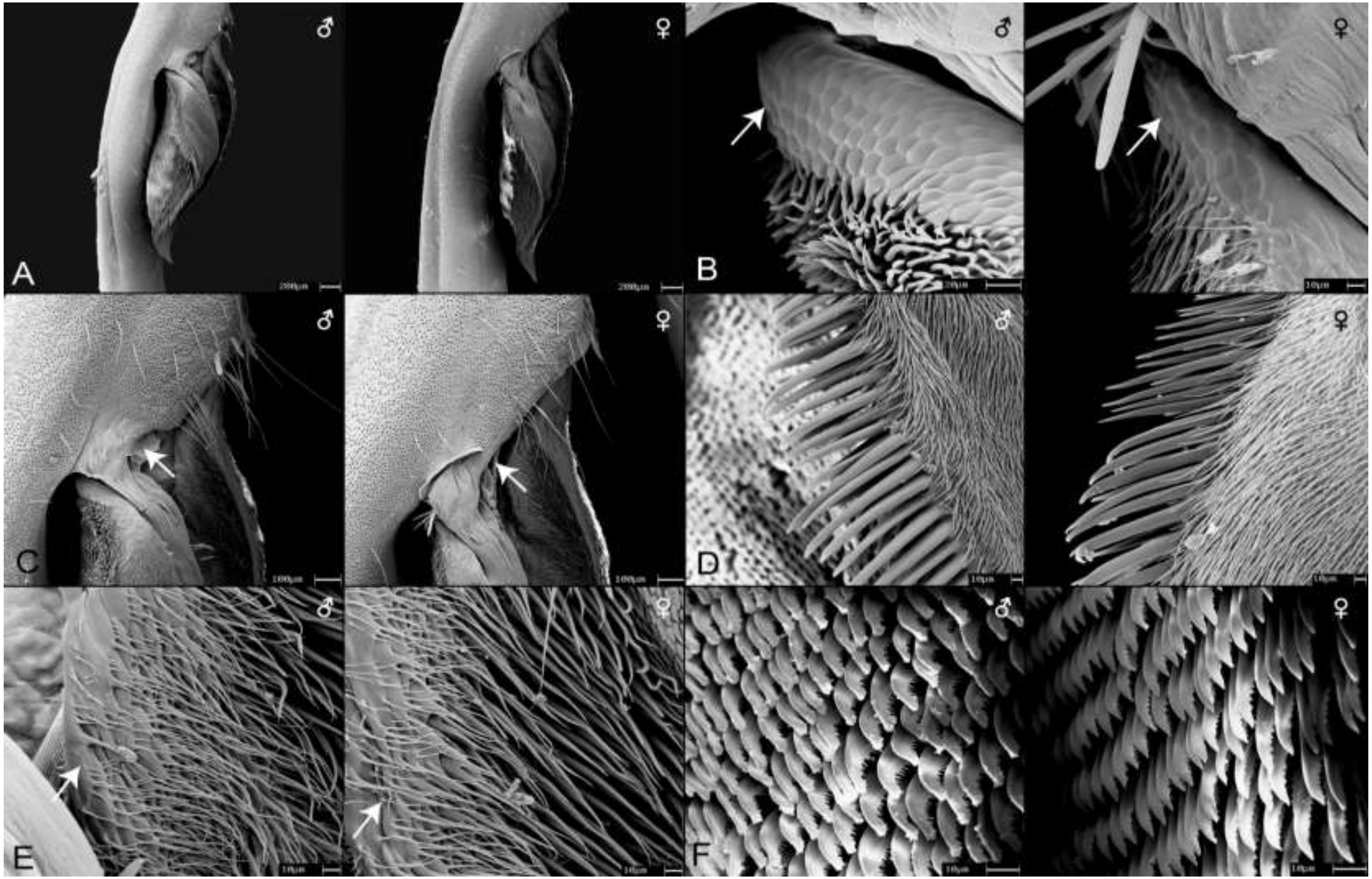


Figure 89. Ultrastructure of the epiphysis of *Pseudosphinx tetrio*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

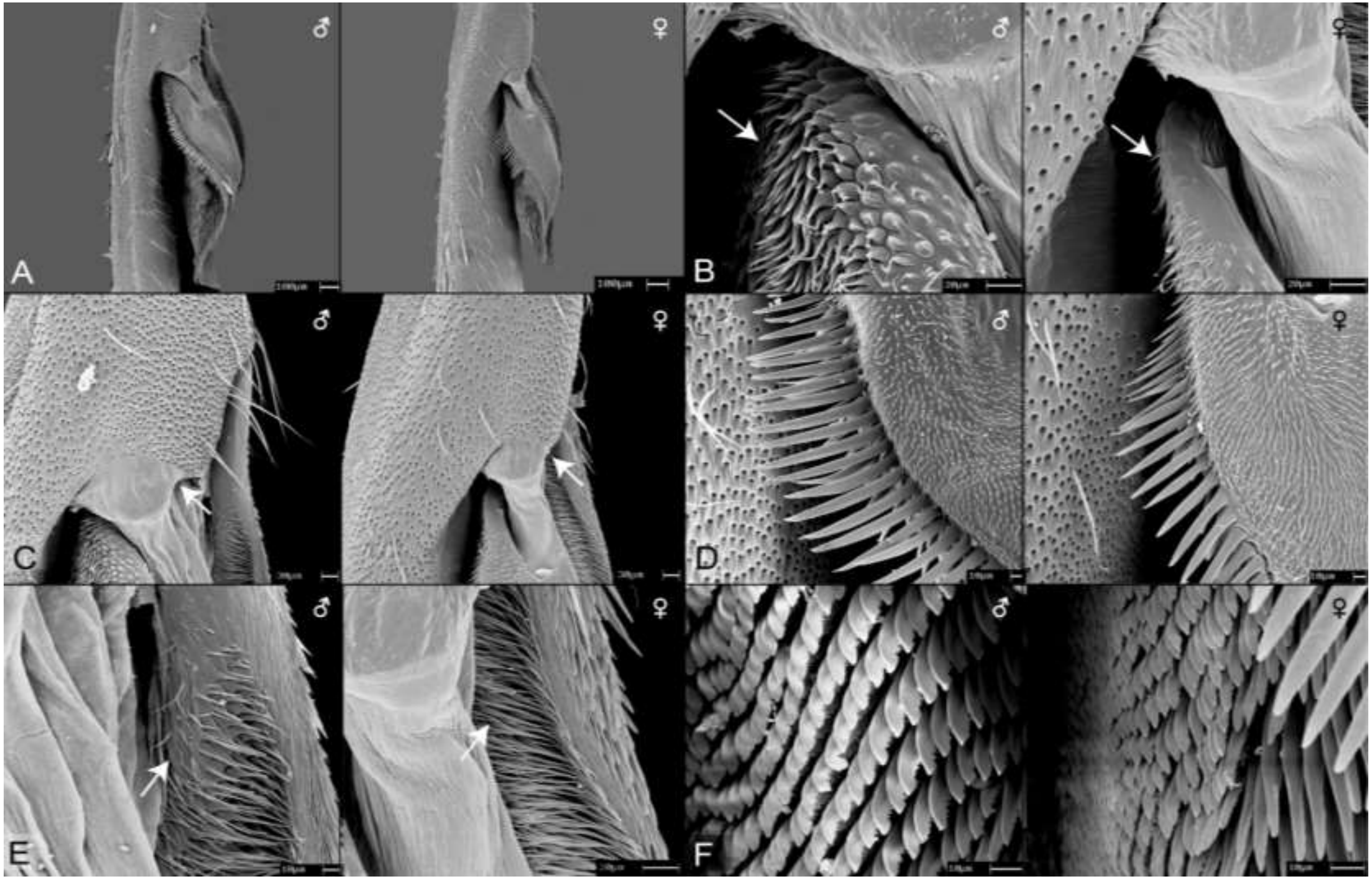


Figure 90. Ultrastructure of the epiphysis of *Aleuron iphis*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

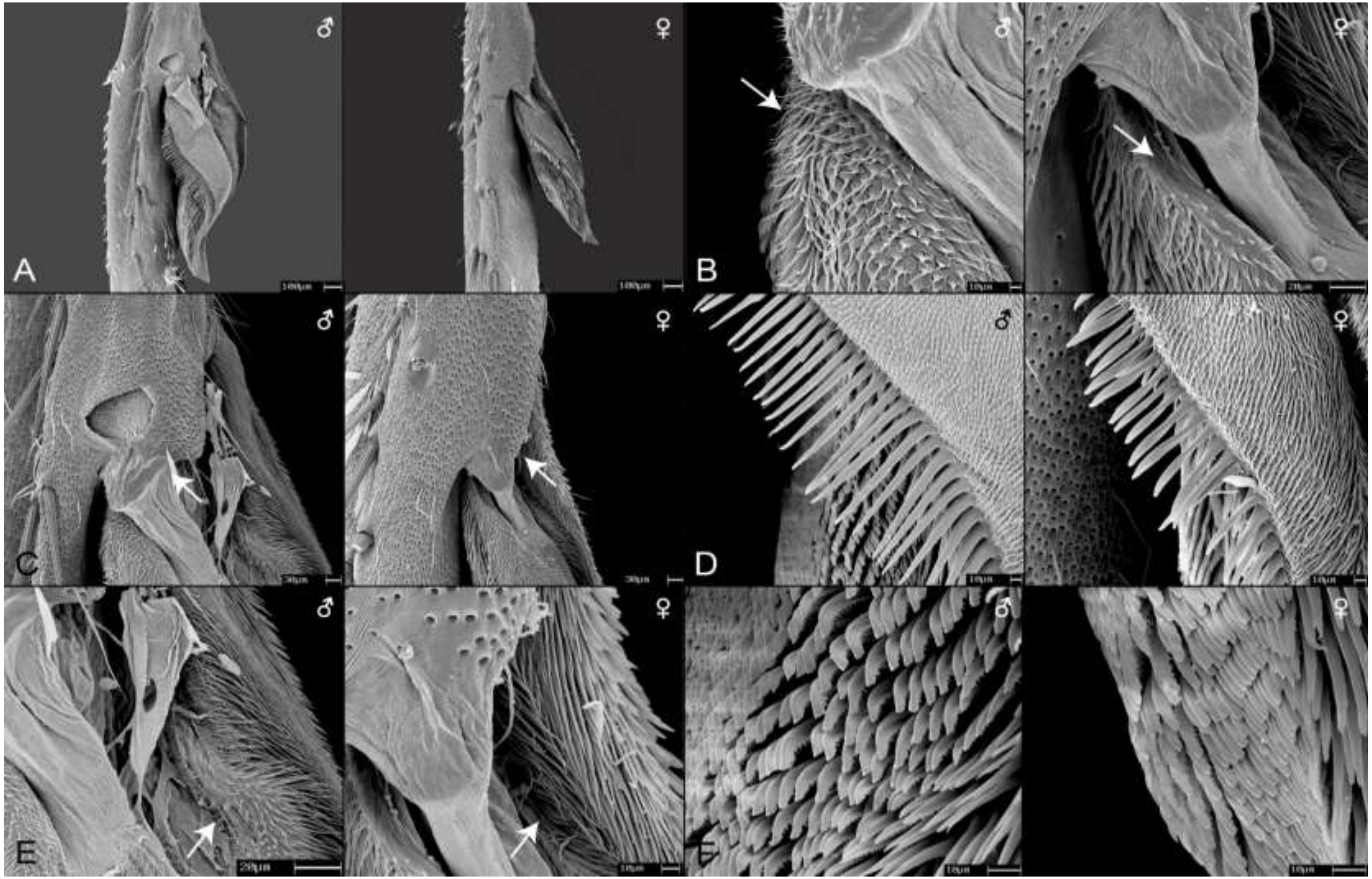


Figure 91. Ultrastructure of the epiphysis of *Unzela japix discrepans.* A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

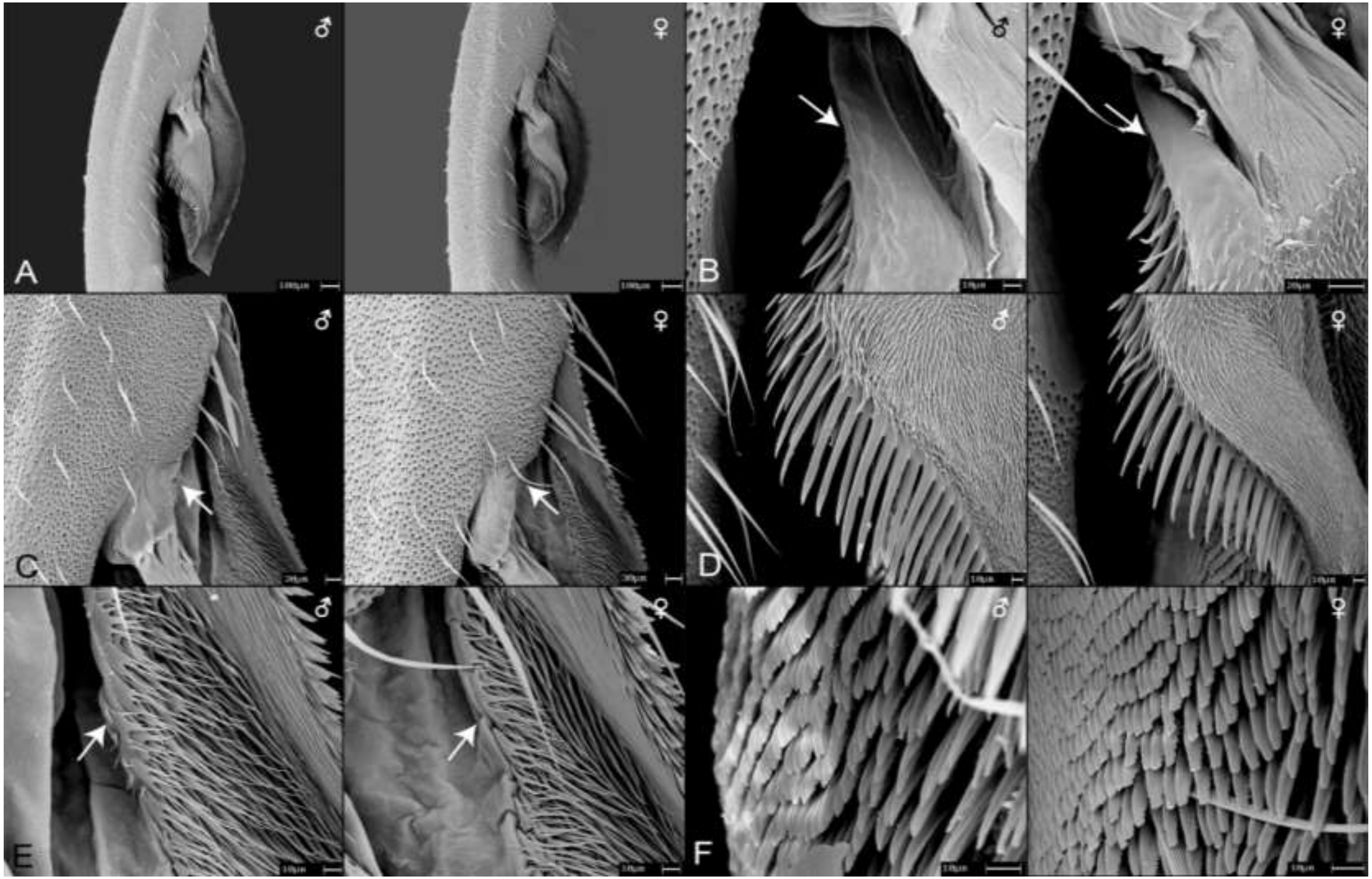


Figure 92. Ultrastructure of the epiphysis of *Enyo lugubris.* A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin surface, F. Acanthae.

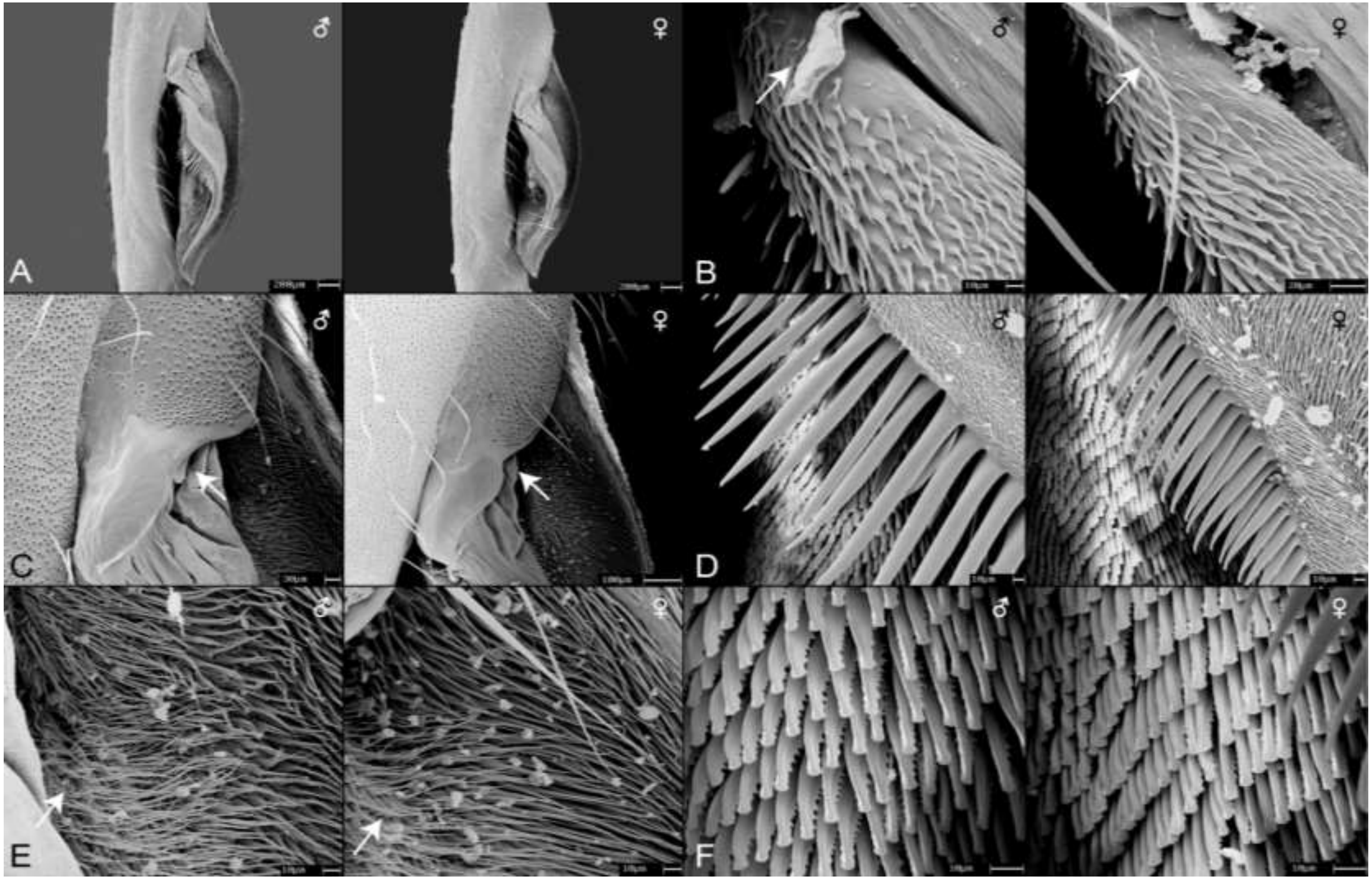


Figure 93. Ultrastructure of the epiphysis of *Eumorpha obliquus*. A. General view, B. Inner margin surface, C. Invagination, D. Comb, E. Outer margin, F. Acanthae.

3.2. Brief description of the antennae

All the studied antennae are filiform and densely scaled dorsally (Figures 95-157), most of them presented pronounced sexual dimorphism on the size of the antennal sensilla. Most males have long and developed sensilla and females lack them (smooth surface). However, there are exceptions as females of *Callionima* (Figs 105-108) with short sensilla along the surface similar to the males, females of *Aleuron* (Figs 142-145) and *Unzela japix discrepans* (Figure 146) show some small sensilla scattered on the antennal surface.

The antennae of Dilophonotini average 16.18 ± 4.04 mm (including all specimens of this tribe). When comparing antenna sizes among genera of Dilophonotini, *Hemaris* (11 ± 0.816 mm)*, Perigonia* (11.54 ± 0.914 mm) and *Enyo* (11.95 ± 1.274 mm) show, in average, the shortest antennae. Moreover, *Pseudosphinx* (26.07 ± 1.083 mm), *Pachylia* (21.48 ± 2.911 mm) and *Oryba* (20.67 ± 1.941 mm) have the longest antennae (Figure 94, Appendix E). Other species with shortest antennae are *Hemaris croatica* (10.50 ± 0.707 mm), *Perigonia pallida* (11.00 ± 0.408 mm) and *Enyo lugubris* (11.05 ± 0.765 mm), and other species with longest antennae are *Pachylia ficus* (24.60 ± 1.404 mm)*, Oryba achemenides* (22.25 ± 0.354 mm) and *Isognathus caricae* (20.80 ± 0.902 mm). The antennae of Philampelini average 21.57 ± 2.89 mm (including all specimens of this tribe), when comparing antenna sizes between species. *Eumorpha fasciatus* (18.58 ± 0.718 mm) shows the shortest antennae and *Eumorpha anchemolus* (26.60 ± 1.724 mm), the longest antennae.

Most males have longer antennae than females; except in 15 of species. Thirteen species show females with longer antennae than males: H*emaris croatica*, *Pachylia darceta*, *Pachylia syces*, Callionima *innus*, *Callionima nomius*, *Callionima parce*, *Oryba kadeni*, *Madoryx bubastus*, *Madoryx oiclus*, *Madoryx plutonius*, *Isognathus menechus*, *Pseudosphinx tetrio* and *Eumorpha vitis*. As well as, *Callionima guiarti* and *Nyceryx continua continua* do not show dimorphism in the length (Appendix E).

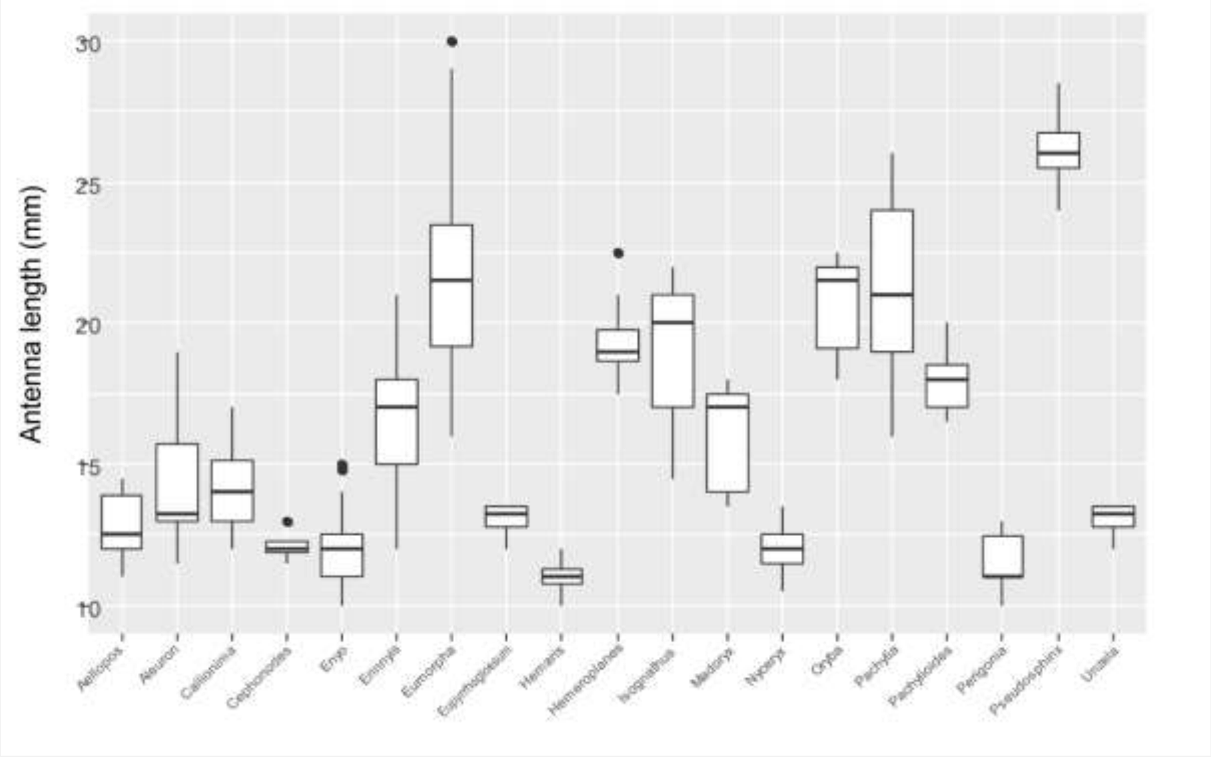
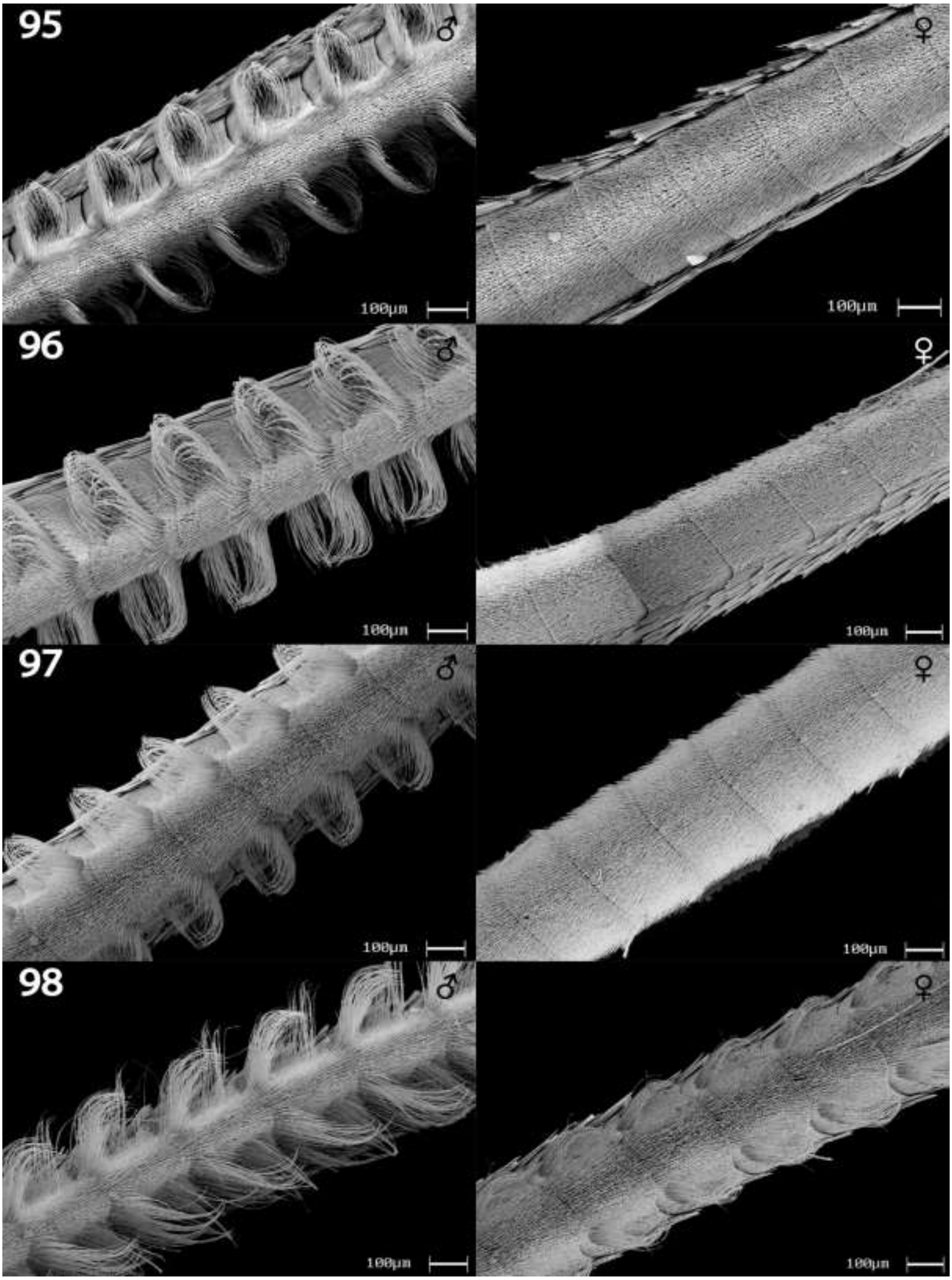
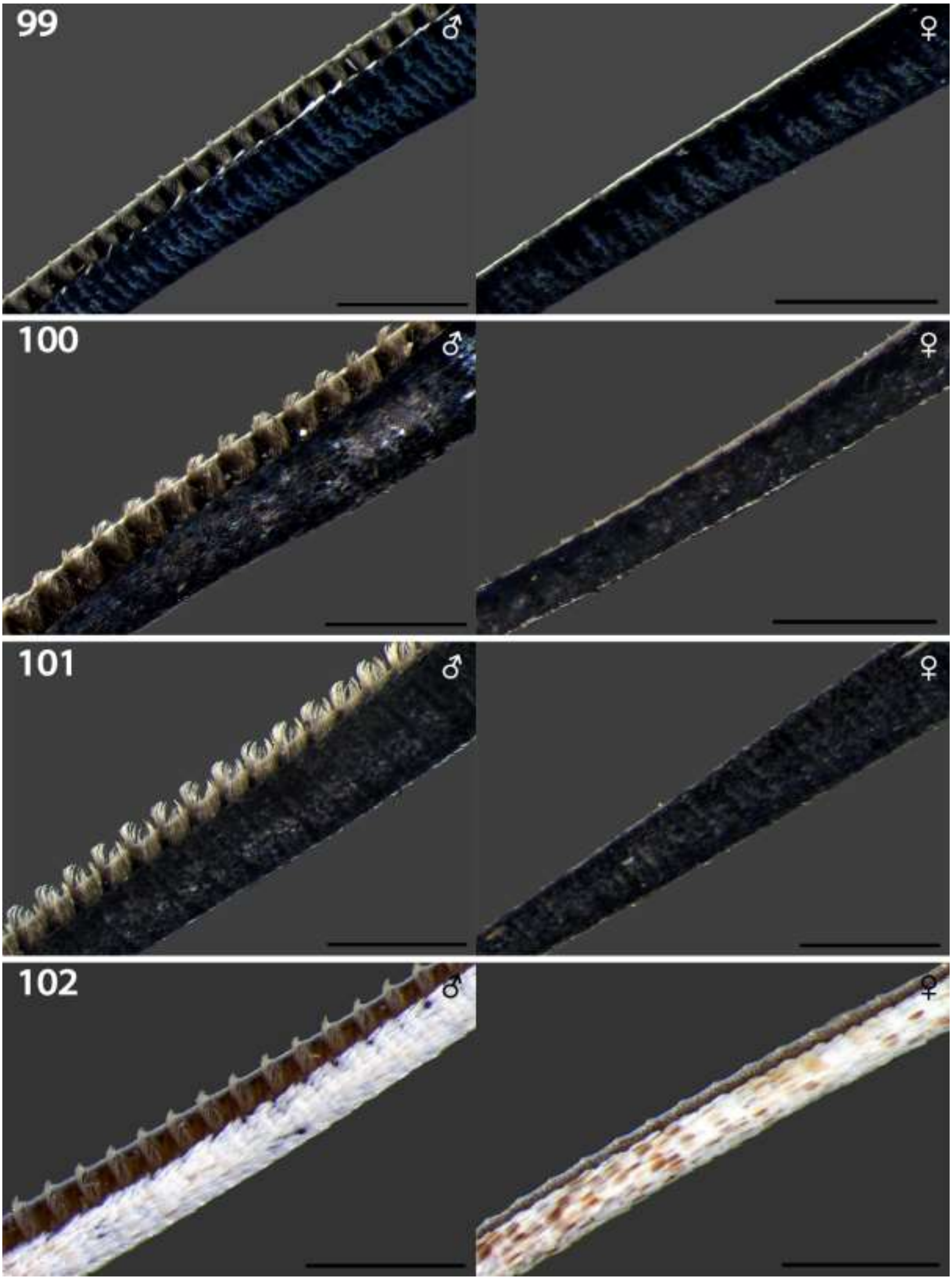


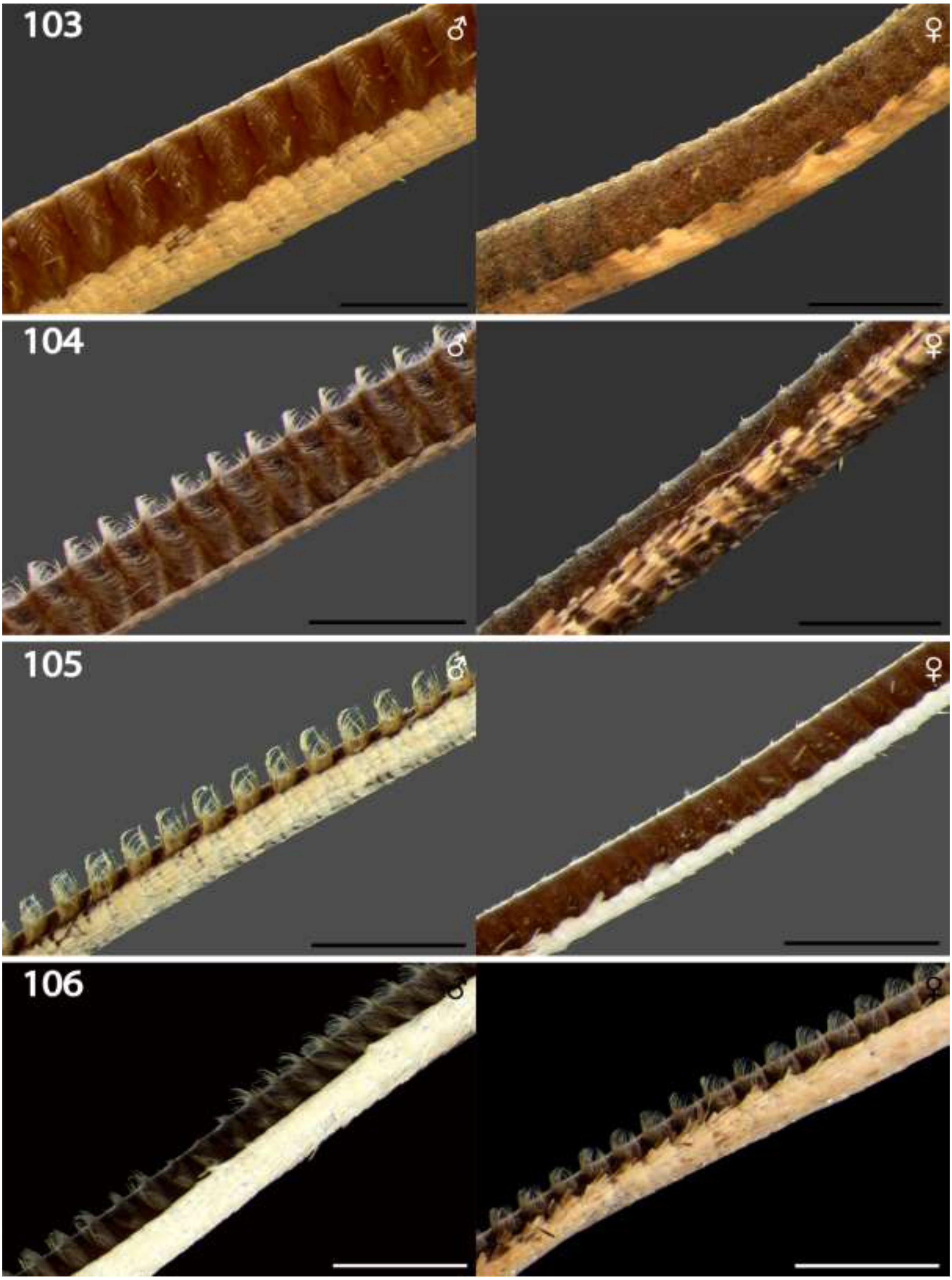
Figure 94. Boxplot of antennae length by genus. Dots indicate outliers.



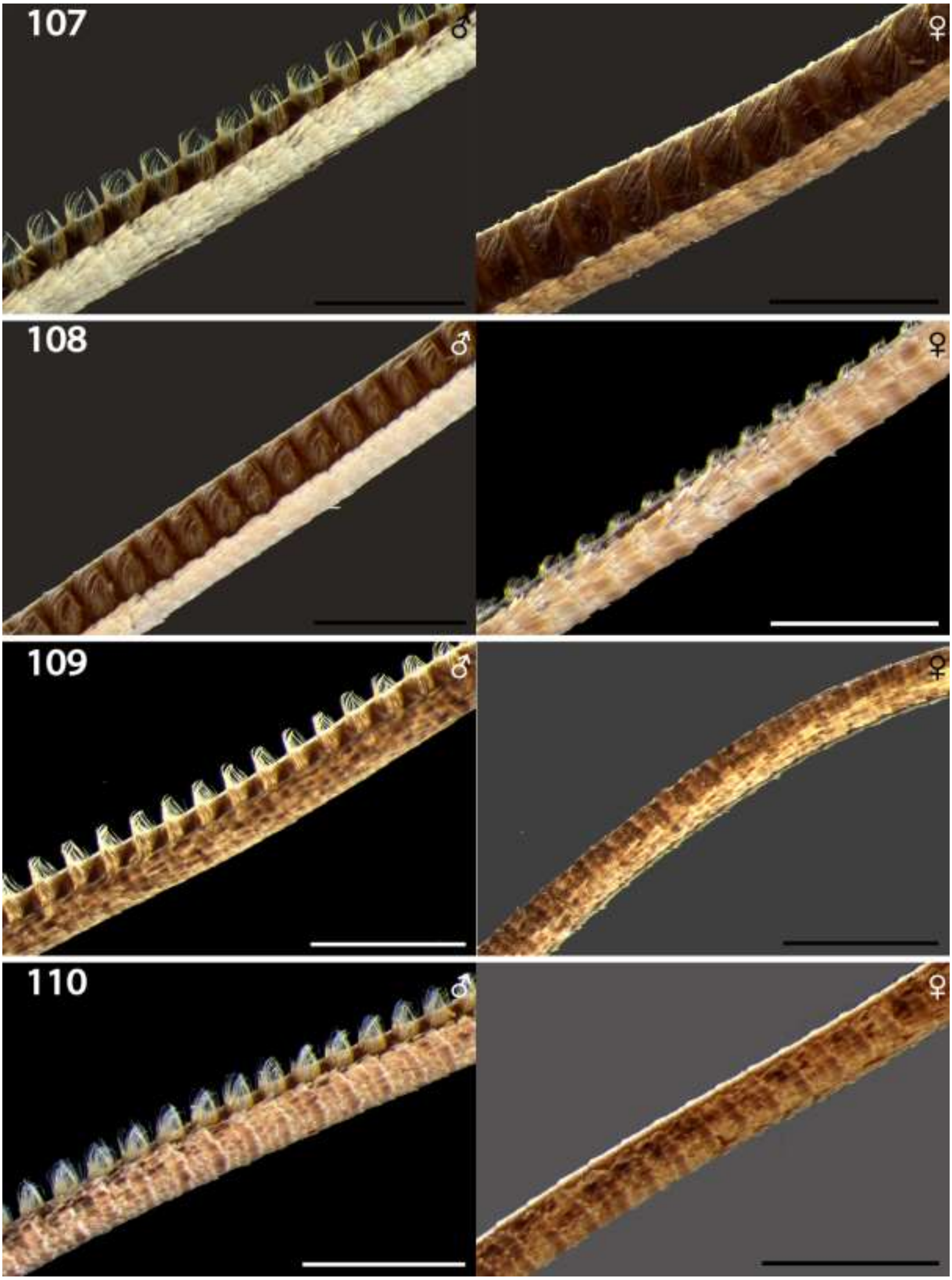
Figures 95-98. SEM of antennae. 95. *Cephonodes hylas*, 96. *Hemaris diffinis*, 97. *Pachylia darceta,* 98. *Callionima parce.*



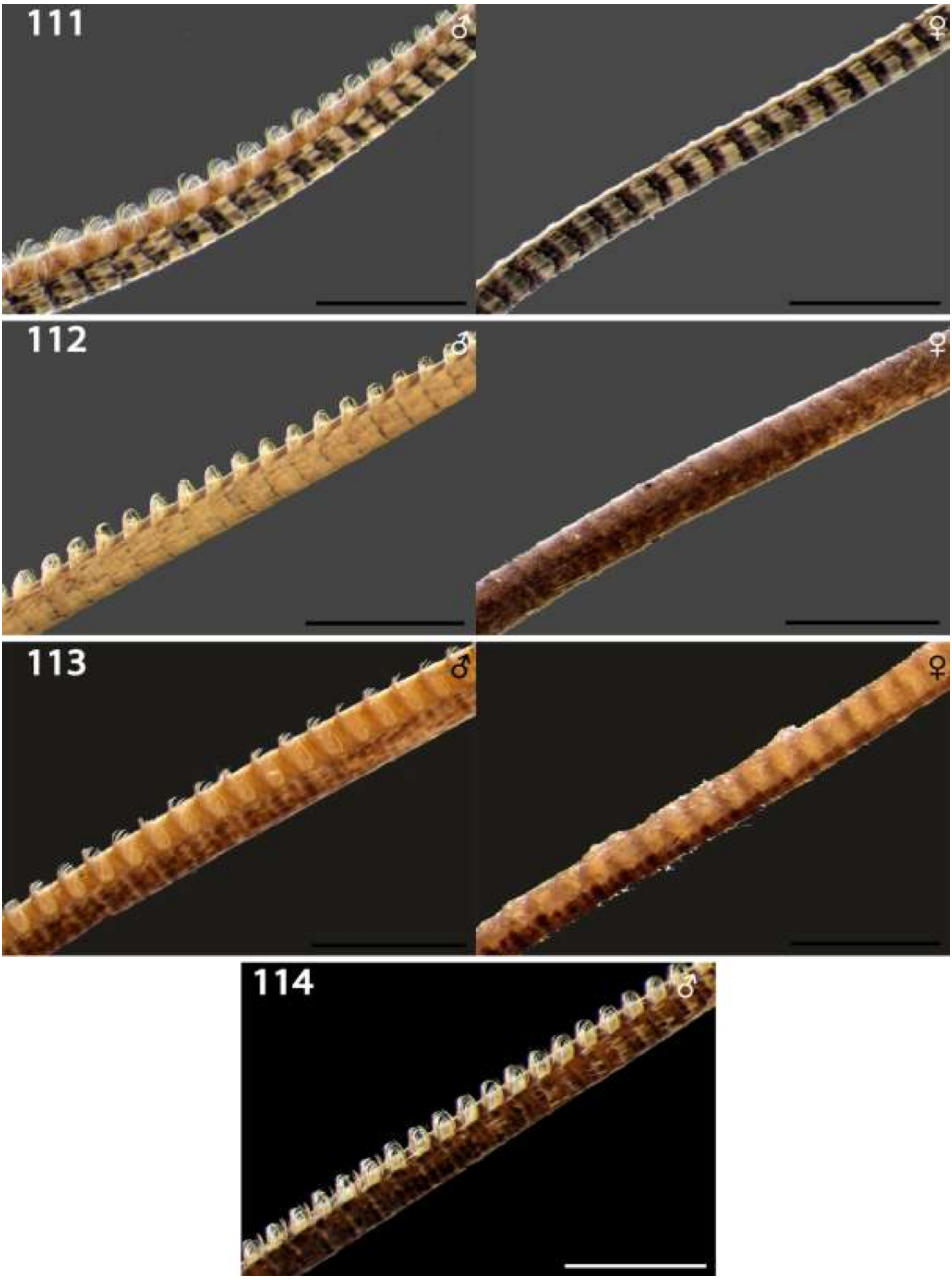
Figures 99-102. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 99. *Cephonodes hylas*, 100. *Hemaris diffinis*, 101. *Hemaris croatica,* 102. *Pachylia darceta.* Scale bar: 1 mm.



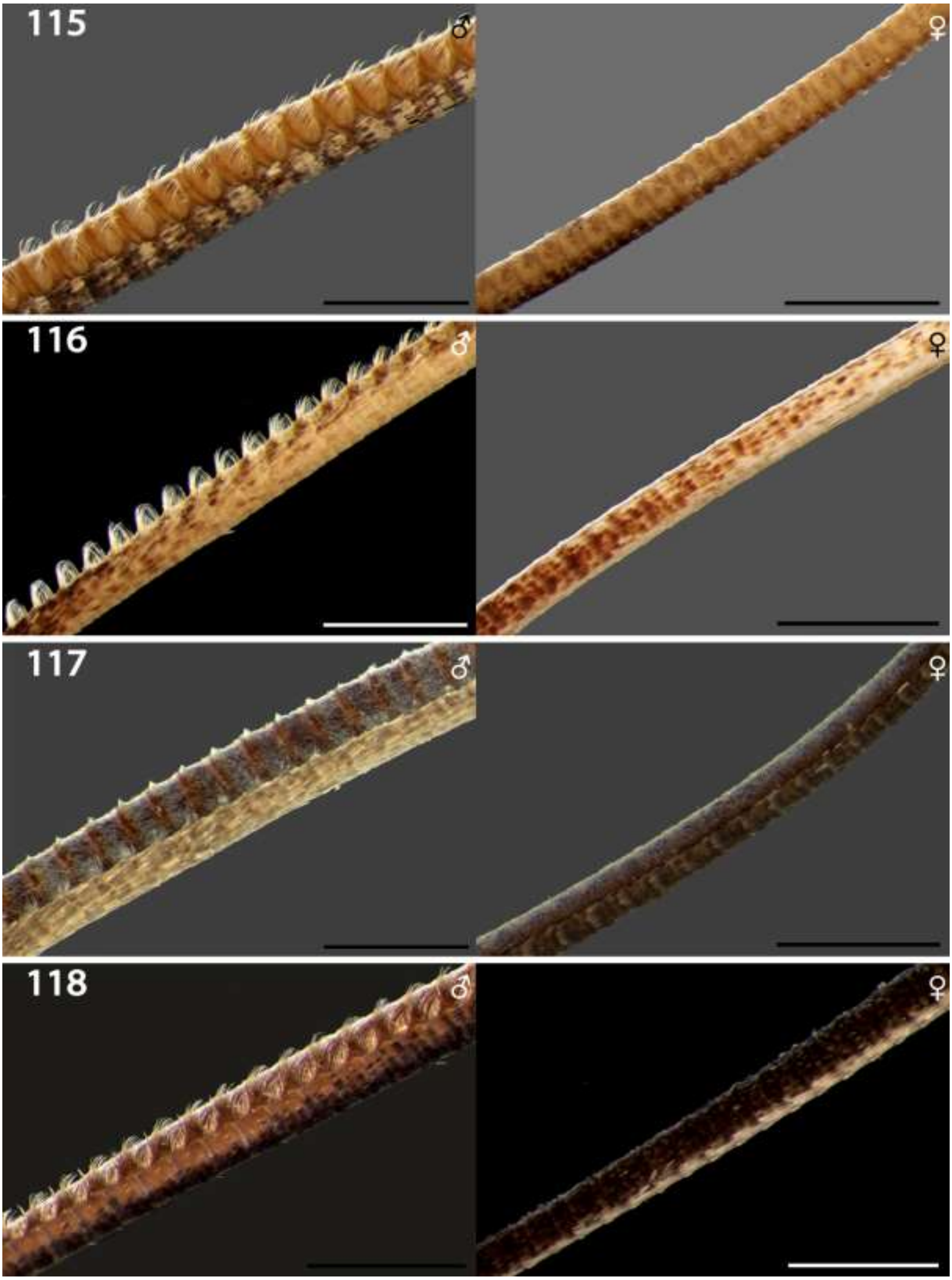
Figures 103-106. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 103. *Pachylia ficus*, 104. *Pachylia syces*, 105. *Callionima guiarti,* 106. *Callionima innus.* Scale bar: 1 mm.



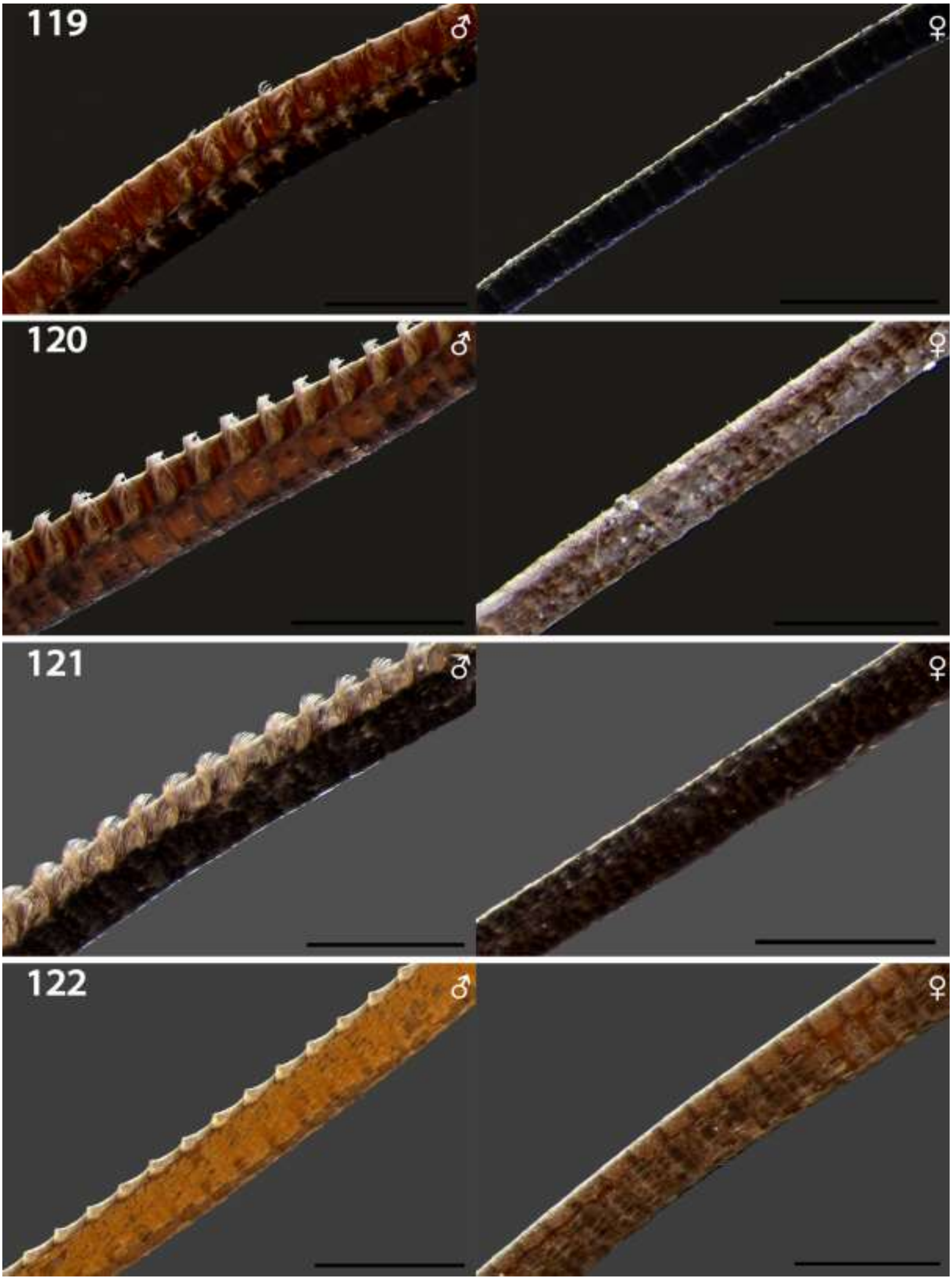
Figures 107-110. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 107. *Callionima nomius*, 108. *Callionima parce*, 109. *Nyceryx alophus,* 110. *Nyceryx continua continua.* Scale bar: 1 mm.



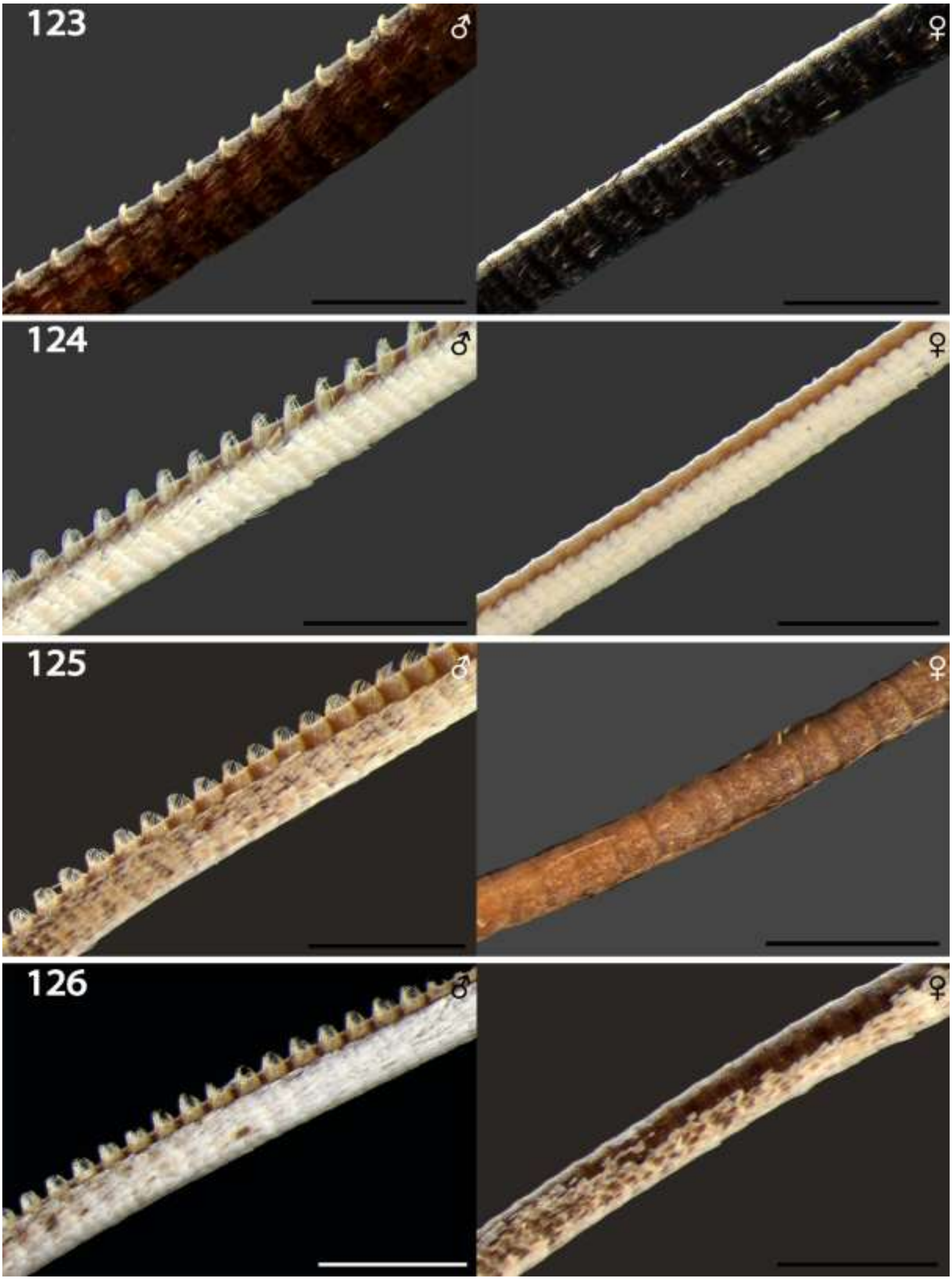
Figures 111-114. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 111. *Nyceryx nictitans nictitans*, 112. *Nyceryx stuarti*, 113. *Perigonia pallida,* 114. *Perigonia lusca.* Scale bar: 1 mm.



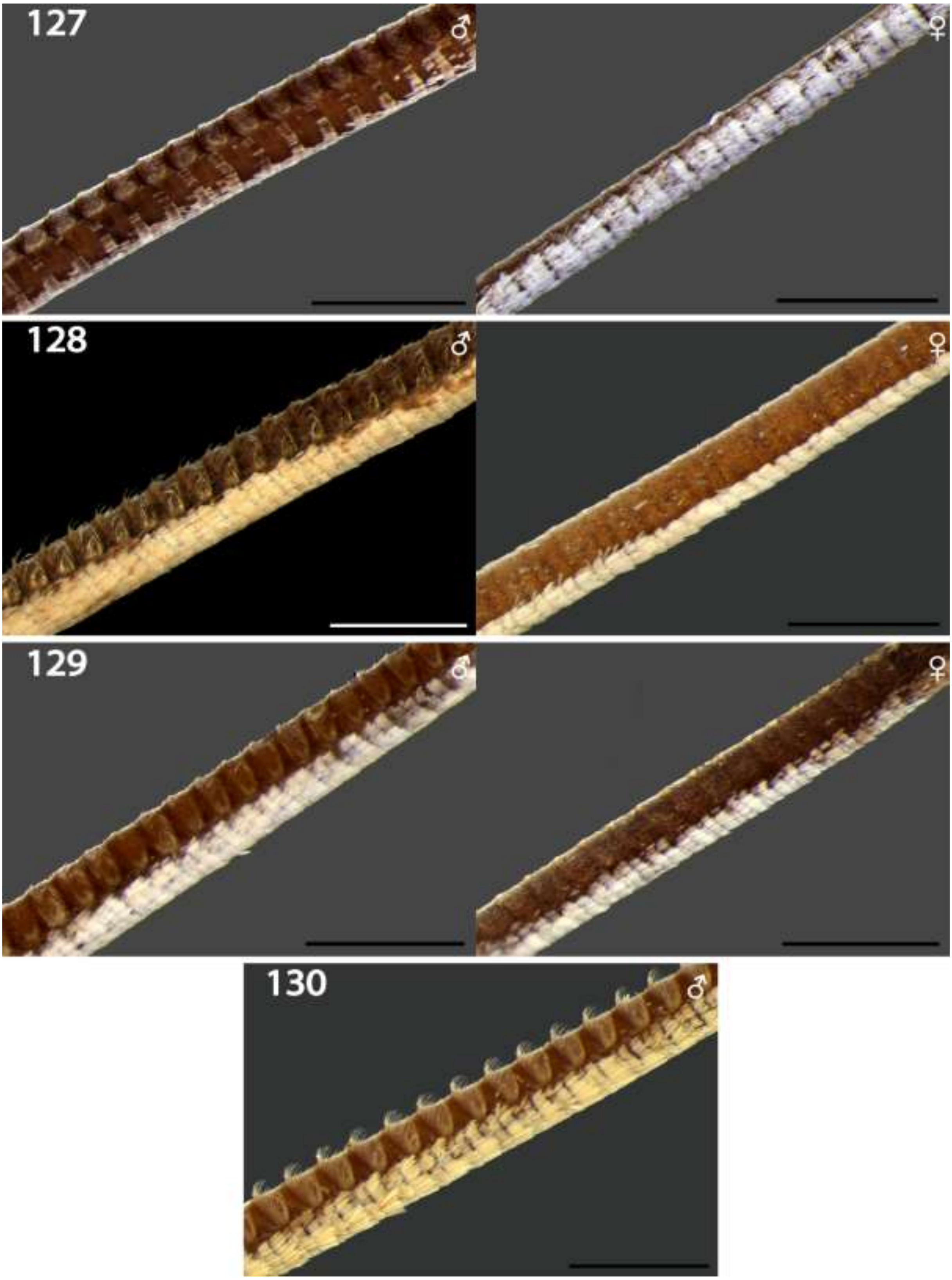
Figures 115-118. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 115. *Perigonia passerina*, 116. *Perigonia stulta*, 117. *Eupyrrhoglossum sagra,* 118. *Aellopos ceculus.* Scale bar: 1 mm.



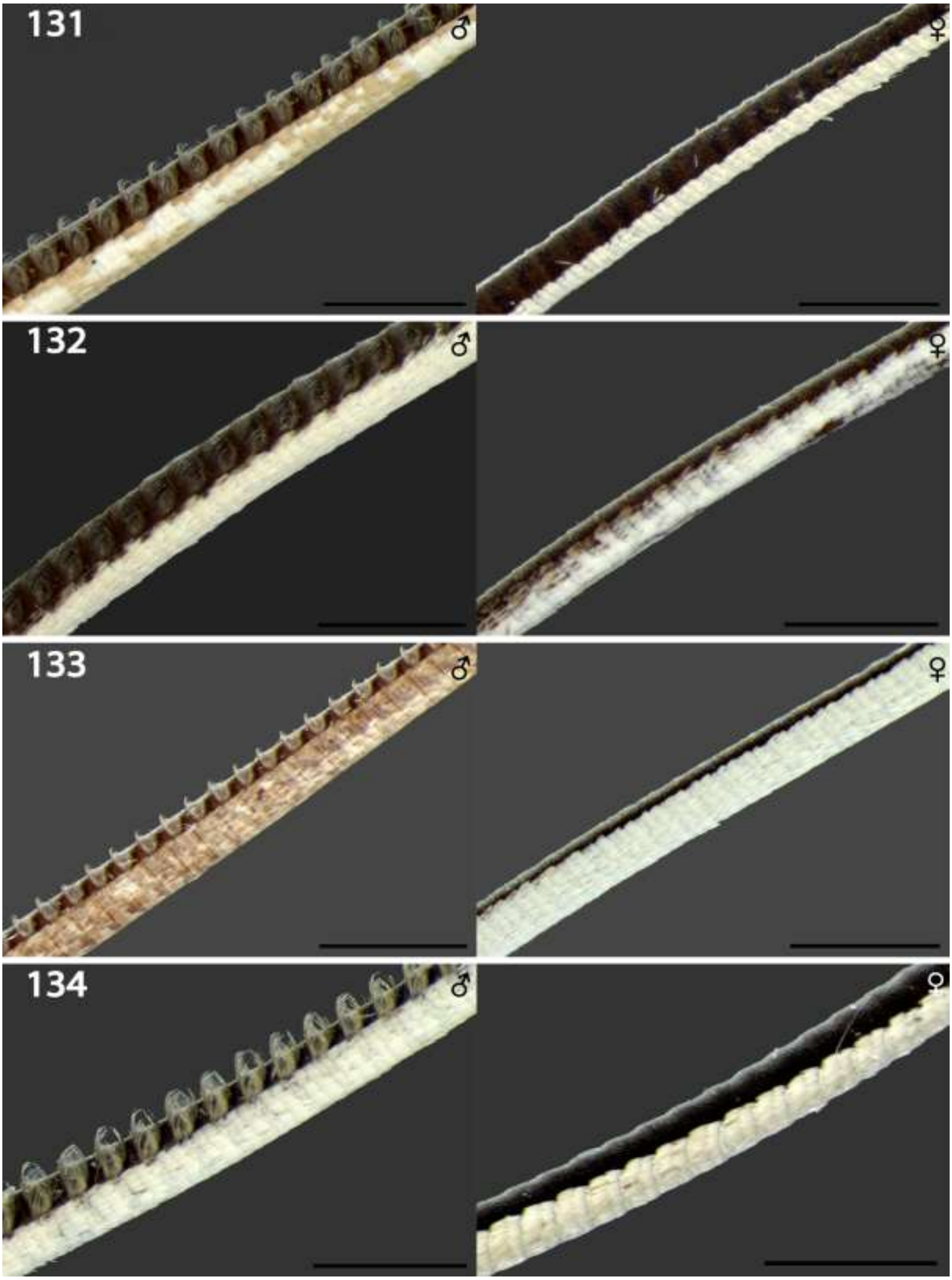
Figures 119-122. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 119. *Aellopos fadus*, 120. *Aellopos tantalus*, 121. *Aellopos titan,* 122. *Oryba achemenides.* Scale bar: 1 mm.



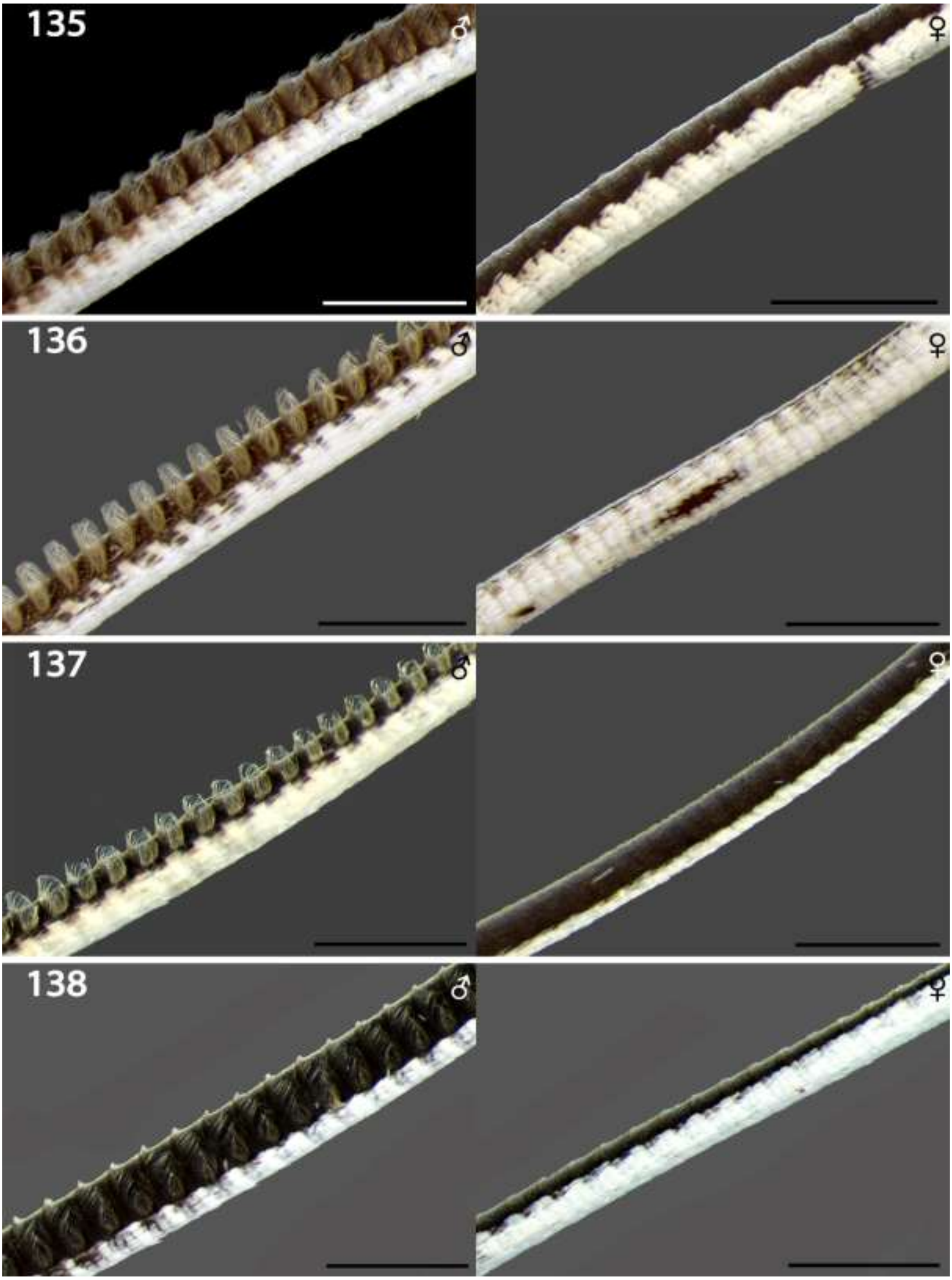
Figures 123-126. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 123. *Oryba kadeni*, 124. *Pachylioides resumens*, 125. *Madoryx bubastus,* 126. *Madoryx oiclus.* Scale bar: 1 mm.



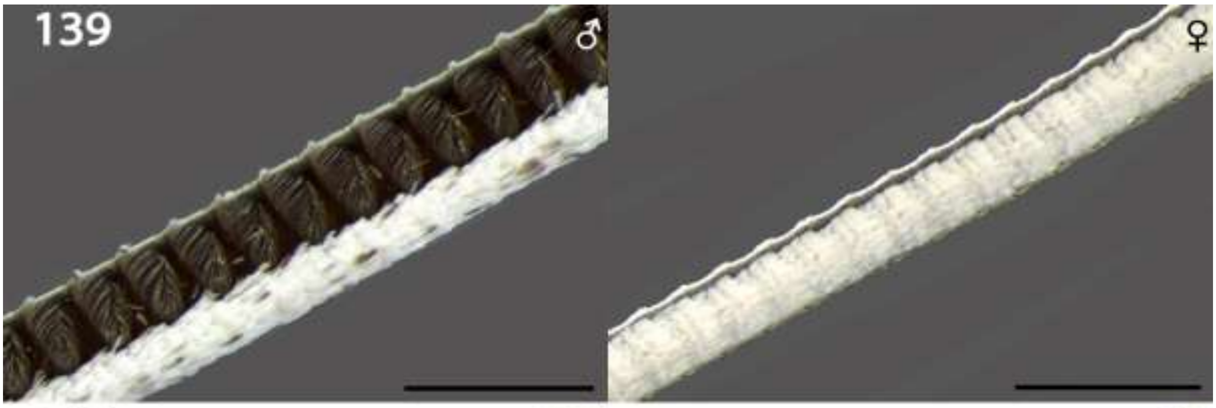
Figures 127-130. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 127. *Madoryx plutonius*, 128. *Hemeroplanes ornatus*, 129. *Hemeroplanes triptolemus,* 130. *Hemeroplanes longistriga.* Scale bar: 1 mm.

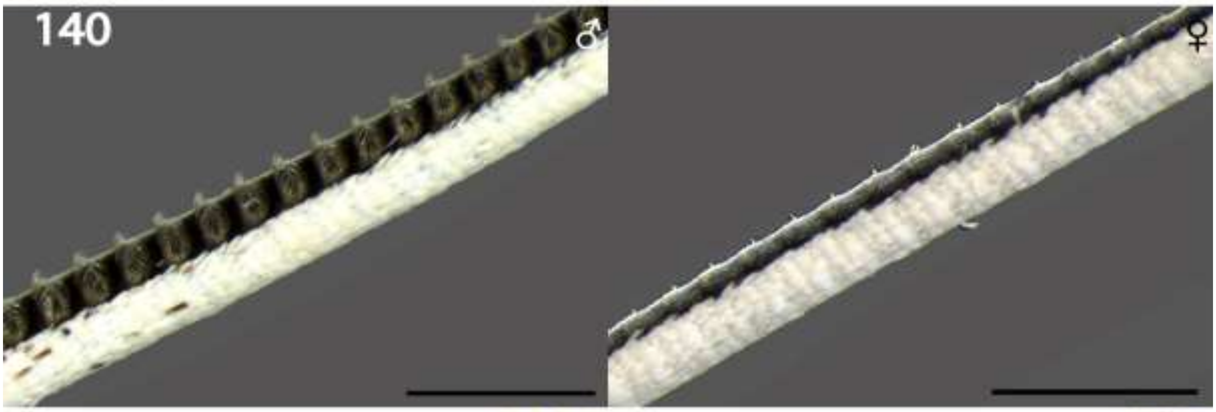


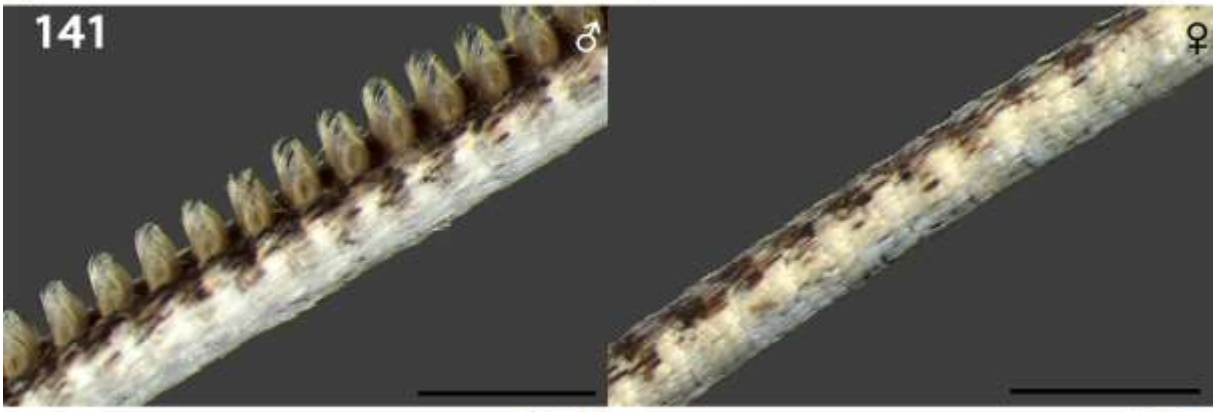
Figures 131-134. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 131. *Erinnyis alope*, 132. *Erinnyis crameri*, 133. *Erinnyis ello,* 134. *Erinnyis impunctata.* Scale bar: 1 mm.

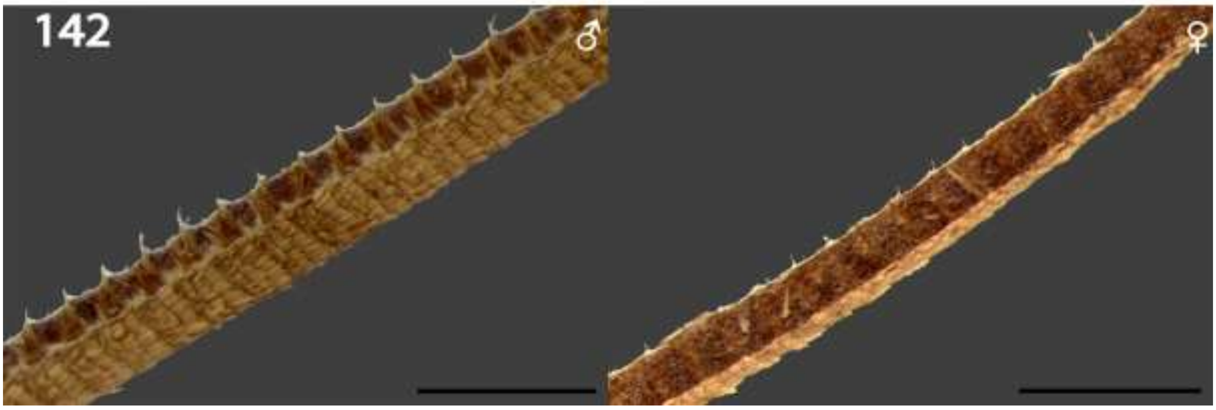


Figures 135-138. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 135. *Erinnyis lassauxii*, 136. *Erinnyis obscura*, 137. *Erinnyis oenotrus,* 138. *Isognathus allamandae.* Scale bar: 1 mm.

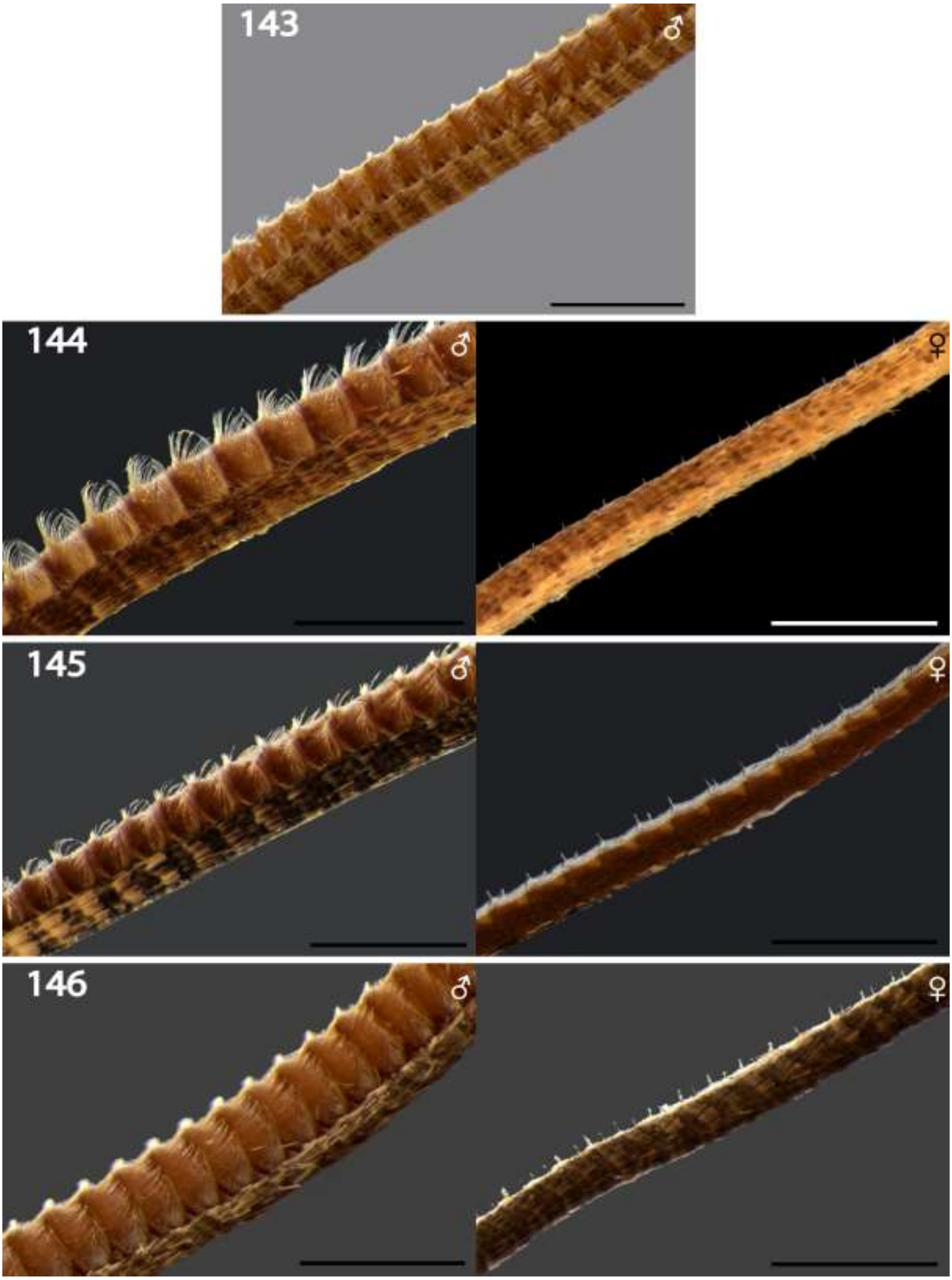




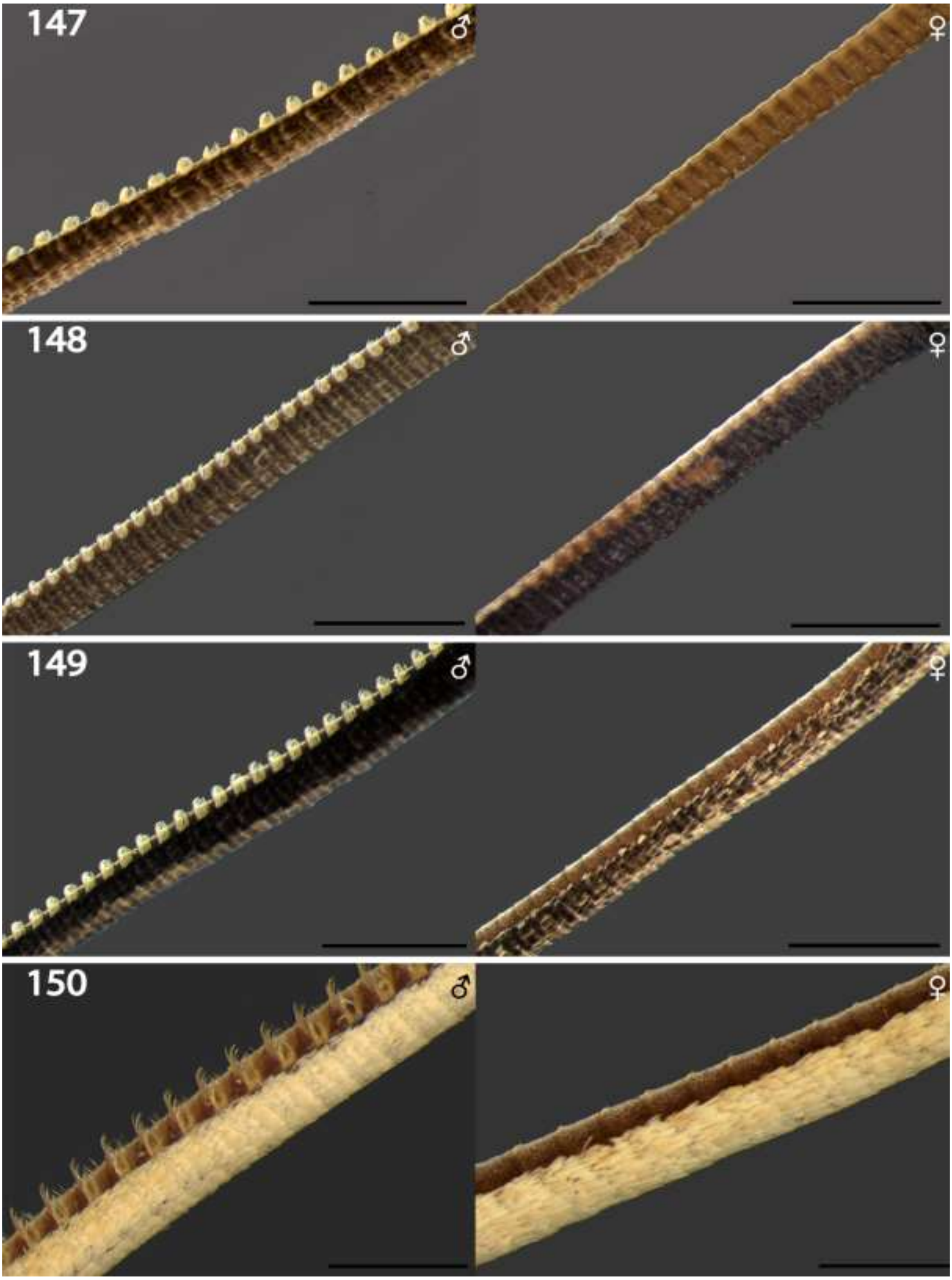




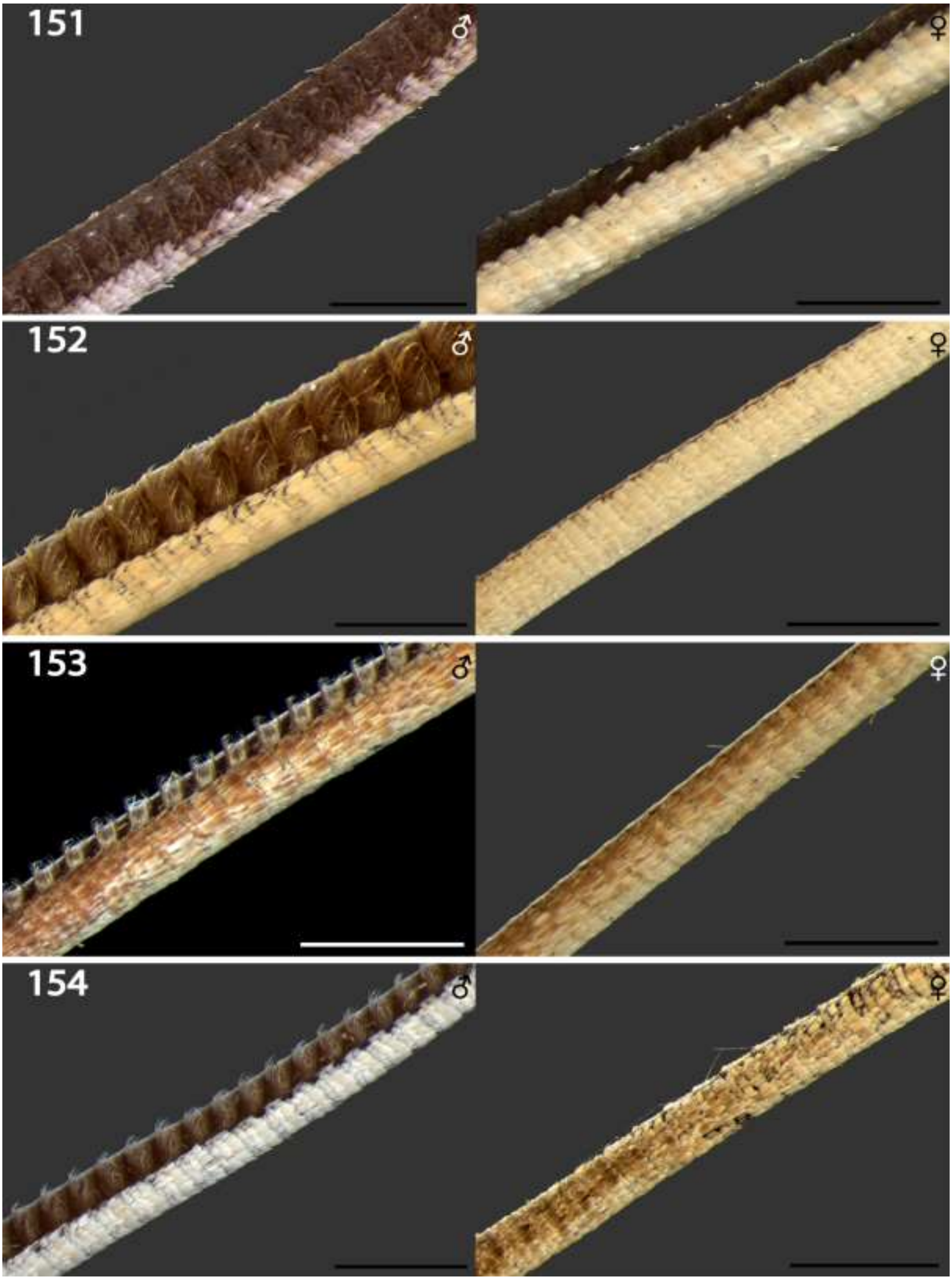
Figures 139-142. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 139. *Isognathus caricae*, 140. *Isognathus menechus*, 141. *Pseudosphinx tetrio,* 142. *Aleuron carinata.* Scale bar: 1 mm.



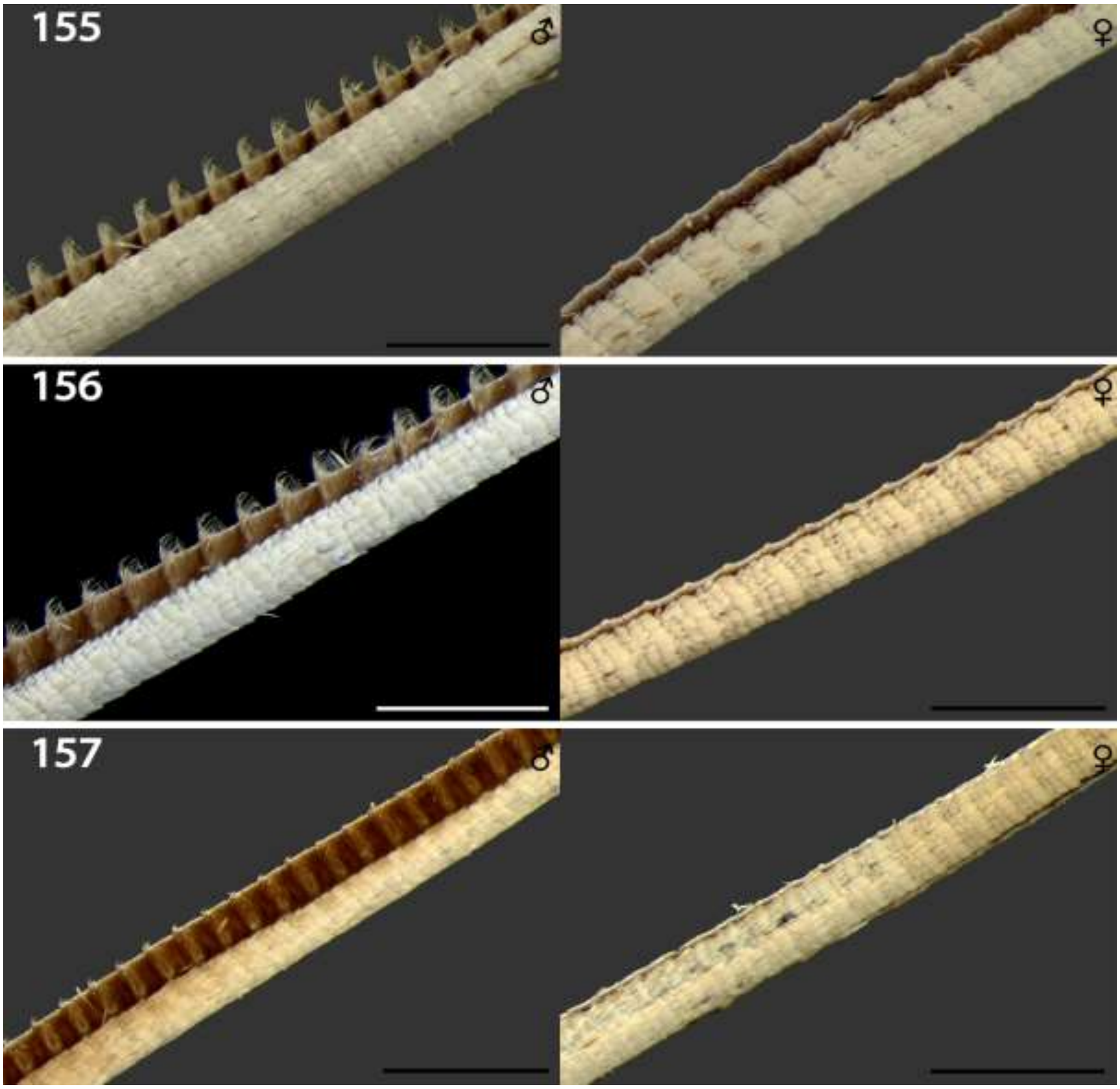
Figures 143-146. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 143. *Aleuron chloroptera*, 144. *Aleuron iphis*, 145. *Aleuron neglectum,* 146. *Unzela japix discrepans.* Scale bar: 1 mm.



Figures 147-150. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 147. *Enyo gorgon*, 148. *Enyo lugubris*, 149. *Enyo ocypete,* 150. *Eumorpha analis.* Scale bar: 1 mm.



Figures 151-154. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 151. *Eumorpha anchemolus*, 152. *Eumorpha fasciatus*, 153. *Eumorpha labruscae,* 154. *Eumorpha megaecus.* Scale bar: 1 mm.



Figures 155-157. Antennal morphology of selected hawkmoths (Lepidoptera: Sphingidae). 155. *Eumorpha obliquus*, 156. *Eumorpha translineatus*, 157. *Eumorpha vitis.* Scale bar: 1 mm.

3.3. Association between epiphysis and other variables

QQplots and Shapiro-Wilk test usually applied to verify the normality showed a non-normal distribution in all the measurements (Figure 158; Table 8). Box-Cox transformation was applied to normalize the data; however, the expected results were not obtained, and the data could not be normalized (Table 8).

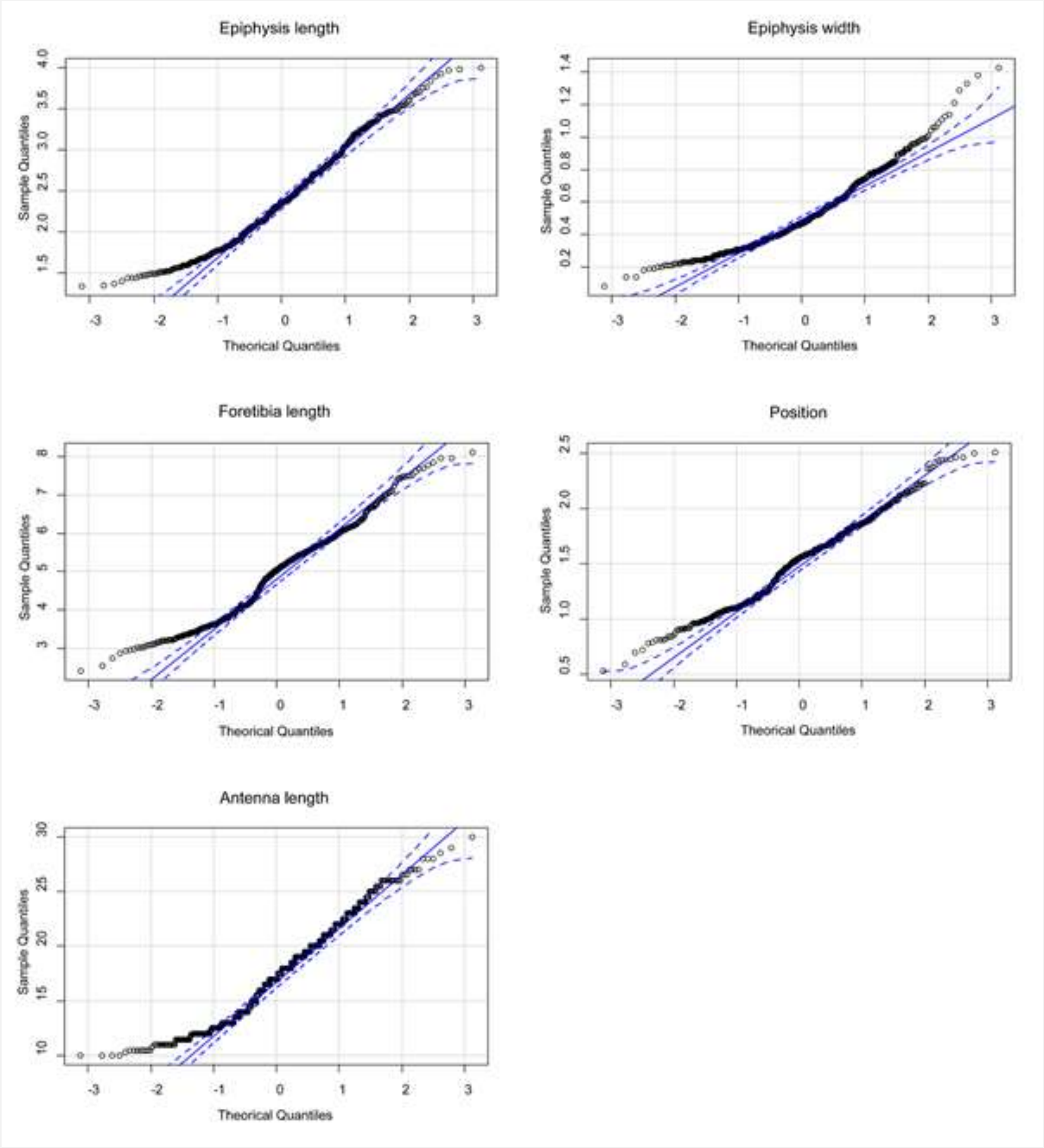


Figure 158. QQ-plots of all quantitative variables showed non-normality data.

Table 8. Results of Shapiro-Wilk test before and after Box-Cox transformation with the lambda value for all variable studied.

Measurements	Shapiro-Wilk	Lambda value	Box-Cox (*)
Epiphysis length	0,000006726	0,05	0,00001478
Epiphysis Width	0,00000000000002795	0,1	0,04205
Antenna length	0,0000000002014	0,05	0,000000009458
Foretibia length	0,00000005708	0,45	0,0000002637
Position	0,0001011	0,7	0,0003217

A PCA showed that the PC1 accumulated the maximum variation, being the component of greatest importance (Figure 159). All the measurements contributed with variation to the PC1, principally the “epiphysis length”. Table 9 shows the contribution of each variable to each component. In addition, a biplot using the PC1 and PC2 values showed an allometric relationship among the measurements. Thus, “Position” is strongly associated to “Foretibia length”, and “Antenna length” is strongly associated to “Epiphysis length” (Figure 160).

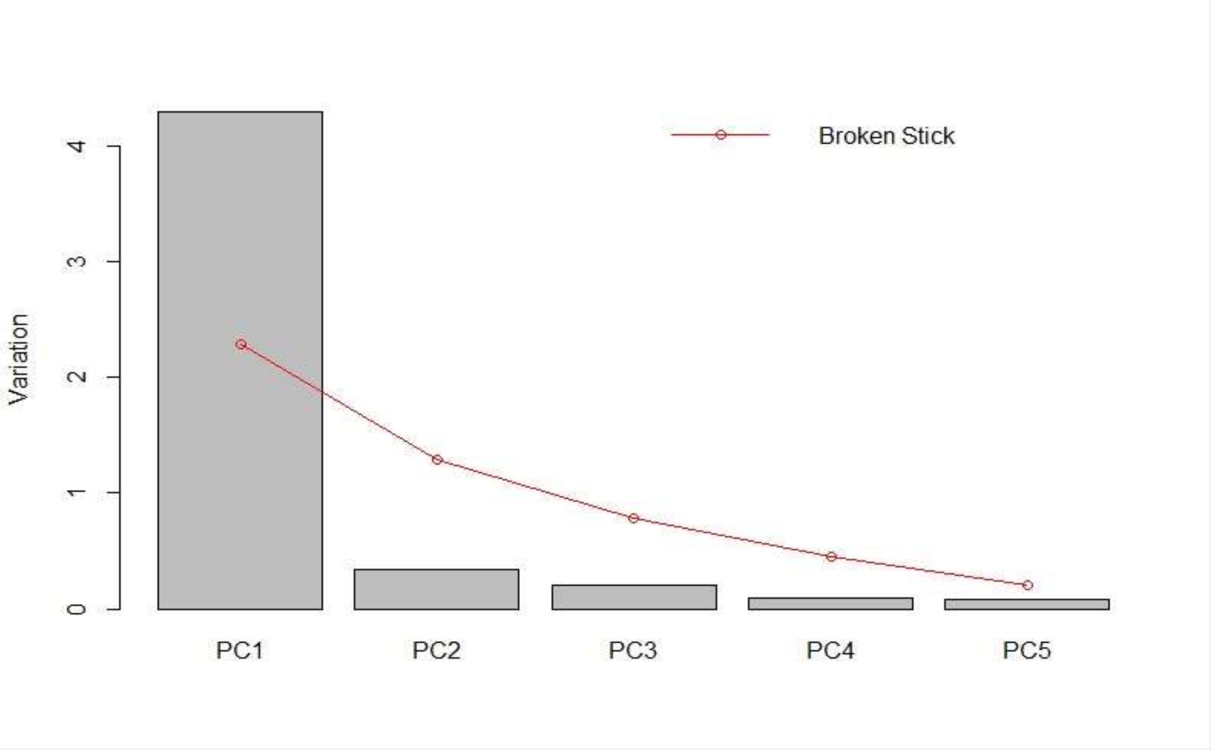


Figure 159. Eigenvalues and their contributions.

Table 9. Eigenvalues and component scores of all frequencies for principal components (PCs) 1 -5 calculated by PC analysis

Variables	PC1	PC2	PC3	PC4	PC5
Epiphysis length	3.103	-0.017	0.723	-0.133	-0.666
Epiphysis width	2.793	-1.616	-0.436	0.059	0.059
Position	2.978	0.757	-0.985	-0.437	-0.076
Foretibia length	3.098	0.586	-0.107	0.806	0.076
Antenna length	3.098	0.160	0.724	-0.306	0.610

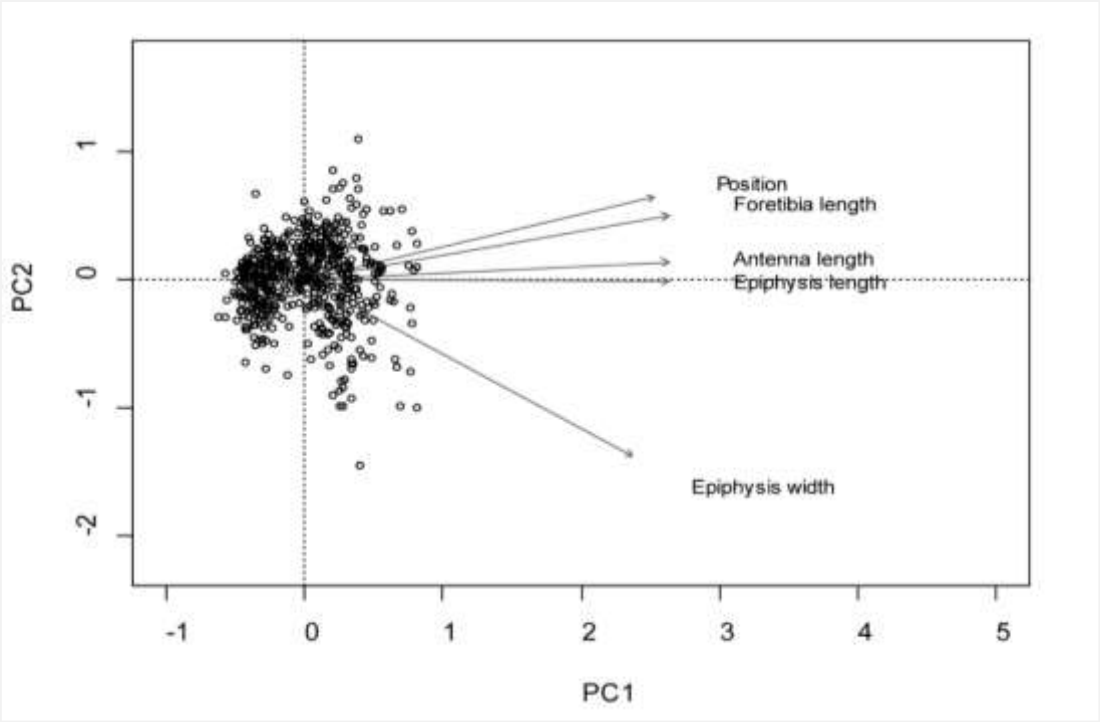


Figure 160. Relationships of the measurements shown in a Principal Components Analysis.

Using the information from PC1, a boxplot was computed to visualize the variations among genera. Figure 161 shows that there is a considerable variation in *Pachylia*, *Oryba*, *Isognathus*, *Hemeroplanes*, *Aellopos* and *Unzela*. Figure 161 showed that overlapping boxplots have less difference between in size (e. g. *Madoryx*, *Hemeroplanes*, *Isognathus*, *Erinnyis*, *Pachylia* and *Oryba*). Thereby, Kruskal-Wallis Chi reported differences in variation regarding genus, the genera that do not overlap in Figure 161 presented significant values of variation. See Appendix F to see the comparison matrix.

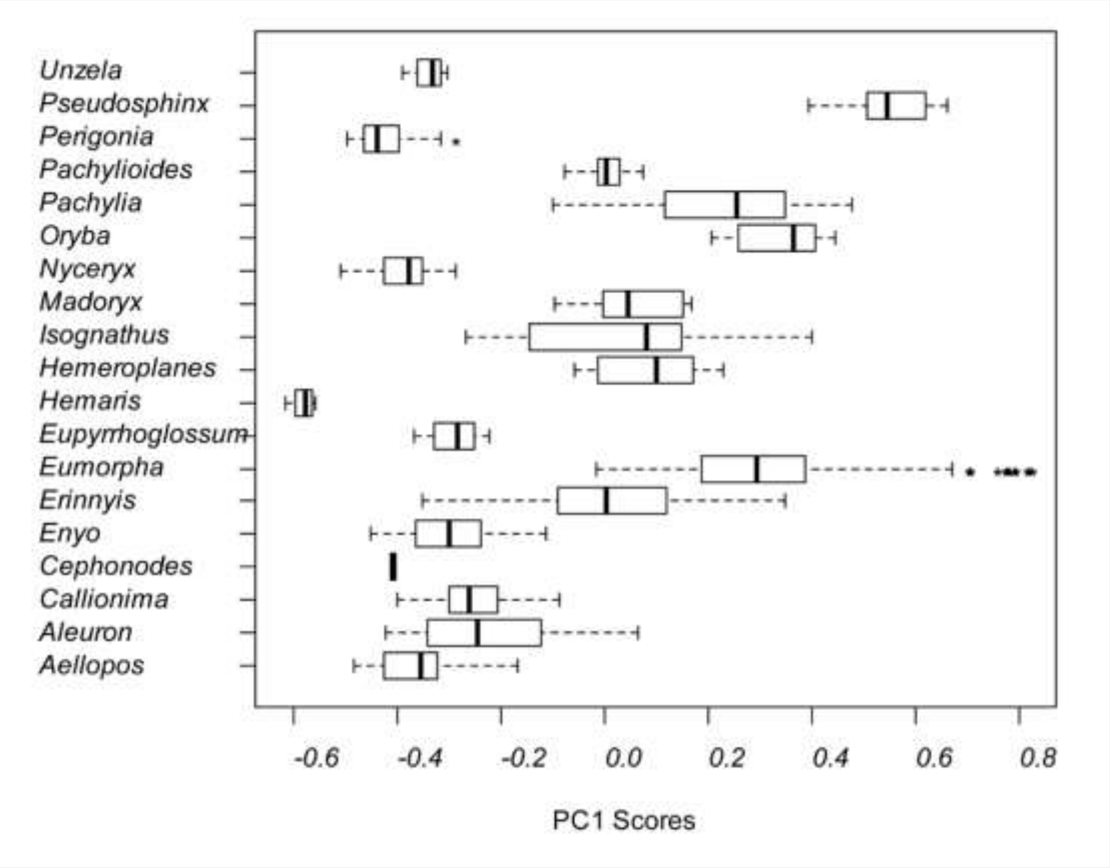


Figure 161. Boxplot showing the variation among genera.

The regression analysis among most related variables (epiphysis length – antenna length; position – foretibia length) shows a positive inclination, demonstrating a positive regression among the related variables. In other words, epiphysis length increases as antenna length increases, and position increases as foretibia length increases (Figure 162, Figure 163). However, the association relationships among the measures studied vary among genera, that is, the value of the degree of fit (R-squared) was different in each genus (Table 10, Figure 162, Figure 163).

With reference to the correlation of the epiphysis length and antenna length, it was observed that seven genera show a value of R-squared higher than 30%, reflecting a medium to strong relationship between epiphysis length and antenna length (Table 10). However, the genera *Nyceryx*, *Pachylioides* and *Pseudosphinx* presented R-squared lower than 30% reflecting a low association between this two variables (Figure 162).

Between the position and foretibia length, nine genera showed a value of R-squared higher than 30%, this percentage reflects a medium to strong relationship between the two variables, which was confirmed by a significant p-value (Table 10). However, only *Pachylioides resumens* presented R-squared lower than 30% reflecting a low association between the two variables (Figure 163).

Table 10. Values obtained with model II regression (Fit using Standardized Major Axis).

Genus	Antenna length-Epiphysis length				Foretibia length-Position			
	Elevation	Slope	R-square	p-value	Elevation	Slope	R-square	p-value
Callionima	0.848	0.983	0.548	1.34E-11	0.543	0.813	0.563	5.24E-12
Enyo	0.819	1.100	0.338	3.14E-04	0.481	0.726	0.703	6.11E-10
Erinnyis	0.854	0.979	0.770	< 2.22E-16	0.576	0.865	0.799	< 2.22E-16
Eumorpha	0.829	1.035	0.650	< 2.22E-16	0.503	0.934	0.722	< 2.22E-16
Isognathus	0.920	0.996	0.773	1.87E-15	0.572	0.754	0.864	< 2.22E-16
Nyceryx	0.943	0.541	0.131	0.0298	0.534	0.456	0.573	9.34E-08
Pachylia	0.792	1.198	0.338	2.86E-05	0.566	0.745	0.652	2.05E-11
Pachylioides	0.814	1.188	0.075	0.3236	0.468	1.340	0.041	0.46652
Perigonia	0.882	0.857	0.382	1.68E-03	0.499	0.900	0.393	1.36E-03
Pseudosphinx	0.928	0.919	0.136	0.1762	0.714	0.597	0.799	7.02E-06

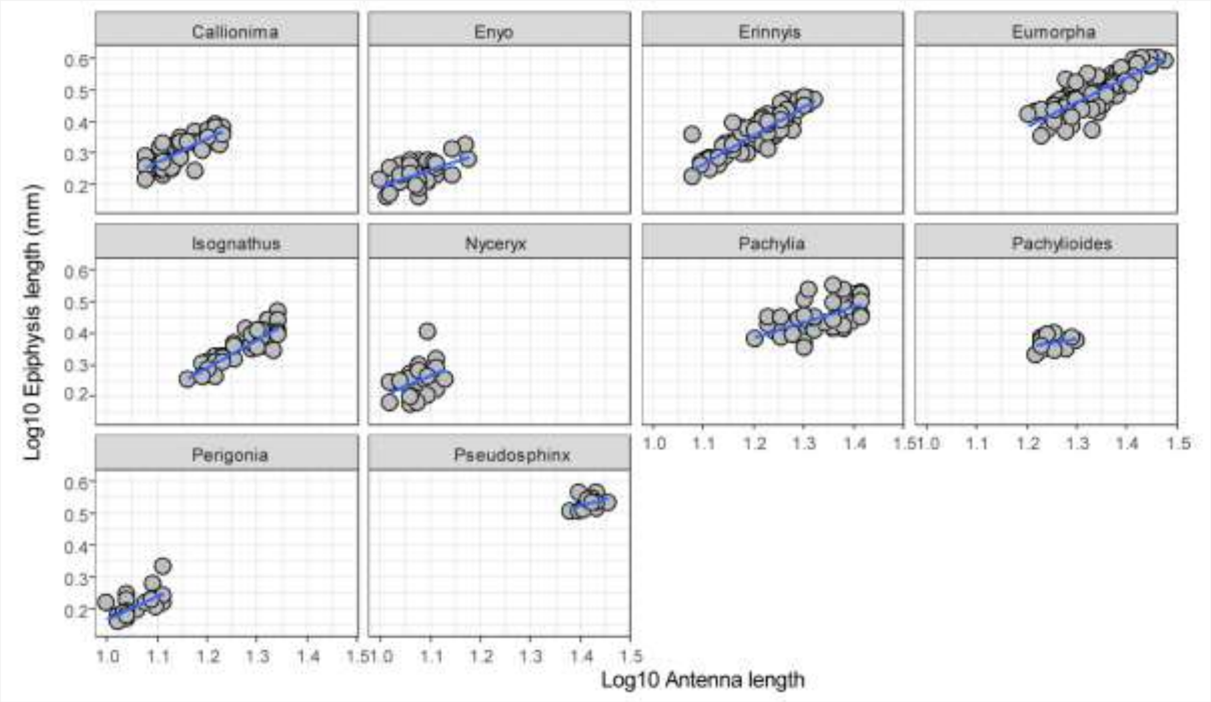


Figure 162. Scatterplot of epiphysis length against antenna length in Log10.

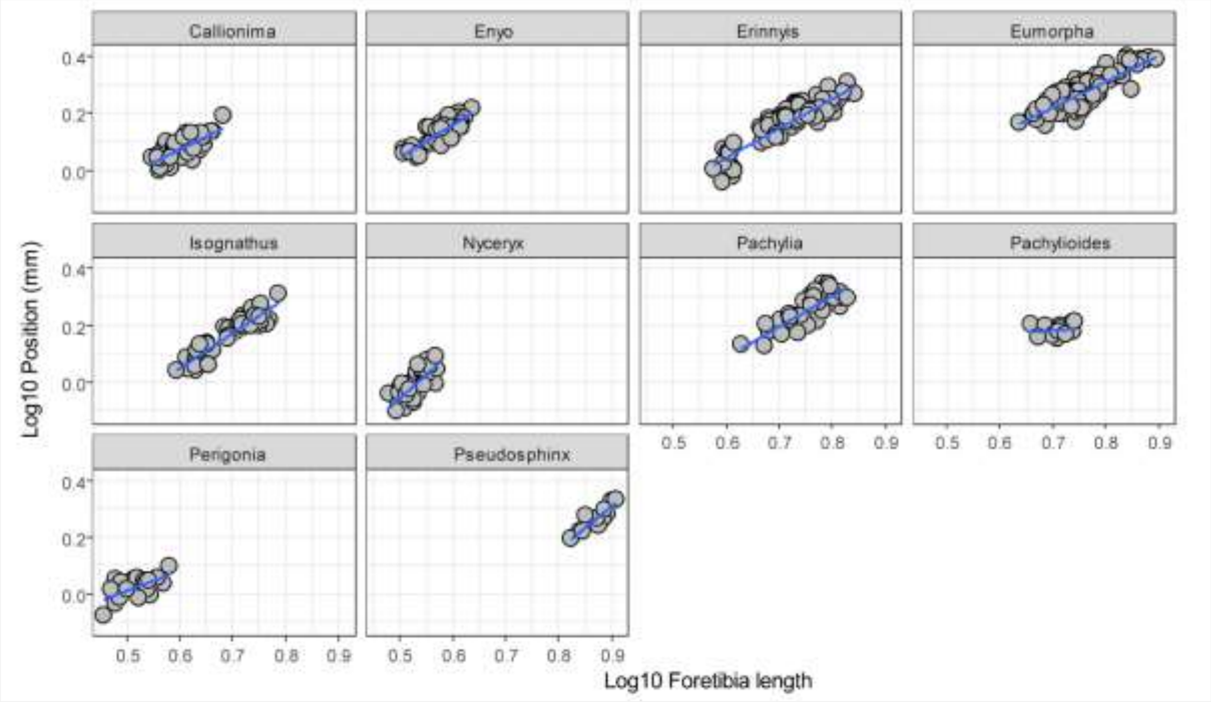


Figure 163. Scatterplot of position against foretibia length in Log10.

3.4. Geometric Morphometric of the epiphyses

3.4.1. Procrustes ANOVA

The Procrustes ANOVA applied to estimate the measurement error (ME) showed that the mean square for individual variation exceeded the measurement error; therefore, it was negligible (Table 11).

Table 11. Procrustes ANOVA for both centroid size and shape of epiphyses.

Centroid Size					
Effect	SS	MS	dF	F	p-value
Individual	136.094368	0.282353	482	1332.98	<.0001
Error 1	**0.020547**	**0.000212**	**97**		
Shape					
Effect	SS	MS	dF	F	p-value
Individual	3.59385820	0.0007456137	4820	17.04	<.0001
Error 1	**0.04244446**	**0.0000437572**	**970**		

Sums of squares (SS) and mean squares (MS) are in units of Procrustes distances.

3.4.2. Differences among genera

3.4.2.1. Regression Analysis

Multivariate regression showed low percentage allometric but significant when pooled by tribes Dilophonotini (n = 360) and Philampelini (n = 120); the percentage of influence of size on the shape was 11.712 % (<.0001). Figure 164 shows that Philampelini have species with epiphyses larger than Dilophonotini. Independent analyses show significant allometry in Dilophonotini (%predicted: 5.934%, p <.0001) and not significant in Philampelini (%predicted: 3.600%, p = 0.0053). Figure 165 shows *Perigonia*, *Enyo* and *Nyceryx* with the smallest centroid size and *Pseudosphinx* and some specimens of *Pachylia* with the biggest centroid size. Figure 166 shows *Eumorpha vitis* with the smallest epiphysis and *E. anchemolus* with the biggest.

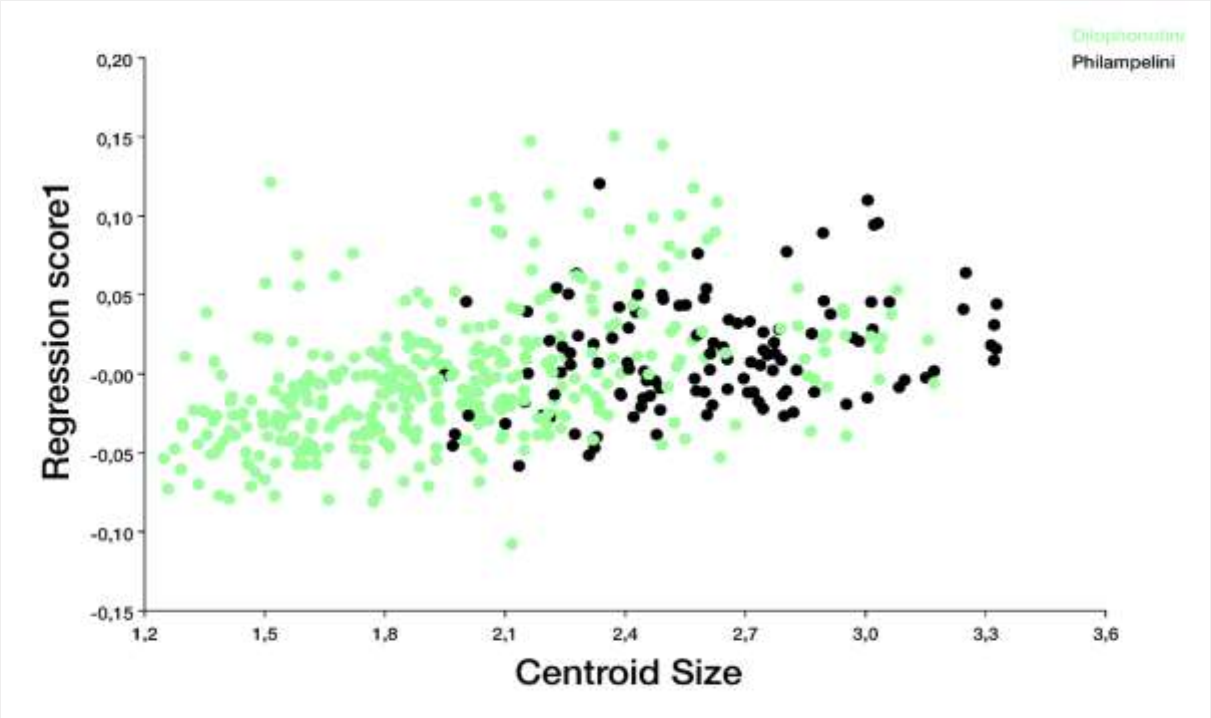


Figure 164. Multivariate regression grouping the Dilophonotini and Philampelini tribe determined by centroid size (positive allometry is shown).

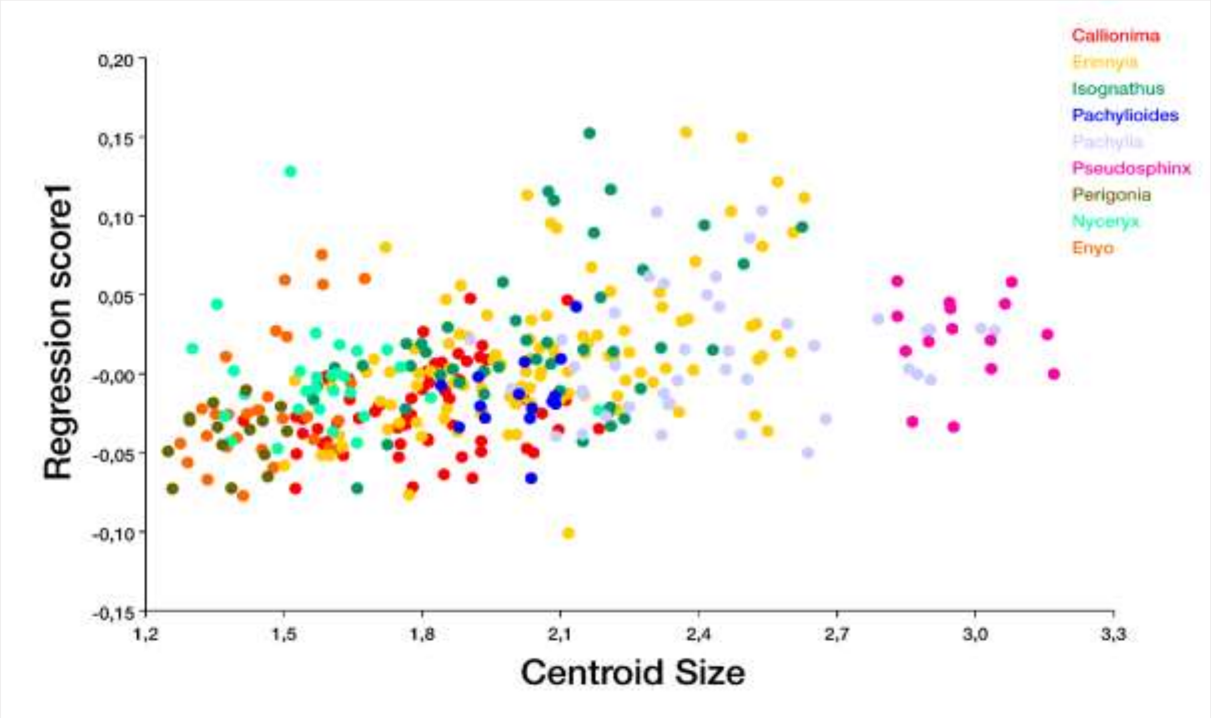


Figure 165. Multivariate regression grouping the genera of Dilophonotini determined by centroid size (positive allometry is shown).

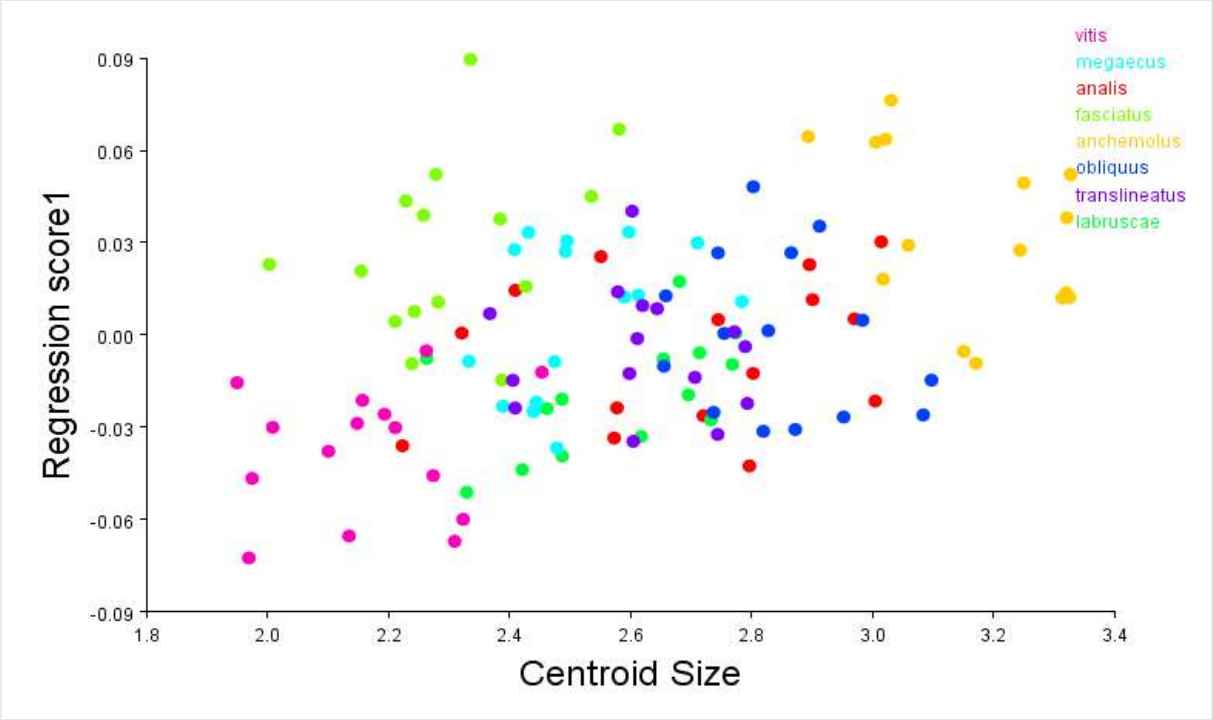


Figure 166. Multivariate regression of Philampelini determined by centroid size (negative allometry is shown).

3.4.2.2. Principal Component Analysis (PCA) and Canonical Variate Analysis (CVA)

In order to show the variation in the epiphysis shape, Principal Component Analysis (PCA) indicates that there is a low morphometric variation in the shape of the epiphyses between the genera. PC1 and PC2 show the variations mainly in: internal margin of the epiphysis (im) (landmark 6), margin of foretibia (imt) (landmarks 1, 3, 4) and the posterior region (landmark 5) (Figure 4, Figure 167). The PC1 accumulated the maximum variation in the epiphyses, being the most important component (54.5%); PC2 contributed with 26.49%, and the PC3 contributed with 6.93%.

Despite the low resolution of the groups shown in Figure 168, PC1 manages to separate some genera, so we have on the right side *Erinnyis*, *Pseudosphinx*, *Isognathus* and *Callionima*, disaggregated from *Enyo* and *Pachylioides*; in turn, PC2 fails to disperse groups of genera. Canonical Variation Analysis (CVA) reflect the PCA and Discriminant analysis results, which is able to disaggregate *Pseudosphinx*, *Callionima* and *Erinnyis* from *Pachylioides* and

Enyo, due to high variation in PC1. However, among them, there are specimens that are closely morphometrically similar; therefore, they do not completely disaggregate one from the other (Figure 168).

Finally, a Principal Components Analysis using the average shape of the epiphyses indicates that the PC1 distinguished two large groups. First group consisting of *Perigonia*, *Callionima*, *Pseudosphinx*, six species of *Erinnyis*, *Nyceryx*, *Isognathus* and two species of *Pachylia,* and the second consisting of *Pachylioides*, *Enyo*, *Eumorpha*, one species of *Pachylia* and one species of *Erinnyis* (Figure 169). *Enyo* species (*E. lugubris* and *E. ocypete*) and *Pachylioides resumens* are very close to each other, which means morphological similarity (Figure 169)

On the other hand, some species are morphometrically more similar to other genera to which they do not belong, as in *Pachylia* (Figure 169). *Pachylia syces* has more similarity to some species of *Erinnyis*, *P. darceta* with species of *Eumorpha*, *Enyo* and *Pachylioides,* and *P. ficus* with *Isognathus* and *Nyceryx*. PC2 divided the genera *Callionima*, *Nyceryx*, *Erinnyis*, and *Eumorpha*. Average shape (epiphysis) of *Pachylia* species are scattered among them, showing the low similarity between them, in addition, *Eumorpha* genus is divided into two groups separated by PC2 (Figure 169).

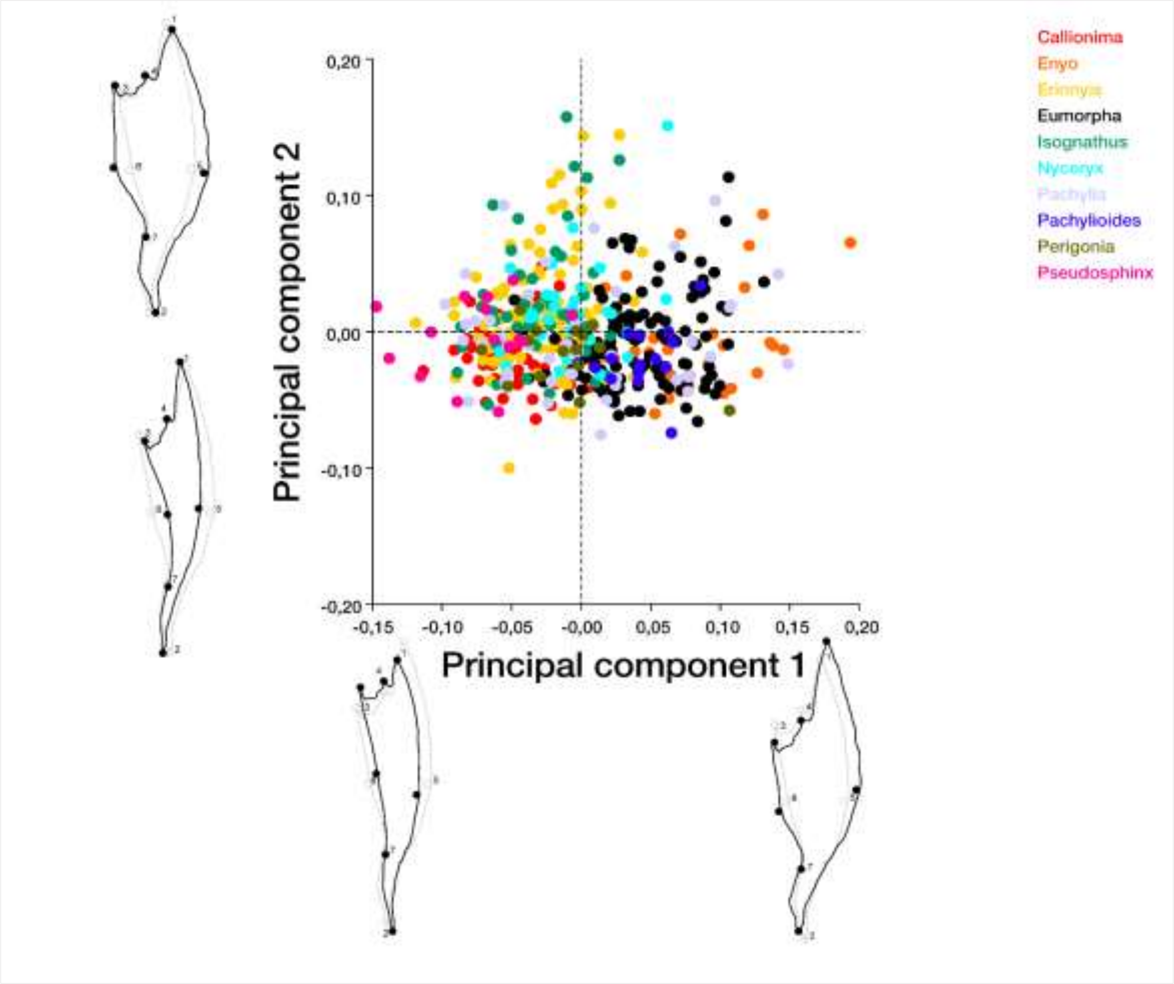


Figure 167. Morphological variation grouped by genera explained by PC 1 and PC 2. The view of each landmark configuration is shown below and beside to the graph (Scale factor: right 0.15, left -0.15; above 0.10, below -0.10).

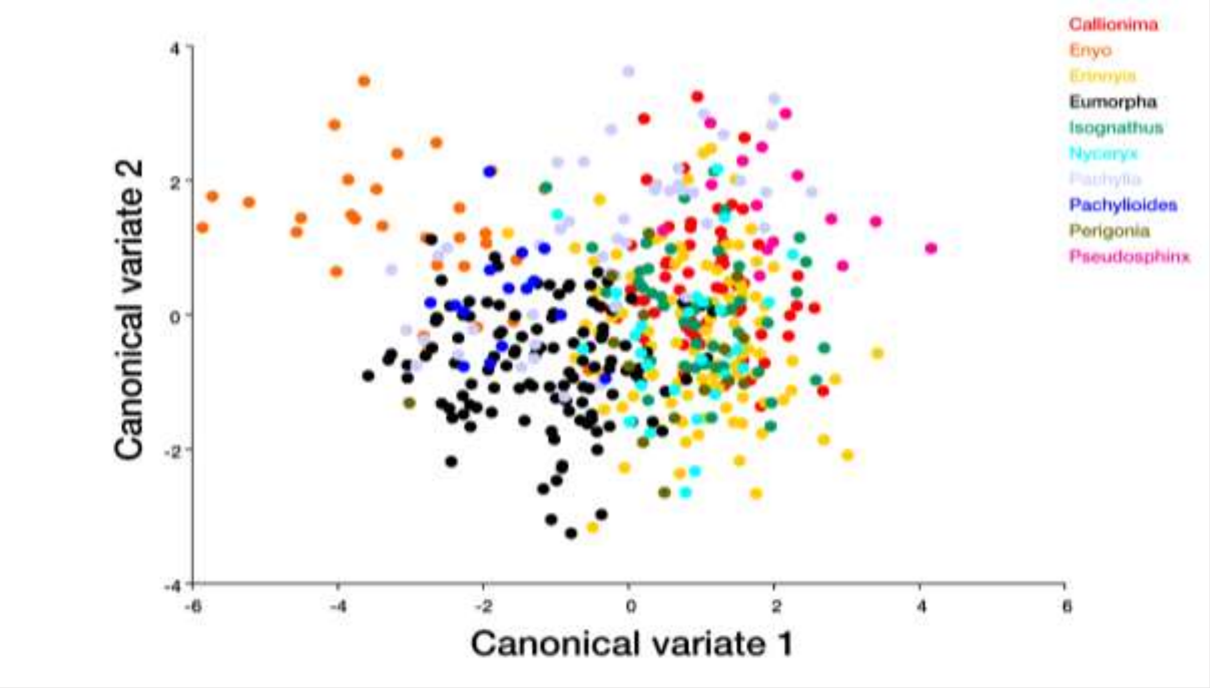


Figure 168. Morphological variation shown by Canonical Variate Analysis grouped by genera.

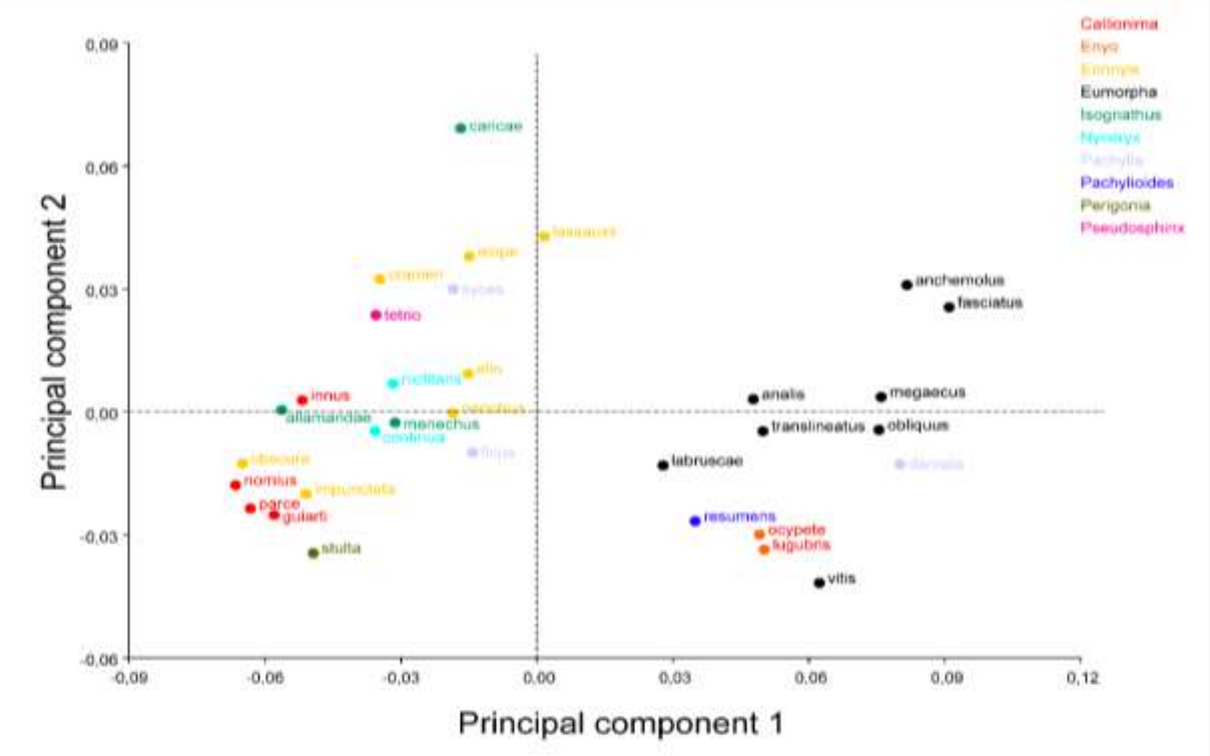


Figure 169. Morphological variation expressed by average shape of epiphysis pooled by species.

3.4.2.3. Discriminant Function Analysis

The Mahalanobis distances to differentiate the epiphyses between Dilophonotini and Philampelini showed small value but significant (Mahalanobis distance: 1.5392, p> .0001). Figure 170 shows an overlap between Dilophonotini and Philampelini species, this indicates that some species of *Eumorpha* have similar epiphyses to Dilophonotini species. Therefore, there are species in Dilophonotini that have a different shape of epiphyses compared to Philampelini; the bars outside the overlap represent this.

Analyses among genera show the highest significant distance of Mahalanobis between *Pachylioides* – *Pseudosphinx*, *Enyo* – *Pseudosphinx*, *Pseudosphinx* – *Eumorpha* and *Enyo* – *Callionima,* while lowest significant distance between *Callionima* – *Erinnyis* and *Erinnyis* – *Isognathus* (Table 12). This analysis reveals that the morphological variation among genera based on shape of epiphyses is small but not significant, except in the pairs *Perigonia* – *Erinnyis*, *Perigonia* – *Nyceryx* and *Perigonia* – *Callionima* that presented small Mahalanobis distances but not significant. Graphs of discriminant function of each genus are shown in Appendix G.

Moreover, all the values obtained were reflected in a UPGMA tree, where it is observed which are genera close to each other, four groups are formed. The first group conformed by *Erinnyis*, *Perigonia*, *Nyceryx*, *Callionima* and *Isognathus*; which is morphometrically more related to the second group, it includes *Eumorpha* and *Pachylia*. All the genera mentioned above are linked to a third group (*Enyo* and *Pachylioides*), which have a low value of Mahalanobis distance. Finally, the fourth group is the genus *Pseudosphinx*, which is further away from the tree, indicating low morphometric similarity with the rest of the genera (Figure 171).

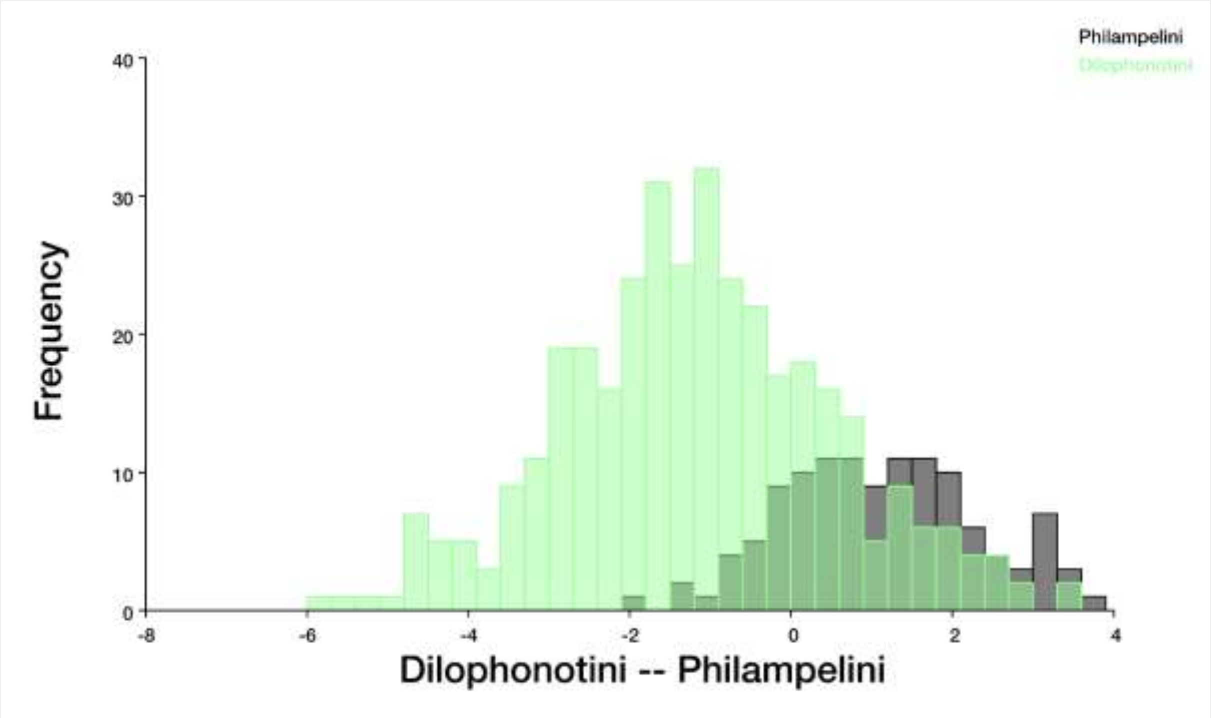


Figure 170. Discriminant function showing the-leave-one-out-cross-validation between tribes.

Table 12. Mahalanobis distance among genera of Dilophonotini and Philampelini as given the Pairwise discriminant analyses for shape. Significance values are shown between parentheses.

Genera	*Callionima*	*Enyo*	*Erinnyis*	*Eumorpha*	*Isognathus*	*Nyceryx*	*Pachylia*	*Pachylioides*	*Perigonia*
Enyo	5.125 (<.0001)	-	-	-	-	-	-	-	-
Erinnyis	1.218 (<.0001)	4.392 (<.0001)	-	-	-	-	-	-	-
Eumorpha	3.241 (<.0001)	2.986 (<.0001)	2.493 (<.0001)	-	-	-	-	-	-
Isognathus	2.281 (<.0001)	4.534 (<.0001)	1.199 (<.0001)	3.123 (<.0001)	-	-	-	-	-
Nyceryx	2.255 (<.0001)	4.753 (<.0001)	1.532 (<.0001)	2.143 (<.0001)	2.542 (<.0001)	-	-	-	-
Pachylia	2.320 (<.0001)	3.166 (<.0001)	2.164 (<.0001)	2.105 (<.0001)	2.595 (<.0001)	2.435 (<.0001)	-	-	-
Pachylioides	4.440 (<.0001)	2.851 (<.0001)	3.943 (<.0001)	1.943 (<.0001)	4.747 (<.0001)	3.937 (<.0001)	2.449 (<.0001)	-	-
Perigonia	1.817 (0.0010)	4.317 (<.0001)	1.277 (0.0430)	1.7921 (<.0001)	2.257 (<.0001)	1.688 (0.0290)	2.631 (<.0001)	3.895 (<.0001)	-
Pseudosphinx	3.091 (<.0001)	6.809 (<.0001)	2.904 (<.0001)	4.805 (<.0001)	3.450 (<.0001)	3.932 (<.0001)	2.912 (<.0001)	8.549 (<.0001)	3.649 (<.0001)

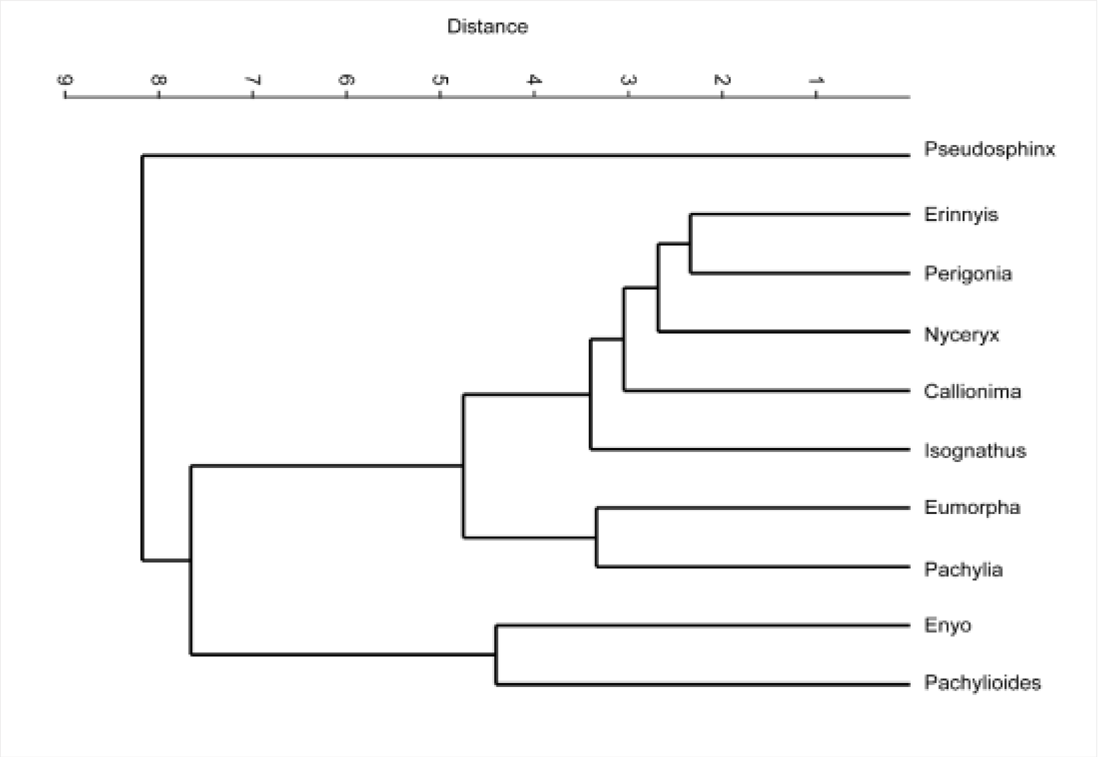


Figure 171. UPGMA tree based on Mahalanobis distance with 10000 permutations per test.

3.4.3. Sexual Dimorphism

3.4.3.1. Regression Analysis

Multivariate regression showed low percentage allometric but significant (Female, n = 207; Male, n = 273). Percentage of influence of size on the shape was 12.208% (<.0001). Figure 172 shows a slight positive allometry and it is observed that there are females and males of almost similar size. In addition, males had the largest epiphyses and females, the smallest epiphyses.

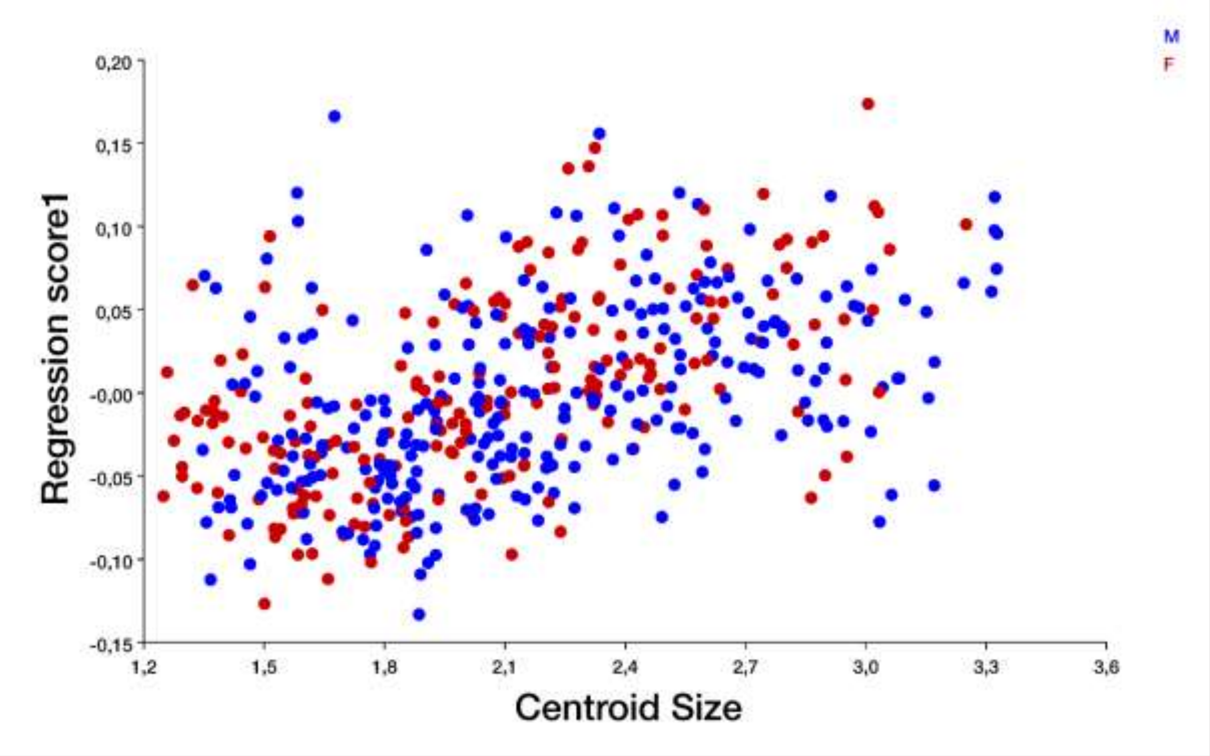


Figure 172. Multivariate regression grouping by sex determined by centroid size (positive allometry is shown). M = Male, F = Female.

3.4.3.2. Principal Component Analysis (PCA)

The analysis indicates that there is no morphometric variation in the shape of the epiphyses between sexes. PC1 and PC2 show a small variation in the margin of the tibia (imt) (Figure 173). Therefore, there is no sexual dimorphism between the studied genera based on the epiphyses shape.

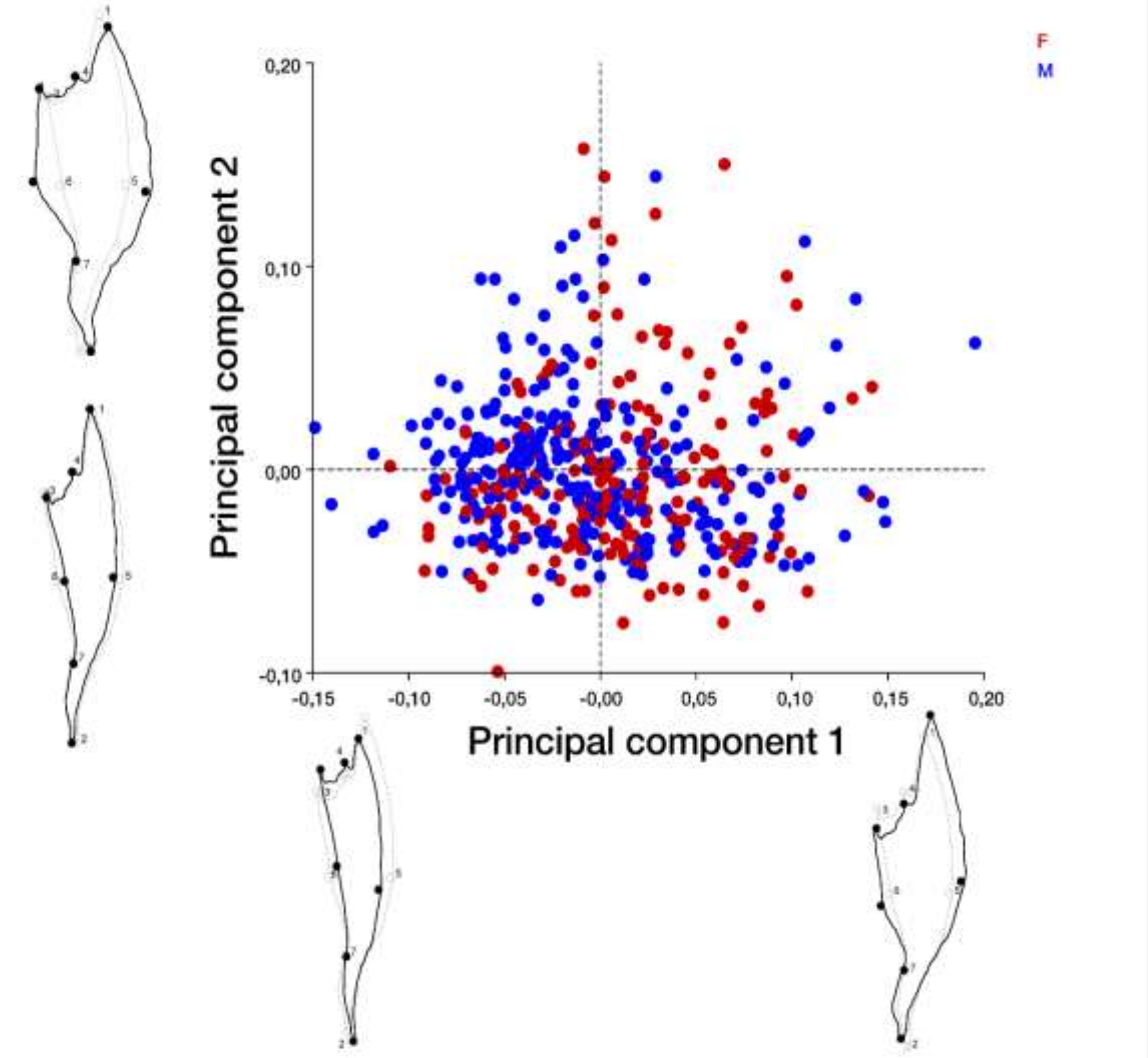


Figure 173. Morphological variation grouped by sex determined by PC 1 and PC 2 (M = Male, F = Female). The view of each landmark configuration is shown below and beside to the graph (Scale factor: right 0.15, left -0.15; above 0.15, below -0.05).

3.4.3.3. Discriminant Function Analysis

Discriminant analysis using Mahalanobis distance showed no difference between both sexes based on the shape of the epiphysis (Figure 174). Mahalanobis distance showed a small value between both sexes being significant (Mahalanobis distance: 0.9860, p>.0001). This analysis reveals that the sexual dimorphism based on shape of epiphyses is almost null.

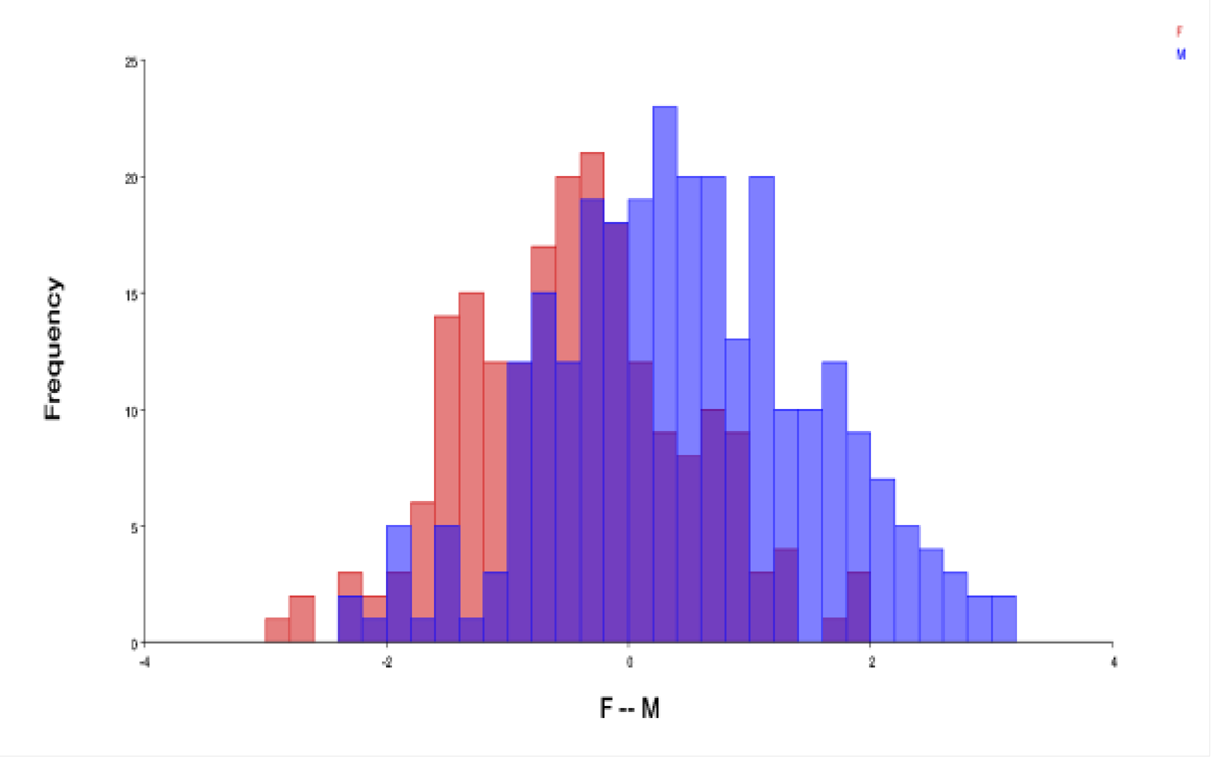


Figure 174. Discriminant function showing the-leave-one-out-cross-validation by sex (M = Male, F = Female).

3.4.4. Phylogenetic mapping

To evaluate the evolutionary allometry it was applied the multivariate regression of independent contrasts of epiphysis shape on independent contrasts of centroid size. This analysis shows low allometry and not statistically significant (15.286%, $p = 0.2045$) (Figure 175), despite not being significant, this influences the phylogenetic mapping as shown in Figure 176. PC1 distinguished two large groups, the first consisting of *Perigonia*, *Callionima*, *Pseudosphinx*, *Erinnyis*, *Nyceryx* and *Isognathus*, and the second consisting of *Pachylioides*, *Enyo*, *Eumorpha* and *Pachylia*. Moreover, PC2 separated *Enyo, Pachylioides*, *Perigonia* and *Callionima*, from the genera *Eumorpha*, *Pachylia*, *Erinnyis*, *Nyceryx*, *Isognathus* and *Pseudosphinx*. Allometry was eliminated to phylogenetically map the genera, and the PCA without allometry varied considerably to the PCA with allometry (Figures 176, 177).

In the PCA without allometry, PC1 distinguished two large groups, the first consisting of *Perigonia*, *Callionima*, *Pseudosphinx*, *Erinnyis*, *Nyceryx* and *Isognathus*, and the second consisting of *Pachylioides*, *Enyo*, *Eumorpha* and *Pachylia*. Moreover, PC2 separated *Pachylioides*, *Perigonia*, *Callionima* and *Pseudosphinx*, from the genera *Enyo*, *Erinnyis*, *Nyceryx* and *Isognathus*. Considering the component PC2, the average shape of *Eumorpha* and *Pachylia* are positioned precisely in the middle of the graph, not fitting into any quadrant (Figure 177).

Black lines linking the genera represent the phylogenetic relationships between genera according to Kawahara *et al*. (2009), this analysis shows species that are phylogenetically related tend to resemble phenotypically; therefore, it is expected that in the studied genera that are sister groups, they present more morphologically similar epiphyses. Starting with this premise, *Nyceryx* + *Perigonia* are sister groups (node 111 in Kawahara *et al.*, 2009), however, their epiphyses are slightly different in the inner margin (in) and the posterior region (PR). *Callionima* is sister group of these two genera (node 47 in Kawahara *et al*., 2009), however, it was observed that its epiphysis is more similar to *Perigonia*, with a slight variation in the margin of the foretibia (imt). Additionally, *Pachylioides* (node 25 in Kawahara *et al*., 2009) and *Pachylia* (node 20 in Kawahara *et al*., 2009) are also sister groups of the genera mentioned above, however there is very low similarity in the shape of the epiphysis comparing with *Callionima*, *Nyceryx* and *Perigonia* (Figure 177).

Likewise, *Erinnyis*, *Isognathus* and *Pseudosphinx* are phylogenetically close taxa (node 113 in Kawahara *et al.*, 2009) (Figure 177); the three genera are similar considering PC1, with a slight variation in the inner margin of the foretibia. In addition, *Pseudosphinx* and *Isognathus* are sister group (node 114 in Kawahara *et al*., 2009), whereby they have almost no variation.

Finally, *Eumorpha* and *Enyo* have a very similar epiphysis, which would be explained by the close phylogenetic relationship of both genera (node 62 in Kawahara *et al*., 2009) (Figure 177). To conclude, this analysis shows that there is phylogenetic signal ($p = 0.0206$) between the genera studied, this means, the epiphyses in the phylogenetic tree do not resemble each other.

The centroid size of the epiphyses was also mapped in the phylogeny, so we can see that *Pachylioides*, *Isognathus* and *Erinnyis* show centroid size similar because they belong to the same clade (node 48 in Kawahara *et al.*, 2009). *Pseudosphinx* has the largest epiphysis size than *Isognathus*, and in the same way it happens between *Eumorpha* and *Enyo*, which are sister group (Figure 178).

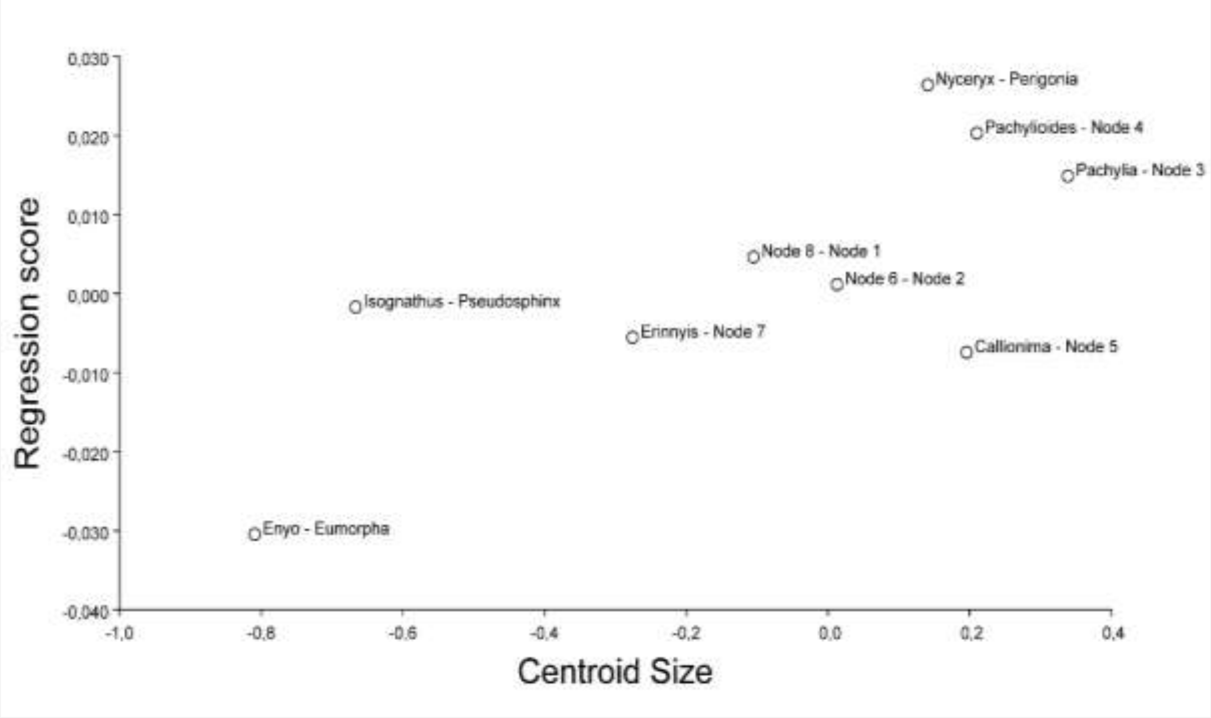


Figure 175. Evolutionary allometry of epiphysis shape, based on multivariate regression of independent contrasts of shape on independent contrasts of centroid size.

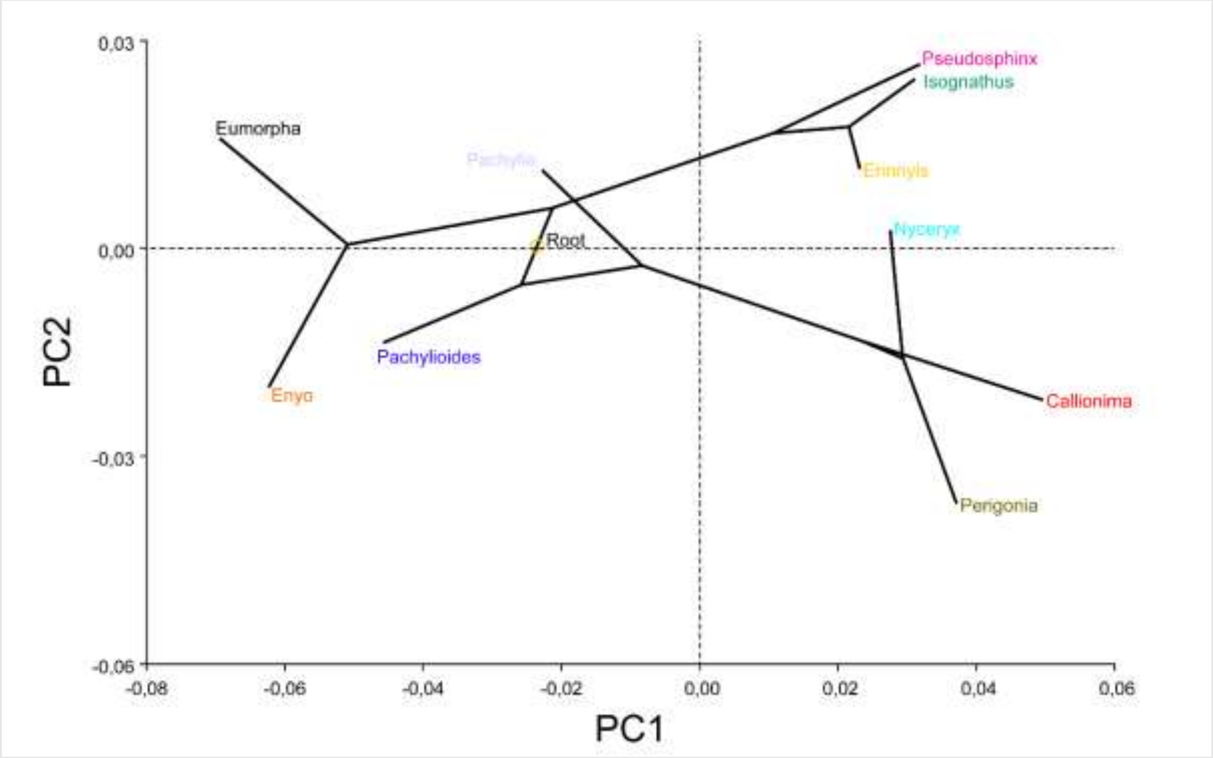


Figure 176. Reconstruction of evolutionary changes in epiphysis shape. The phylogenetic tree has been superimposed onto a plot of the first 2 principal components among genera means. The tips of the terminal branches are at the locations of genera means. The positions of the internal nodes were reconstructed by squared-change parsimony using the composite tree topology of Kawahara *et al*., 2009, and branch lengths derived from estimated divergence times. PCA with allometry.

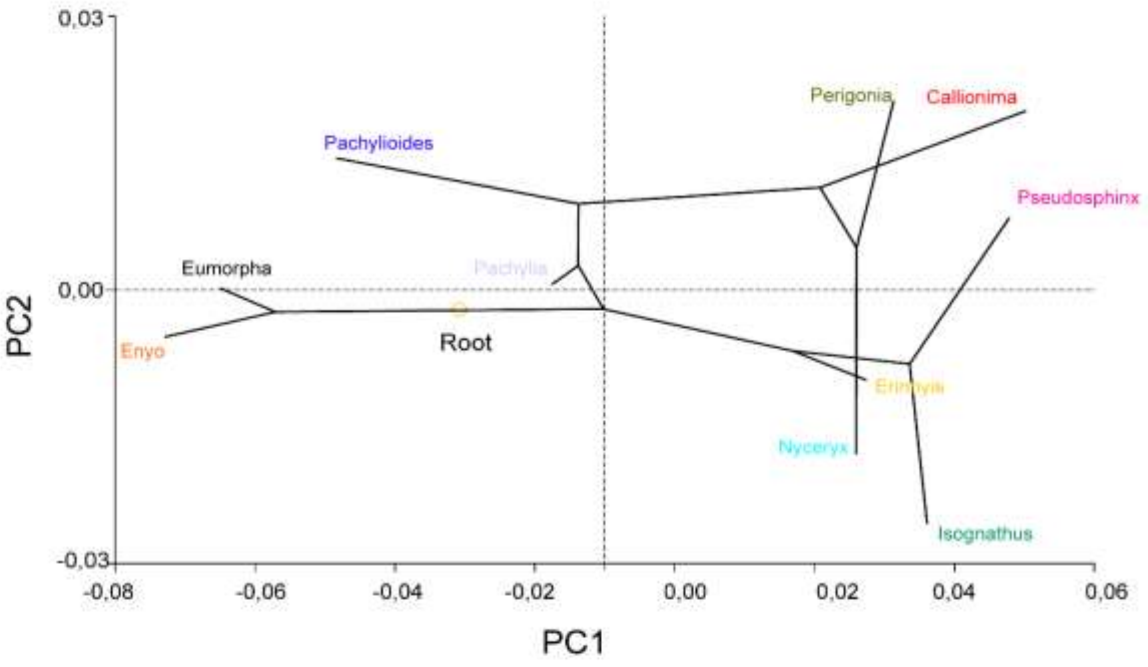


Figure 177. Reconstruction of evolutionary changes in epiphysis shape. The phylogenetic tree has been superimposed onto a plot of the first 2 principal components among genera means. The tips of the terminal branches are at the locations of genera means. The positions of the internal nodes were reconstructed by squared-change parsimony using the composite tree topology of Kawahara *et al.*, 2009, and branch lengths derived from estimated divergence times. PCA without allometry.

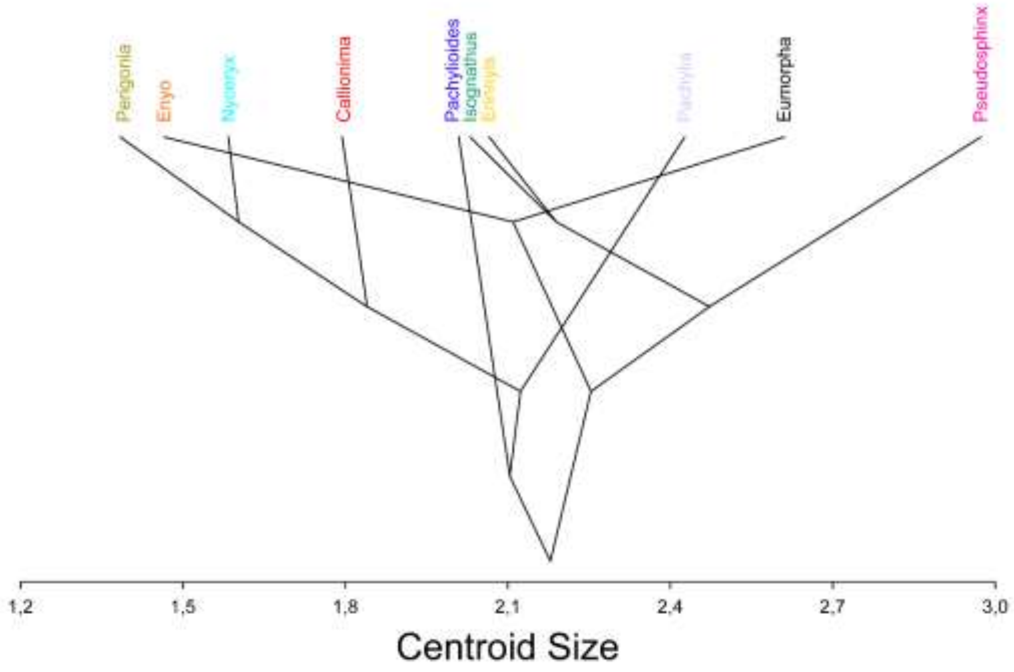


Figure 178. Reconstruction of evolutionary changes in epiphysis shape considering the centroid size.

4. DISCUSSION

4.1. Epiphyses: morphological patterns and terminology

Epiphyses, the so-called “cleaning organ” of lepidopteran’s antennae, are structures taxonomically important located on the inner surface of foretibiae (Philpott, 1924; Burrows, 1932; Lemaire and Wolfe, 1988; Schoorl, 1990; Minet, 1994; Schmitt *et al.*, 1996; Mielke *et al.*, 2008; Mielke and Drechsel, 2009; Pinheiro *et al.*, 2011; Mielke and Casagrande, 2013; Castro-Torres and Llanderal-Cázares, 2016; Perini *et al.*, 2019) .The presence of this structure is a supposed synapomorphy of Lepidoptera, with secondary loss in some lineages (Common, 1975; Kristensen *et al.*, 2007). Furthermore, the different “types” of epiphyses have been used by some authors to distinguish taxonomic groups (Philpott, 1924; Robbins, 1989; Mielke and Casagrande, 2013; Perini *et al.*, 2019). However, studies exploring the detailed morphology of this structure are scarce and a complete description, recognizing possible characters and characters states phylogenetically are still absent in the literature.

In this work, we present the detailed epiphysis’ description for two Lepidoptera subtribes: Dilophonotini and Philampelini (Macroglossinae, Sphingidae), suggesting new characters and new terminology for this complex and important structure. Even though all Sphingidae species have a well-developed epiphysis (Rothschild and Jordan, 1903), the works mentioning this structure are based in superficial morphological analyzes, with no detailed and deeply circumscription of characters that might be useful for a better understanding of the biology and evolution of these moths (Philpott, 1924; Thelen and Farish, 1977; Odell *et al.*, 1982; Robbins, 1989). In addition, these works included very few species of the subfamily Smerinthinae and subtribe Sphingini (Philpott, 1924; Kent and Griffin, 1990). Therefore, our description of the epiphyses Macroglossinae are unprecedented.

The use of epiphysis variation in a taxonomic context has been emphasized by several authors (Schoorl, 1990; Mielke and Almeida-Neto, 2007; Mielke, Brosch and Naumann, 2008; Pinheiro, Silva and Duarte, 2011; Mielke and Casagrande, 2013), including studies related with the identification of species with some economic importance (Perini *et al.*, 2019). Commonly, three aspects (treated here as “characters”) of the epiphysis’ morphology are highlighted in the literature: shape, position and, more frequently, size. For example, Philpott (1924) described the epiphysis of some groups (Micropterigidae, Pterophoridae, Crambidae, Erebidae, Notodontidae, Geometridae, etc.), with reference to the shape, position and size; but with the use of poorly standardized characters. Odell *et al.* (1982) and Schoorl (1990) also used shape and size in their descriptions (for *Lymantria dispar* and many species of Cossidae, respectively); however, these authors did not cite the position. Other studies only have reference of one character (generally, size), with no reference to the others like in many species of Saturniidae (Mielke and Almeida-Neto, 2007; Mielke *et al.*, 2008; Mielke and Drechsel, 2009; Mielke and Casagrande, 2013).

In our study, we analyzed shape, position and size of the epiphyses of species belonging to Dilophonotini and Philampelini, but unlike Philpott (1924) we used an approach of detailed and careful descriptions, with a standardization of characters and character states. Unlike most of the previously cited authors, which described epiphysis with reference of two or one aspect only, we analyzed a more comprehensive range in variation of position, size and shape of the epiphyses (including a geometric morphometric analysis).

It is interesting to mention that Perini *et al.*, (2019) provided a taxonomic key based on four characters from the epiphysis to identify the species of *Helicoverpa* (Noctuidae). Two of these characters had been previously mentioned by other authors (size and position) (Philpott, 1924; Odell *et al.*, 1982; Schoorl 1990), and the others were admittedly unpublished: the shape of the lateral margin of the epiphysis and the apical portion of the comb. We did not analyze these two last characters because they did not show morphological variation in our study group (Dilophonotini and Philampelini).

In addition to the three characters cited above (shape, size, position), 19 new characters were proposed in the present study (17 from epiphysis itself and five from the acanthae found under of the comb). All the characters here proposed follow a new terminology developed to describe the epiphysis structure, looking for a standardization of morphological descriptions. If we consider only the three characters traditionally used by other authors to describe epiphysis (Philpott, 1924; Odell *et al.*, 1982; Robbins, 1989; Mielke and Almeida-Neto, 2007; Mielke *et al.*, 2008; Mielke and Drechsel, 2009; Pinheiro *et al.*, 2011; Mielke and Casagrande, 2013), we can view this structure as poorly variable, with almost no potential as a taxonomic character (see Phillpot,1924). However, based on our 22 characters, we demonstrated that the epiphyses of Dilophonotini and Philampelini can have slight morphological variations at genus and species levels, but the variation at the tribe and subtribe levels can be striking.

4.1.1. Shape

A variety of terminology has been used in the literature to designate the shape of the epiphysis, depending on the group of study or the researcher's tradition. In addition, different aspects of the shape have been attributed referring to the same character plus many terms have been used to refer to the same morphological shape. Therefore, there is no a uniform terminology with a proliferation of confusion.

Terms found in the literature referring the states of the epiphysis shape are: (i) folded leaf; (ii) concave forming a rounded cannel; (ii) concave to the limb; (iv) centrally folded; (v) curved; (vi) slightly flattened (Philpott, 1924); (vii) claw-like (Madden, 1944); (viii) elongated (Callahan and Carlysle, 1971); (ix) slightly curved; (x) not curved (Odell *et al.*, 1982); (xi) oval; (xii) tooth-like (Schoorl, 1990); (xiii) pectinate (Schmitt *et al.*, 1996); (xiv) foliaceous (Leite *et al.*, 2010); (xv) spur-like (Philpott, 1924; Castro-Torres and Llanderal-Cázares, 2016); (xvi) brush-like (Sambaraju *et al.*, 2016). Of all these terms, only three are commonly used for the epiphyses of hawkmoths: concave forming a rounded channel as in *Coequosa australasiae* (Donovan, 1805) (Smerinthinae); concave to the limb, centrally folded as in *Agrius convolvuli* (Linnaeus, 1758) (Sphinginae); and claw-like as in *Manduca sexta* (Sphinginae). *Agrius convolvuli* and *M. sexta* have epiphyses similar to the ones of those species examined in our study. However, Philpott (1924) described the structure as "concave to the limb, centrally folded" and Madden (1944) uses the term "claw-like", demonstrating the lack of consensus and need for a detailed morphological description. Consequently, we rejected the terms previously associated with the epiphysis shapes in Sphingidae and proposed three new terms: (i) elongated; (ii) lanceolate, and (iii) spoon-shaped; each one with their respective morphological descriptions. Morphological and molecular characters showed the subtribe Hemarina as sister group of the remaining macroglossines (Kawahara *et al.* 2009), this might to explain the “elongated shape” as unique feature in this group. Additionally, the shape of epiphyses in Dilophonotina and Philampelini might be a conserved character in this group (Stojanovic *et al.*, 1999), because they showed two shapes, which the most common was “lanceolate” (56 species), this type of shape also was showed in *Sabatinca* and *Micropteryx* (Micropterigidae) (Philpott, 1924). We suppose that the lanceolate epiphyses was present in the common ancestral species and has been preserved in the contemporary species being examined, however, a future study could deny or affirm this hypothesis.

4.1.2. Size

As mentioned in the previous section about the terminology of the epiphysis shape, there is no standardization to describe the size of the epiphyses. There are quantitative descriptions, presenting the size measured in millimeters (Odell *et al.*, 1982; Perini *et al.*, 2019); there are comparative measurements, in which the relation between the size of the epiphysis and other parts of the body is highlighted [for example: “epiphysis with more than half the length of tibia” (Pinheiro *et al.*, 2011)]. Additionally, there are the vague and not at all accurate descriptions: “epiphysis reaches *almost* to apex of tibia” (Schmitt, 1996); and “epiphysis *very short*” (Burrows, 1932). Of all these descriptions, the most common are those that relate the size of the epiphysis with the size of the tibia: the relative ratio between epiphyses and tibiae (i.e. (Mielke *et al.*, 2008; Mielke and Drechsel, 2009). Considering accuracy and precision, we prefer in this study to treat the size of the epiphyses as a quantitative character, measured in millimeters, as Odell *et al.*, (1982) and Perini *et al.*, (2019) did it. The ratio between the sizes of the tibiae and the size of the epiphyses is an interesting aspect evaluated but using real measurements and not only comparative proportions like in previous works.

Our results suggest that the epiphyses of Philampelini are longer than the epiphyses of Dilophonotini. *Eumorpha anchemolus* (Cramer, 1779) (mean = 3.711 ± 0.223 mm, n = 15), a Philampelini, was reported as the specie with the longer epiphysis, and *Aellopos tantalus* (Linnaeus, 1758) (mean = 1.460 ± 0.085 mm, n = 2), a Dilophonotini, with the shorter one. Both species have a longer epiphysis when compared with the noctuids observed by Perini *et* *al.*, (2019): *Helicoverpa gelotopoeon* (Dyar 1921) (mean = 0.67 ± 0.036 mm, n = 8), *Helicoverpa zea* (Boddie, 1850) (mean = 0.88 ± 0.042 mm, n = 8); and, *Helicoverpa armigera* (Hübner, 1808) (mean = 0.95 ± 0.114 mm, n = 8). Furthermore, *P. tetrio* has a longer epiphysis than males and females of *Lymantria dispar* (Linnaeus, 1758) (2-3 mm), but *A. tantalus* has a similar epiphysis (long) to some females of *L. dispar* (1-1.5 mm) Odell *et al.*, (1982).

4.1.3. Position

The position of the epiphyses on the foretibia are usually described in the literature considering the following aspects: (i) the quantitative distance (in millimeters) in relation to the tibia-femur articulation (Perini *et al.*, 2019); (ii) a vague notion of distance (more proximal or more distal), with no exact measurements (Philpott, 1924; Kristensen, 1999). We chose to use the first approach because we consider that it is more accurate, making possible the reproducibility of this study. In addition, this approach facilitates any future comparative analysis.

Perini *et al.*, (2019) showed how the position of the epiphysis can be affected by the size of the tibia in *Helicoverpa* species (Noctuidae): the epiphysis may be in a more proximal or distal position depending on the tibia length. Philpott (1924, p. 216) pointed out that "Presumably, after development into a strigil (epiphysis), the structure moved basal or distal in sympathy with the tibial modification or other conditions as the different shapes evolved". Our results corroborated with these studies: tibiae with a longer length present the epiphyses inserted more distally, while in the tibiae with a shorter length, the epiphyses are inserted more proximally. For example, *Oryba*, *Eumorpha* and *Pseudosphinx* that have the epiphyses in a more distal position also have the longer tibiae. On the other hand, *Hemaris* has the most proximal epiphyses and the shortest foretibia.

4.1.4. Accessory comb

The epiphysis of the Dilophonotini and Philampelini species analyzed in this work present a comb situated in its inner margin as well as other Sphingidae species [e. g. *Manduca* *sexta* (Sphinginae), in Kent (1990) and Madden (1944); *Agrius convolvuli* (Sphinginae), in Philpot (1924); *Ceridia* sp. (Smerinthinae), in Rothschild and Jordan, 1903); *Coequosa australasiae* (Smerinthinae), in Philpott (1924)]. The presence of this comb is not exclusive of Sphingidae species because it has also been observed in other lepidopterans families, such as Micropterigidae, Pterophoridae, Crambidae, Erebidae, Notodontidae, Geometridae (Philpott, 1924); Lyonetiidae (Schmitt *et al.*, 1996); Cossidae (Schoorl, 1990); Papilionidae (Robbins, 1989; Leite *et al.*, 2010); Hesperiidae (Robbins, 1989); Pyralidae (Sambaraju *et al.*, 2016); and Noctuidae (Philpott, 1924; Perini *et al.*, 2019). However, in some species of the families Mnesarchaeidae, Hepialidae, Psychidae, Tortricidae and Castniidae this structure is absent (Philpott, 1924). It is possible that the epiphysis comb is a character that independent evolve in various lineages of Lepidoptera or/and it have been lost several times. This hypothesis can be tested in a future phylogenetic study.

4.1.5. The acanthae

The acanthae of Dilophonotini and Philampelini are characterized by having dentiform projections, which differs completely from *Papilio glaucus* Linnaeus, 1758 (Papilionidae) – with a "papilla-shaped acanthae" (Robbins, 1989) and from *Lymantria. dispar* (Linnaeus, 1758) (Lymantridae) – with "spatuladas acanthae" (Odell *et al.*, 1982). Both *P. glaucus* and *L. dispar* lack the dentiform projections along the acanthae, with an acanthae structure less ornamented. It is possible that the epiphyses of Dilophonotini and Philampelini are better equipped to assist in the antennal cleaning than the epiphysis of the others two groups analyzed in previous studies.

We could not compare the shape of the acanthae observed in our study with those mentioned by Odell *et al.* (1982) and Robbins (1989). The shape of the acanthae varies depending on the position of this structure in the epiphysis. For example, acanthae located in medial/lateral margin and those found below the comb are different from each other in the same epiphysis. Therefore, the lack of information on the location in the works of Odell *et al.* (1982) and Robbins (1989) makes comparison impossible. The different shapes of acanthae in an epiphysis suggest that each of them could be specialized to clean particles of different sizes, as observed for ant' species *Camponotus rufifemur* Emery, 1900 (Hackmann *et al.*, 2015).

We reinforce the claim that the shape of the acanthae can be an important source of taxonomic information (Richards and Richards, 1979). The shape of this structure could be constant in species of some genera (Richards and Richards, 1979) and useful to distinguish some high-level taxa. Future taxonomic works, using SEM techniques and a more comprehensive sampling, could explore deeply the potential of the acanthae characters.

4.2. Sexual dimorphism

Of the 59 species used in this study, 45 Dilophonotini species and 5 Philampelini species present sexual dimorphism in characters related to the epiphysis. This pattern coincides with the observations of several authors for different Lepidoptera taxa (Philpott, 1924; Kent and Griffin, 1990; Schoorl, 1990; Minet, 1994; Kristensen, 1999). Six species of Dilophonotini (*Pachylia syces*, *Callionima nomius*, *Aellopos ceculus*, *Hemeroplanes triptolemus*, *Erinnyis crameri* and *Enyo ocypete*), and three species of Philampelini (*Eumorpha fasciatus*, *Eumorpha megaecus* and *Eumorpha vitis*) do not show sexual dimorphism. The lack of differentiation between male and female epiphysis in these species could be associated with the lack of dimorphism in the antennae, since the morphology of both structures are strictly associated (Philpott, 1924; Odell *et al.*, 1982).

Most Dilophonotini/Philampelini males have longer epiphysis than females (n = 54 species). This result is the same of the observation made for the species *Lymantria dispar* by Odell *et al.* (1982). Females of the species *Cephonodes hylas*, *Pachylia darceta*, *Callionima nomius*, *Madoryx oiclus* and *Isognathus menechus* have the epiphysis longer than males. Castro-Torres and Llanderal-Cázares (2016) also observed this pattern for *Comadia redtenbacheri* (Cossidae). Females with longer epiphysis could be related with a possession of a longer antennae (Philpott, 1924; Odell *et al.*, 1982), or with a supposed more relevance of this structure in females than in males (Castro-Torres and Llanderal-Cázares, 2016). It has been shown that the body size is smaller in males and larger in females (Miller, 1997; Stillwell *et al.*, 2010), however, our results showed that the length of the epiphyses have more associated with the antennae size than with body size, it could be studied in the future.

The species of Dilophonotini and Philampelini observed in this work do not present sexual dimorphism in the epiphysis' shape, except for the species *Oryba kadeni*. In this species, males have a spoon-shaped epiphysis and females, a lanceolate one. This variation could be associated with the specific sensory function of the female antennae in *Oryba* species, like in gypsy moth (Odell *et al.*, 1982).

Sexual dimorphism also occurs in the ornamentation of the epiphysis. For example: 11 species of Dilophonotini and one species of Philampelini show sexual dimorphism in the acanthae located under the comb. Males of some species, such as *Nyceryx nictitans*, *Eupyrrhoglossum sagra* and *Pachylioides resumens*, have more serrated projections and/or a dilated acanthae tip while females do not exhibit this type of ornamentation. The sexual dimorphism of the acanthae could indicate that males and females are exposed and could filter different dirt particles (Odell *et al.*, 1982; Hackmann *et al.*, 2015).

4.3. Association between epiphysis and other variables

4.3.1. Position

Of the ten genera evaluated to test the allometric association between the position of the epiphysis and the size of the tibia, nine of them showed a medium-high association (R > 30%) between these two variables. Some authors reported this association, but not systematically test this hypothesis (Philpott, 1924; Perini *et al.*, 2019). We demonstrate statistically that the position of the epiphyses will vary in relation to the size of the tibia for at least nine of the ten genera analyzed. Therefore, our work corroborates previous studies that cited the relation between these two variables (Philpott, 1924).

However, this is not a general rule for all species: in the species *Pachylioides resumens* we observed a low allometric association (R<30%) between the position of epiphysis and the foretibia length. It is important to highlight that is likely that other factors not evaluated in the present study also can contribute to the determination of the position of the epiphysis (e.g., relationship with other parts of the body controlled by the same gene network; aspects of the biology of each species), therefore, further investigations exploring this topic are encouraged.

4.3.2. Antennae

All the observed antennae (Dilophonotini and Philampelini) are filiform and densely scaled dorsally, coinciding with the description by Kristensen (1999) and Messenger (1997). This type of antennae has also been reported in *Agrius convolvuli* (Symonds *et al.*, 2011) and *Manduca sexta* (Madden, 1944; Shields and Hildebrand, 1999b) both Sphingidae species as well. The antennae of Dilophonotini and Philampelini show pronounced sexual dimorphism on the size of the antennal sensilla. This is generally the pattern of the species of Lepidoptera (Philpott, 1924; Madden, 1944; Kristensen, 1999; Shields and Hildebrand, 1999b; Symonds, Johnson and Elgar, 2011), with females having a less developed antennae (without or with shorter sensilla) than males.

However, we observed females of *Callionima* with the sensilla along the surface of antenna quite similar the males. Females of *Aleuron* and *Unzela japix* also exhibit a discrepant pattern, with some small sensilla scattered on the antennal surface. We raised two hypotheses for these more developed antennae in females: (i) antennae can be used to capture allelochemicals from host plants (“search for hosts hypothesis”; Ndomo-Moualeu *et al.*, 2014), where females will oviposit; (ii) antennae can work to recognize possible pheromones produced by males (“male pheromones hypothesis”; Messenger, 1997; Symonds *et al.*, 2011). These hypotheses can be tested in future studies of chemical ecology involving the mentioned species.

Another difference between sexes was observed in the antennae length. Most of Dilophonotini/Philampelini males have longer antenna than females (44 species). However, in 13 species, females have longer antenna than males, and in two (*Callionima guiarti* and *Nyceryx continua continua*) there is no sexual dimorphism. Madden (1944) also observed no sexual dimorphism of the antennae length for *Manduca sexta.* Symonds *et al.* (2011) mentioned the fact that individuals with a more elaborated antennae should have larger forewing lengths, but in Sphingidae and in our results females have larger forewing lengths (Camargo *et al.*, 2015) and, generally, a less elaborated antennae.

Of the ten genera considered to test the allometric association between the epiphysis length and antenna length, seven of them showed a medium-high association (R > 30%) between these two variables. There is a supposed relation between the morphology of epiphysis and antenna, given the functional relation of these structures. For example, Philpott (1924) pointed out that the shape of the antennae was linked to the shape of the epiphysis and that in several families of Lepidoptera species with the most ornamented antennae had the most developed epiphysis. We can view this position in the following sentence:

> "It will be found that, in general, those species with the most "plumose' 'antennae have the most highly developed strigils [epiphysis]; further, when the male has strongly pectinate antennae and the female simple ones, or nearly so, the former will be found to have a well-developed tibial structure, while that of the latter may he barely half the size" (Philpott, 1924).

It is expected longer epiphyses for longer antennae, particularly, in males – as discussed by Odell *et al.*, (1982) for lymantriid species. But this pattern as well as others evaluated in the present study, may vary depending on the taxon, since the selective pressures and the evolutionary history of each lineage are not the same. Even if we find congruent patterns, there are exceptions (as shown in the examples above), which open the way for new questions and perspectives for future studies.

4.4. Geometric morphometric of the epiphysis

4.4.1. Relationships of epiphysis' shape/size in genera and species

The allometry analysis showed that there is a positive and significant allometry in Dilophonotini (% predicted: 5.382%, p <.0001) and positive but not significant allometry in Philampelini (% predicted: 3.600%, p = 0.0053). These results were expected, since within the Dilophonotini there are specimens in several species that have different epiphyses sizes (from *Perigonia stulta* and *Enyo lugubris* to *Pseudosphinx tetrio* and *Pachylia ficus*), and Philampelini, represented by *Eumorpha* with eight species, have an epiphyses size less variable (from *Eumorpha vitis* to *E. anchemolus*). Allometry results coincide with epiphysis averages in millimeters [e.g. *Perigonia stulta* mean = 1.583 ± 0.092 mm long, 0.237 ± 0.024 mm wide; *Enyo lugubris*; *Pseudosphinx tetrio* mean = 3.399 ± 0.154 mm long, 0.788 ± 0.093 mm wide; *Pachylia ficus* mean = 3.081 ± 0.317 long, 0.561 ± 0.071 wide; *Eumorpha vitis* means = 2.566 ± 0.179 mm long, 0.509 ± 0.059 mm wide; *E. anchemolus* means = 3.711 ± 0.223 mm long, 1.033 ± 0.215 mm wide] (see Table 6). Moreover, species with small epiphysis showed small antennae, and unlike (APPENDIX D), reaffirming the relation between the size of the antennae and epiphysis (discussed in 4.3.2) and the strict functional connection of both structures (Philpott, 1924; Odell *et al.*, 1982).

The PCA' scatterplot shows that the PC1 differentiates a group formed by the genera *Erinnyis*, *Pseudosphinx*, *Isognathus* and *Callionima*, disaggregated from the genera *Enyo* and *Pachylioides*; moreover, *Eumorpha* and *Pachylia* are fully agglomerated in the PCA. The PC2 fails to disperse the genera groups (Figure 167). In addition, CVA and Mahalanobis distance show similar results; the agglomeration between *Eumorpha* and the other genera of Dilophonotini is reflected in the short distance between these two subfamilies (Mahalanobis distance: 1.5392, p>.0001). Furthermore, in general more disaggregated from one another, they show greater distances than others that are more agglomerated in the PCA, which better reflects what happens between some genera [e. g. *Enyo* – *Pseudosphinx* (Mahalanobis distance: 6.809, p<.0001); *Erinnyis* – *Isognathus* (Mahalanobis distance: 1.199, p<.0001)]. Despite not having as much resolution in the PCA, each one of the most disaggregated genera has differences in the epiphysis shape with respect to others, the little disaggregation among genera could indicate a constant shape of the epiphyses with slight variations (in the inner margin of the epiphysis, inner margin of the foretibia and the posterior region, see Figure 4), which coincides with what was found in the morphological analysis, Dilophonotini and Philampelini show a lanceolate epiphysis.

With the objective to observe the morphometric variation of epiphysis between the species, the average shape of each of them was considered. The results are quite interesting because PC1 distinguished two large groups. The first group consists of *Perigonia*, *Callionima*, *Pseudosphinx*, six species of *Erinnyis*, *Nyceryx*, *Isognathus* and two species of *Pachylia*. The second one consists of *Pachylioides*, *Enyo*, *Eumorpha*, one species of *Pachylia* and one species of *Erinnyis* (Figure 168). The PC2 divided the genera *Callionima*, *Nyceryx*, *Erinnyis*, and *Eumorpha*, separating several species of the same genus. Some species are morphometrically more similar to species that belong to other genera. For example, *Pachylia syces* has more similarity to some species of *Erinnyis*; *P. darceta* with species of the genera *Eumorpha*, *Enyo* and *Pachylioides*; and, *P. ficus* with species of the genera *Isognathus* and *Nyceryx*. It would be interesting to map the epiphyses characters in a proposed phylogeny to test the ancestral states and the possible evolutionary convergences to this structure.

On the other hand, Cai *et al.*, (2019) indicated the potential use of geometric morphometrics for the identification of Sphingidae adults based on the wing shapes. Due to the variations of epiphysis shape demonstrated in our work, we see this structure with potential to be explored in future studies to identify species and genera as well. Future studies could reveal the utility of epiphysis morphometrics for more specific taxonomic and phylogenetic specific problems.

4.4.2. Sexual dimorphism

Positive allometry was observed between the epiphyses of males and females (12.208%, p <.0001), however, the analysis did not separate males from females by size (Figure 172), because the allometric effect of the sex could be variable independently in each species or/and genera. This pattern is also observed for the wings of Sphingidae (Camargo *et al.*, 2015) and Geometridae (Benítez *et al.*, 2011; Benítez and Vargas, 2017), and it was not considered unexpected in our study group because the epiphyses size seem to have sexual dimorphism in some species/genera (e.g. *Pachylia ficus*, *Callionima guiarti*, *Erinnyis lassauxii*, among other, see Appendix D). Exploring the allometric effect of sex for each species/genus requires a hypothesis test with a multivariate regression (Klingenberg, 2016) and we encourage future studies with this proposal.

Despite not having as much resolution in the PCA, each one of the most disaggregated genera has differences in the epiphysis shape with respect to others, the little disaggregation among genera might indicate a constant shape of the epiphyses with slight variations. This is reflected in the Mahalanobis distance, which also indicated that there is very low morphometric variation between males and females (Mahalanobis distance: 0.9860, p > .0001), all the epiphyses examined (both in Dilophonotini and Philampelini) are of the “lanceolate type” and the variation is minimal between them, demonstrating what a congruent pattern with our descriptive morphological analysis. Nevertheless, it is recommended to do an independent analysis for each species or genus to be certain that it occurs with sexual dimorphism in the epiphysis shape.

4.4.3. Morphometrics and phylogeny

4.4.3.1. Evolutionary allometry

Epiphyses of Dilophonotini/Philampelini show low evolutionary allometry and not significant statistically (15.286%, p = 0.2045), could be because in our group of study cover a range of size from *Perigonia lusca* (1.583 ± 0.092 mm long) to *Eumorpha anchemolus* (3.711 ± 0.223 mm long) (see Table 6 for more details of sizes), which would not be an important or significant factor in our hawkmoths, as in birds (Klingenberg and Marugán-Lobón, 2013) or in mammals (Klingenberg, 2013a). However, the low allometry modified the phylogeny mapping, therefore, we follow what Klingenberg (2013a) and Klingenberg and Marugán-Lobón (2013) suggested, to eliminating the effects of evolutionary allometry.

4.4.3.2. Map onto Phylogeny

For this analysis, we formulated the following hypothesis: genera closely related would have phenotypically similar epiphyses. In order to test this hypothesis, we searched for phylogenetic signal (Klingenberg and Gidaszewski, 2010; Klingenberg and Marugán-Lobón, 2013), considering the phylogeny proposed by Kawahara *et al.* (2009).

Our results show that there is a significant phylogenetic signal (p = 0.0206), corroborating our hypothesis, which is ‘genera phylogenetically closer have phenotypically similar epiphyses’. The combined phylogeny (PCA + Phylogeny) (Figure 177) shows a clear divergence between the two main clades, mainly in the direction of the first main component. Furthermore, within each lineage, there appears to be a diversification in the direction of the second component.

The clade *Eumorpha + Enyo* (node 62 in Kawahara *et al.*, 2009) and the clade *Erinnyis* + *Isognathus* + *Pseudosphinx* (node 113 in Kawahara *et al*., 2009) have close phylogenetic relationships and a similar epiphysis shape. However, in phylogenetically related genera, in the same clade, such as *Nyceryx* + *Perigonia* + *Callionima* (node 111 in Kawahara *et al.,* 2009) do not have similar epiphyses. In certain genera there seems to be a strong correlation between phylogenetic relationships and the shape of the epiphysis - as expected: closely related groups retain similar morphologies. However, in some genera there is variation in epiphyses shape - this may indicate rapid radiation events or strong selective pressures on this structure (Schluter, 1996).

Finally, the epiphysis centroid size was also mapped on the phylogeny. The proximally related genera *Pachylioides*, *Isognathus* and *Erinnyis* show similar centroid size (node 48 in Kawahara *et al*., 2009), indicating a signal phylogenetic for this clade. Closely related species have a difference in the size of the epiphysis (*Pseudosphinx* and *Perigonia*). It is likely that large epiphyses have evolved in a convergent way, consequently that the largest epiphyses are in groups not closely related.

5. CONCLUSIONS

For the first time, the morphology of the epiphyses of 59 species of Dilophonotini and Philampelini were examined and described in detail using different tools such as steromicrocospe, SEM, and geometric morphometrics. Furthermore, statistical analyzes were carried out to show relationships with other body measurements including antenna length, tibia length and epiphysis position. New terminologies were proposed to standardize future studies aiming a better understanding of the structure.

All the species examined showed typical epiphyses with comb on the inner margin, which appears to be a common feature of several lepidopteran groups, and it is presumed to be a character that independently evolved in various lineages or/and that has been lost several times. Additionally, 22 characters are established to assist in the description and comparison of the epiphyses among species, genera and tribes. Nevertheless, variation of these characters is more evident in genera and tribe levels.

A significant positive allometry demonstrated a relationship between the position of the epiphyses and the foretibia length; in the same way, between the antennae length and the epiphysis length. Epiphyses are sexually dimorphic structures in various characters, including those related to size. Most males have longer epiphyses than females, which may be associated with the antennae length rather than body-size, the variation between males and females are also showed in the antennae length.

Geometric morphometrics showed that some species are more similar to other genera than those that are currently classified. Evolutionary allometry is not an important factor in the evolution of our group of study, and some closely related genera do not have similar epiphyses shape, which might indicate rapid radiation events or strong selective pressures on this structure.

This study is an initial contribution to a more comprehensive understanding of the evolution of the lepidopteran epiphyses, with detailed and illustrated descriptions. We claim for other studies that can reveal new morphological patterns in other moths and butterflies.

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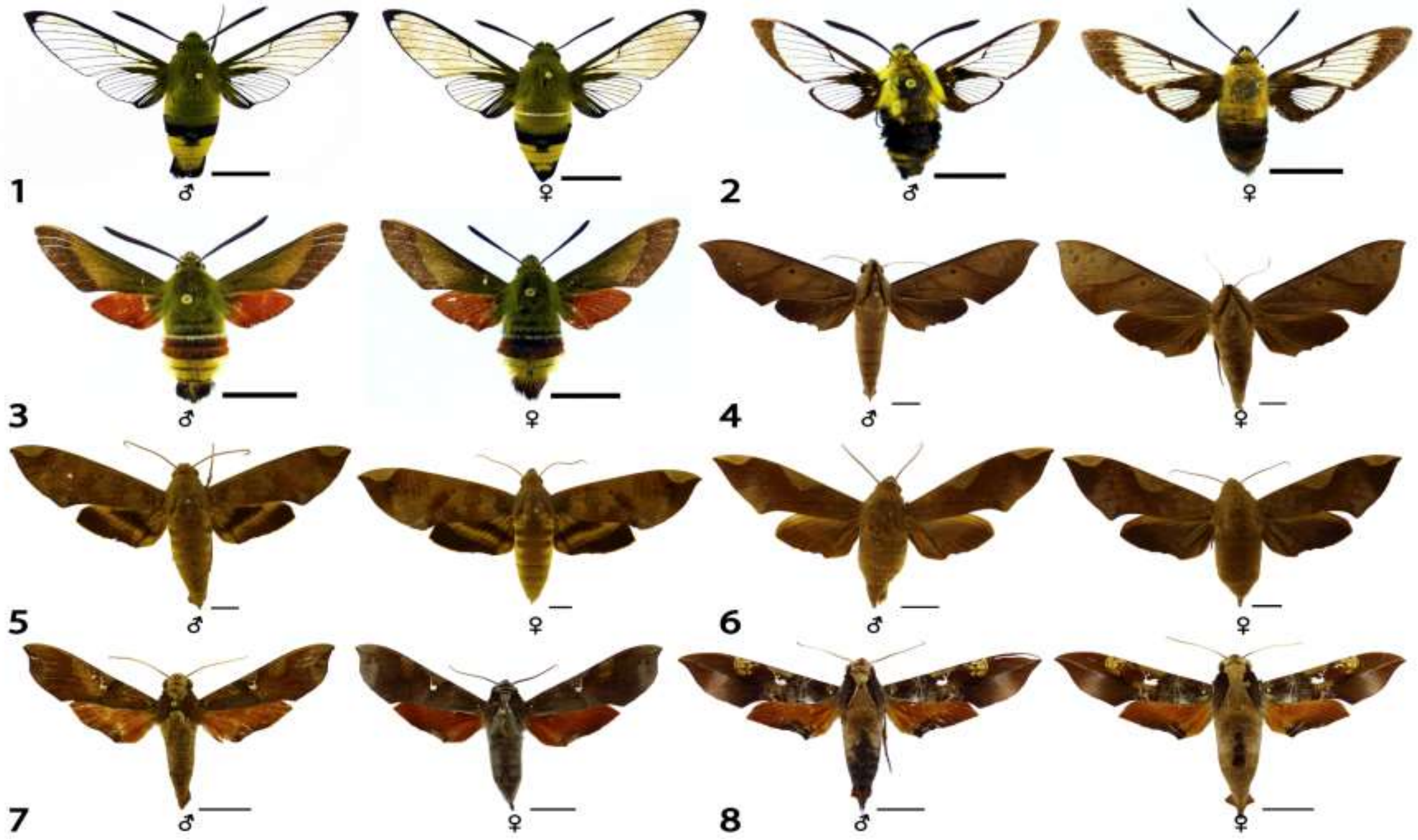
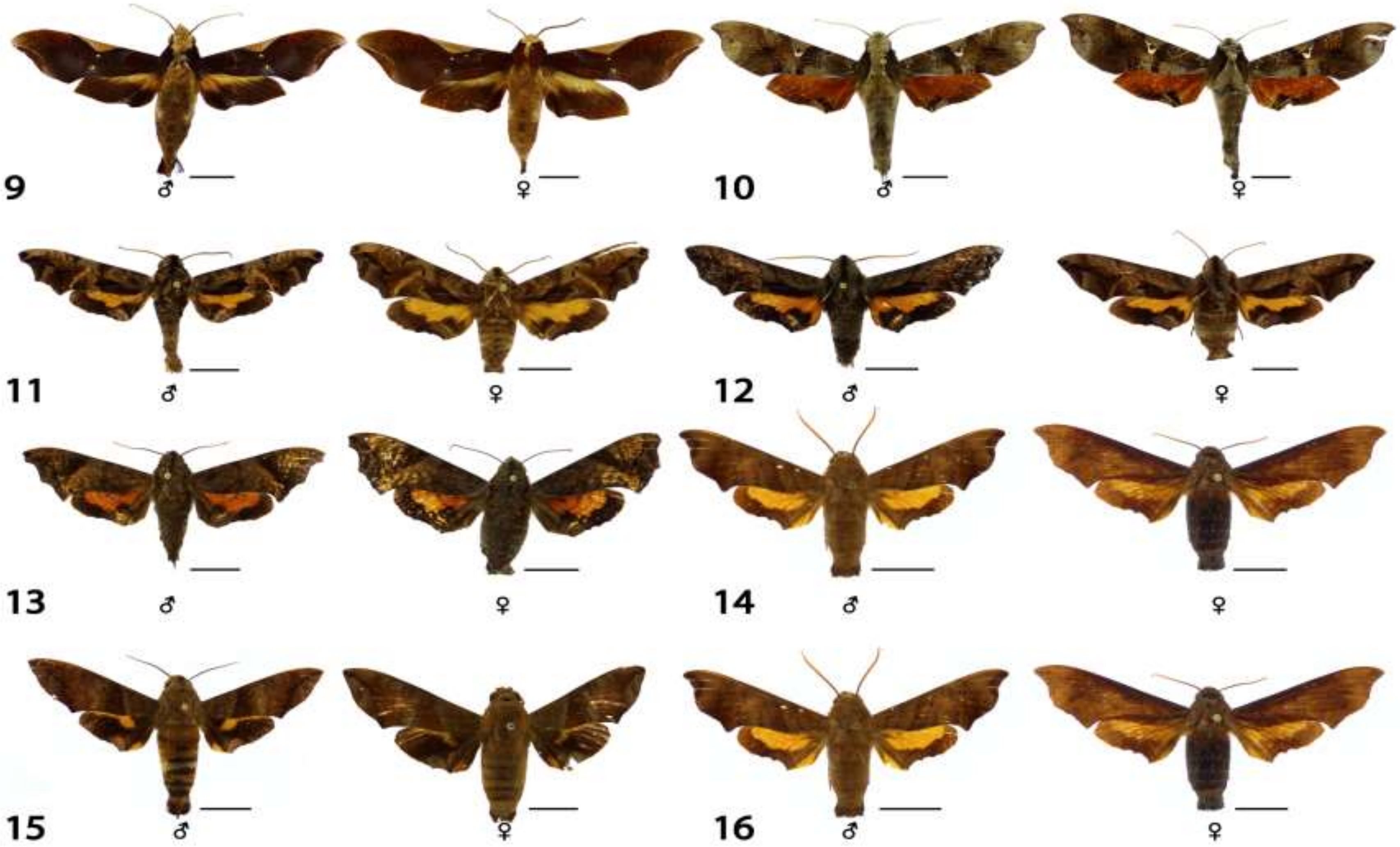
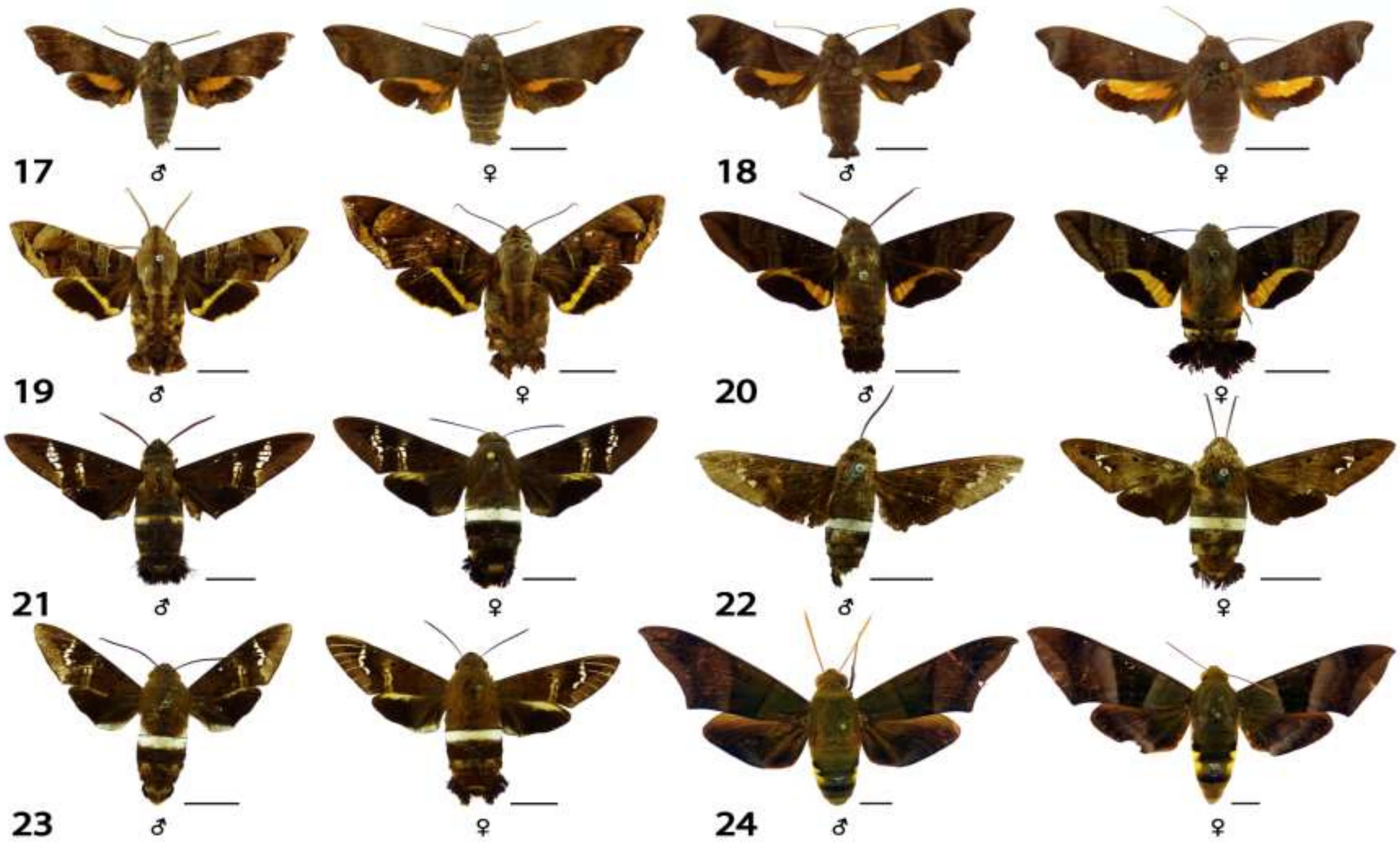
APPENDIX A. Plates of the studied species of Dilophonotini and Philampelini



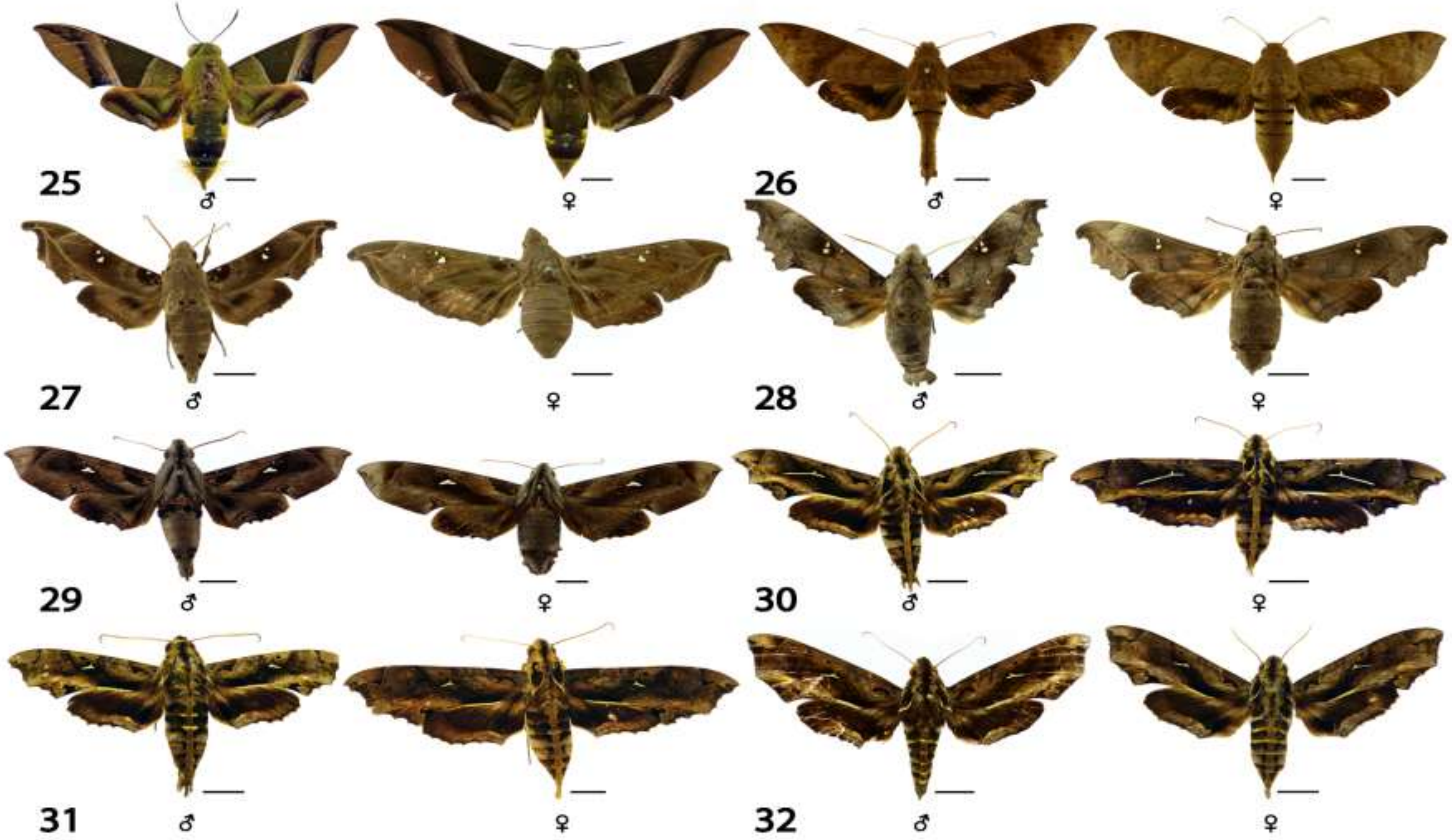
1. *Cephonodes hylas,* 2. *Hemaris diffinis*, 3. *Hemaris croatica,* 4. *Pachylia darceta*, 5. *Pachylia ficus*, 6. *Pachylia syces*, *7. Callionima guiarti*, 8. *Callionima innus* Scale bar: 1 cm.



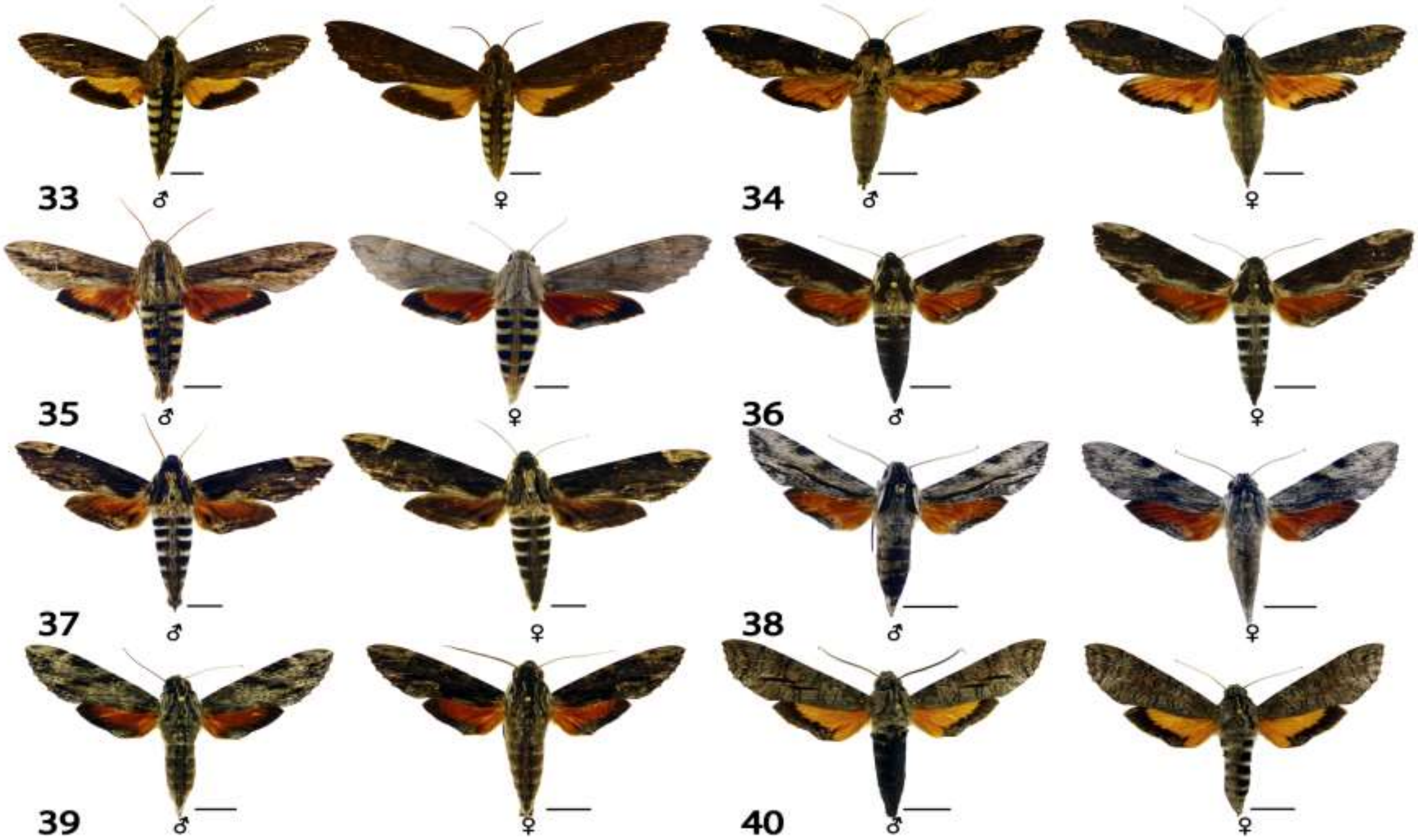
9. *Callionima nomius*, 10. *Callionima parce*, 11. *Nyceryx alophus*, 12. *Nyceryx continua*, 13. *Nyceryx nictitans*, 14. *Nyceryx stuarti*, 15. *Perigonia lusca*, 16. *Perigonia pallida*, Scale bar: 1 cm.



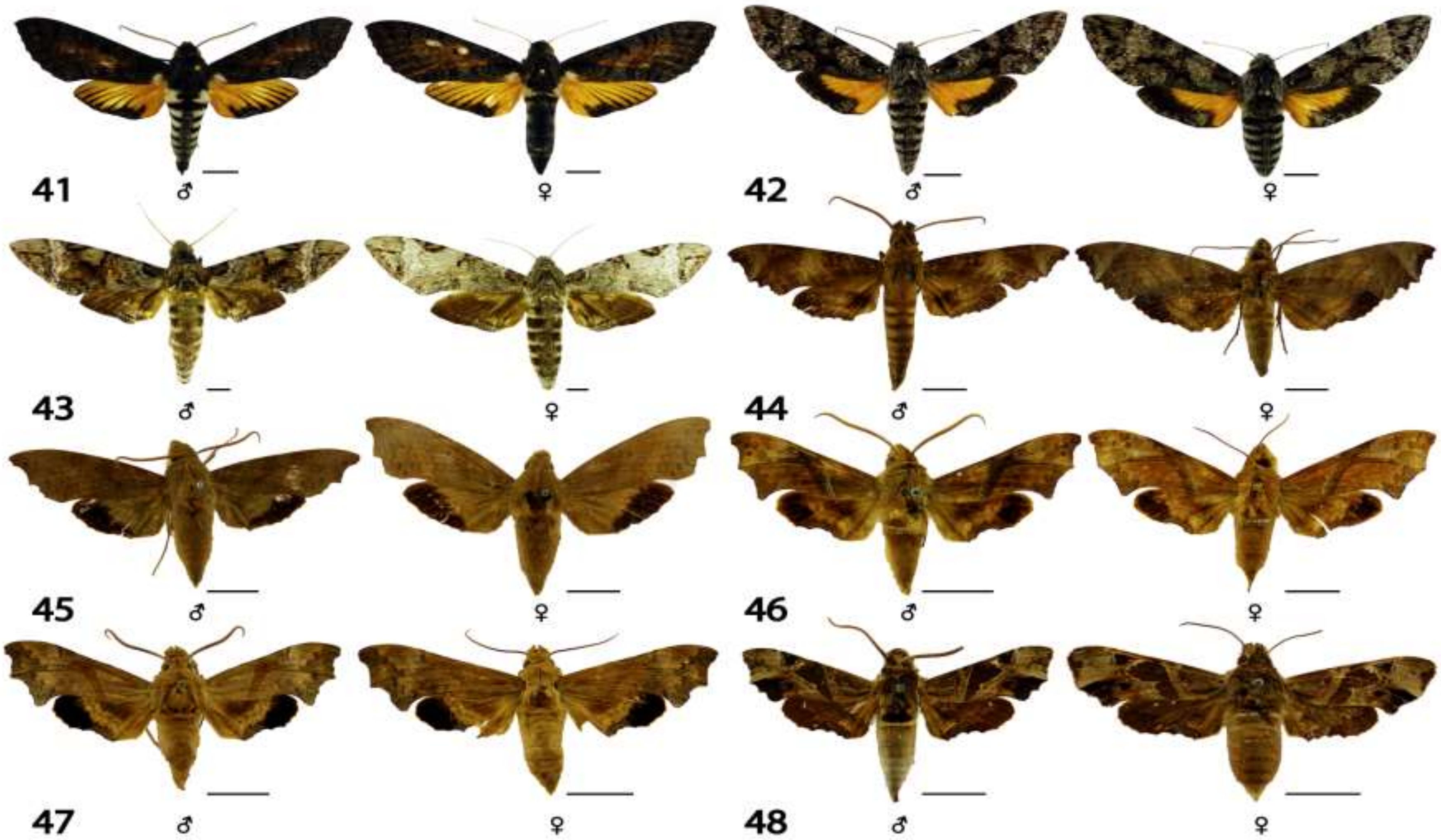
17. *Perigonia passerina*, 18. *Perigonia stulta,* 19. *Eupyrrhoglossum sagra*, 20. *Aellopos ceculus*, 21. *Aellopos fadus*, 22. *Aellopos tantalus*, 23. *Aellopos titan*, 24. *Oryba achemenides*. Scale bar: 1 cm.



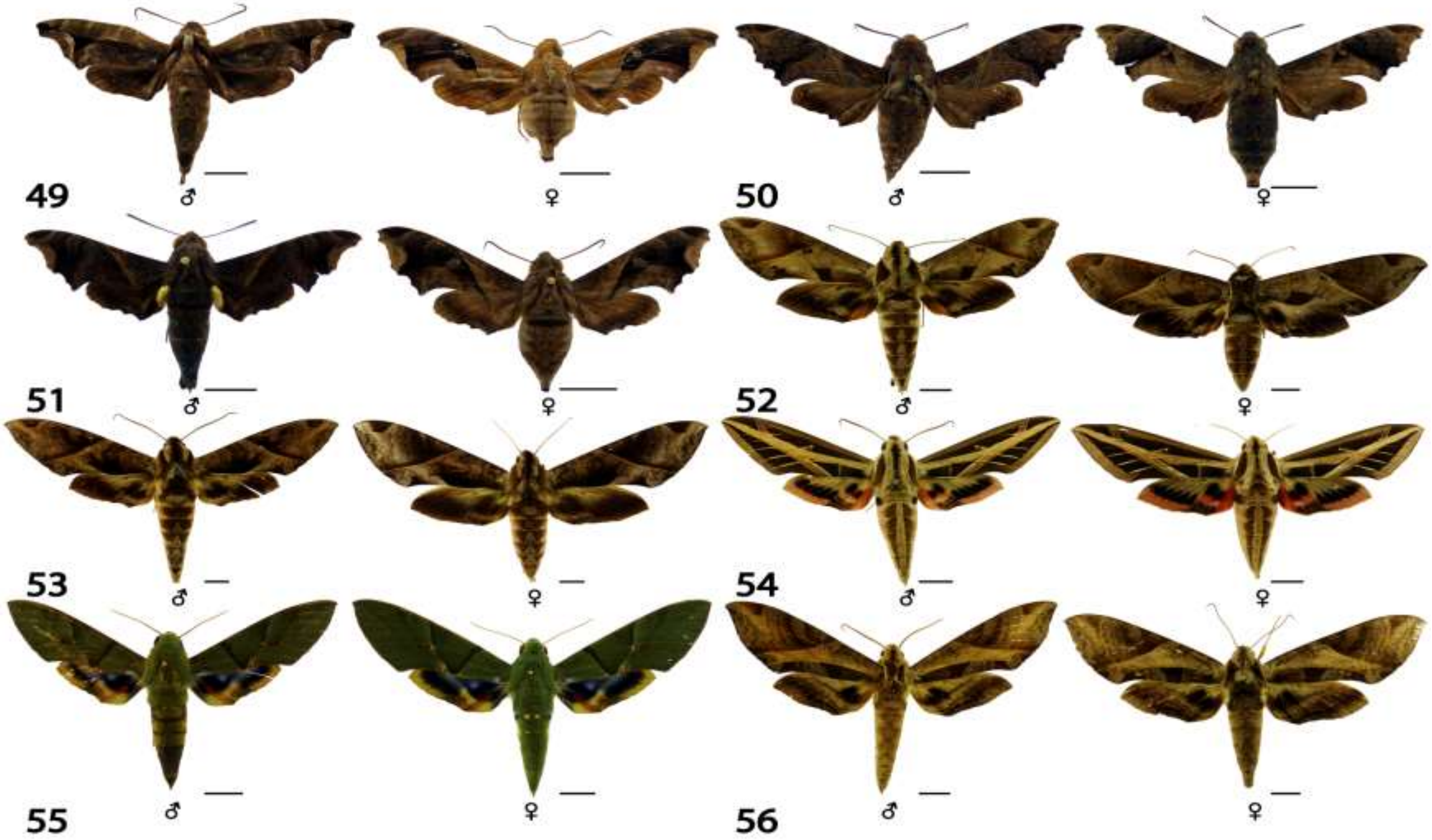
25. *Oryba kadeni,* 26. *Pachylioides resumens*, 27. *Madoryx bubastus*, 28. *Madoryx oiclus*, 29. *Madoryx plutonius*, 30. *Hemeroplanes longistriga*, 31. *Hemeroplanes ornatus*, 32. *Hemeroplanes triptolemus.* Scale bar: 1 cm.



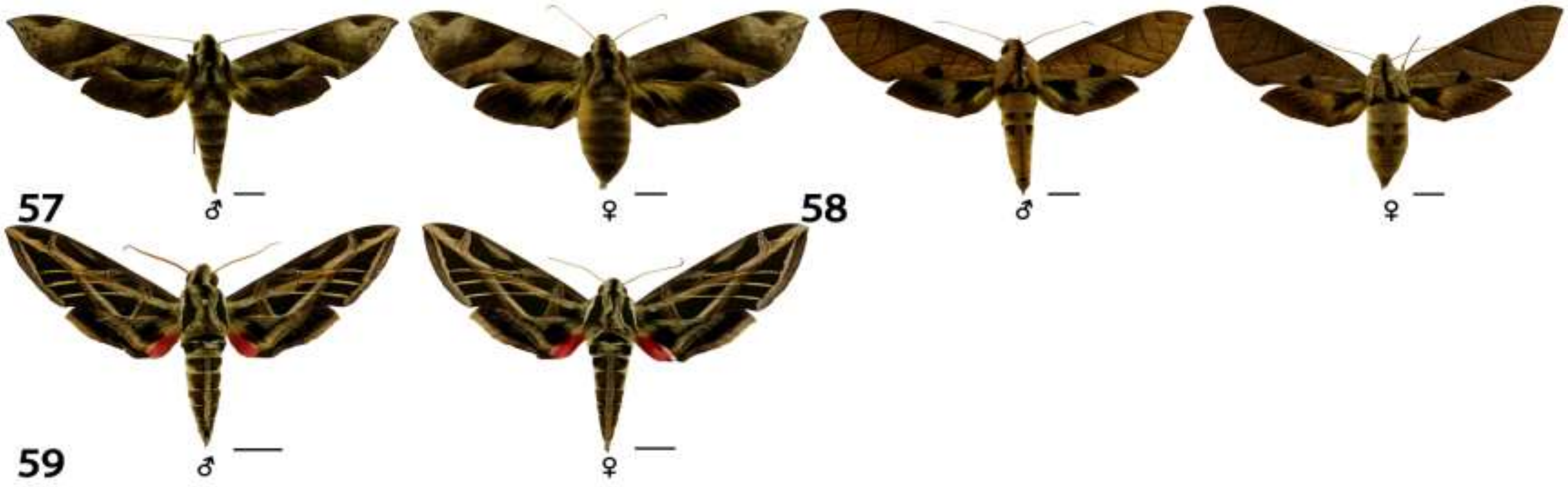
33. *Erinnyis alope*, 34. *Erinnyis crameri*, 35. *Erinnyis ello*, 36. *Erinnyis impunctata,* 37. *Erinnyis lassauxii*, 38. *Erinnyis obscura*, 39. *Erinnyis oenotrus,* 40. *Isognathus allamandae*. Scale bar: 1 cm.



41. *Isognathus caricae*, 42. *Isognathus menechus*, 43. *Pseudosphinx tetrio*, 44. *Aleuron carinata*, 45. *Aleuron chloroptera*, 46. *Aleuron iphis*, 47. *Aleuron neglectum,* 48*. Unzela japix discrepans.* Scale bar: 1 cm.



49. *Enyo gorgon*, 50. *Enyo lugubris*, 51. *Enyo ocypete,* 52. *Eumorpha analis*, 53. *Eumorpha anchemolus*, 54. *Eumorpha fasciatus*, 55. *Eumorpha labruscae*, 56. *Eumorpha megaecus*. Scale bar: 1 cm.



57. *Eumorpha obliquus*, 58. *Eumorpha translineatus*, 59. *Eumorpha vitis*. Scale bar: 1 cm.

APPENDIX B. Detailed list of examined species, code (Epiphysis' code), sex (M: Male, F: Female), Code at the museum ('Specify' code), date (Material examination), tibia side (side where the epiphysis was removed).

Code	Tribe	Subtribe	Genus	Species	Sex	Code at the museum	Locality	Date	Tibia side
533	Dilophonotini	Dilophonotina	*Cephonodes*	*Cephonodes hylas* (Linnaeus, 1771)	M	MZSP 44058	Japan	15/01/2020	left
534	Dilophonotini	Dilophonotina	*Cephonodes*	*Cephonodes hylas* (Linnaeus, 1771)	M	MZSP 44062	Japan	15/01/2020	left
535	Dilophonotini	Dilophonotina	*Cephonodes*	*Cephonodes hylas* (Linnaeus, 1771)	F	MZSP 44063	Japan	15/01/2020	right
536	Dilophonotini	Dilophonotina	*Cephonodes*	*Cephonodes hylas* (Linnaeus, 1771)	F	MZSP 44059	Japan	15/01/2020	right
529	Dilophonotini	Dilophonotina	*Hemaris*	*Hemaris diffinis* (Boisduval, 1836)	M	MZSP 44048	USA	15/01/2020	right
530	Dilophonotini	Dilophonotina	*Hemaris*	*Hemaris diffinis* (Boisduval, 1836)	F	MZSP 44049	USA	15/01/2020	left
531	Dilophonotini	Dilophonotina	*Hemaris*	*Hemaris croatica* (Esper, 1800)	M	MZSP 44053	Ukraine	15/01/2020	left
532	Dilophonotini	Dilophonotina	*Hemaris*	*Hemaris croatica* (Esper, 1800)	F	MZSP 44054	Ukraine	15/01/2020	left
49	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	M	MZSP 31775	BA	27/02/2019	left
50	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	F	MZSP 05470	PA	27/02/2019	left
217	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	M	MZSP 18998	ES	08/08/2019	left
218	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	M	MZSP 18999	ES	08/08/2019	left
219	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	M	MZSP 18997	ES	08/08/2019	left
220	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	M	MZSP 18996	ES	08/08/2019	left
221	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	M	MZSP 19001	ES	08/08/2019	left
222	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	M	MZSP 18995	ES	08/08/2019	left
223	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	M	MZSP 19000	ES	08/08/2019	left
224	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	F	MZSP 19002	ES	08/08/2019	left
225	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	F	MZSP 05473	PA	08/08/2019	left
226	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	F	MZSP 05472	PA	08/08/2019	left
227	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	F	MZSP 31776	Costa Rica	08/08/2019	left
228	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	F	MZSP 05467	PA	08/08/2019	left
229	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia darceta* Druce, 1881	F	MZSP 05468	PA	08/08/2019	left
51	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	M	MZSP 31886	RO	27/02/2019	left
52	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	F	MZSP 26777	SP	27/02/2019	left
230	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	M	MZSP 19043	ES	13/08/2019	left
231	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	M	MZSP 19044	ES	13/08/2019	left
232	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	M	MZSP 19040	RJ	13/08/2019	left
233	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	M	MZSP 05489	ES	13/08/2019	left

234	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	M	MZSP 19042	ES	13/08/2019	left
235	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	M	MZSP 19041	ES	13/08/2019	left
236	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	M	MZSP 05881	SP	13/08/2019	left
237	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	F	MZSP 26629	SC	13/08/2019	left
238	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	F	MZSP 31503	SP	13/08/2019	left
239	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	F	MZSP 25143	SP	13/08/2019	left
240	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	F	MZSP 25144	SP	13/08/2019	left
241	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	F	MZSP 31887	SP	13/08/2019	left
242	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia ficus* (Linnaeus, 1758)	F	MZSP 05533	RJ	13/08/2019	left
53	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	M	MZSP 05551	SP	27/02/2019	left
54	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	F	MZSP 05563	SP	27/02/2019	left
243	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	M	MZSP 05538	SP	13/08/2019	left
244	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	M	MZSP 05540	SP	13/08/2019	left
245	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	M	MZSP 05547	SP	13/08/2019	left
246	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	M	MZSP 05537	SP	13/08/2019	left
247	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	M	MZSP 05557	SP	13/08/2019	left
248	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	M	MZSP 05542	RS	13/08/2019	left
249	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	M	MZSP 05546	SP	13/08/2019	left
250	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	F	MZSP 05561	SP	13/08/2019	left
251	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	F	MZSP 05562	SP	13/08/2019	left
252	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	F	MZSP 05566	SP	13/08/2019	left
253	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	F	MZSP 05564	SP	13/08/2019	left
254	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	F	MZSP 05579	RJ	13/08/2019	left
255	Dilophonotini	Dilophonotina	*Pachylia*	*Pachylia syces* (Hübner, [1819])	F	MZSP 05570	SP	13/08/2019	left
414	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	M	T4113	CE	25/11/2019	left
415	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	M	T4140	CE	25/11/2019	left
416	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	M	T4212	CE	25/11/2019	left
417	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	M	T4560	CE	25/11/2019	left
418	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	M	T0910	CE	25/11/2019	left
419	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	M	T0971	CE	25/11/2019	left
420	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	M	T4239	CE	25/11/2019	left
421	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	M	T4116	CE	25/11/2019	left
422	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	F	T4553	CE	25/11/2019	left
423	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	F	T1870	CE	25/11/2019	left

424	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	F	T1658	CE	25/11/2019	left
425	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	F	T0986	CE	25/11/2019	left
426	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	F	T1357	CE	25/11/2019	left
427	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	F	T1302	CE	25/11/2019	left
428	Dilophonotini	Dilophonotina	*Callionima*	*Callionima guiarti* (Debauche, 1934)	F	T1402	CE	25/11/2019	left
429	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04093	SP	27/11/2019	left
430	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04086	SP	27/11/2019	left
431	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04091	SP	27/11/2019	left
432	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04096	SP	27/11/2019	left
433	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04109	RJ	27/11/2019	left
434	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04234	PR	27/11/2019	left
435	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04760	SC	27/11/2019	left
436	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04475	SP	27/11/2019	left
437	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	F	MZSP 04092	SP	27/11/2019	left
438	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	F	MZSP 04106	SP	27/11/2019	left
439	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	F	MZSP 04126	SP	27/11/2019	left
440	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	F	MZSP 09053	SC	27/11/2019	left
441	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	F	MZSP 04125	RJ	27/11/2019	left
442	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	F	MZSP 04127	SP	27/11/2019	left
443	Dilophonotini	Dilophonotina	*Callionima*	*Callionima innus* Rothschild & Jordan, 1903	M	MZSP 04112	SP	27/11/2019	left
444	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	M	MZSP 04144	SP	27/11/2019	left
445	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	M	MZSP 19014	RJ	27/11/2019	left
446	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	M	MZSP 04148	SP	27/11/2019	left
447	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	M	MZSP 04164	SP	27/11/2019	left
448	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	M	MZSP 15627	MG	27/11/2019	left
449	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	M	MZSP 04170	SP	27/11/2019	left
450	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	M	MZSP 19016	RJ	27/11/2019	left
451	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	M	MZSP 04136	SC	27/11/2019	left
452	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	F	MZSP 04193	SC	27/11/2019	left
453	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	F	MZSP 04192	RJ	27/11/2019	left
454	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	F	MZSP 04194	SP	27/11/2019	left
455	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	F	MZSP 04199	SP	27/11/2019	left
456	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	F	MZSP 04198	SP	27/11/2019	left
457	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	F	MZSP 04197	PA	27/11/2019	right

458	Dilophonotini	Dilophonotina	*Callionima*	*Callionima nomius* (Walker, 1856)	F	MZSP 04195	SP	27/11/2019	left
459	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	M	MZSP 20723	RJ	27/11/2019	left
460	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	M	MZSP 24502	SP	27/11/2019	left
461	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	M	MZSP 20716	ES	27/11/2019	left
462	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	M	MZSP 04269	MT	27/11/2019	left
463	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	M	MZSP 04214	GO	27/11/2019	left
464	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	M	MZSP 04261	SP	27/11/2019	left
465	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	M	MZSP 20721	ES	27/11/2019	left
466	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	M	MZSP 24640	SP	27/11/2019	left
467	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	F	MZSP 27035	SP	27/11/2019	left
468	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	F	MZSP 04283	PB	27/11/2019	left
469	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	F	MZSP 26944	SP	27/11/2019	left
470	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	F	MZSP 26937	SP	27/11/2019	left
471	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	F	MZSP 04300	SC	27/11/2019	left
472	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	F	MZSP 24641	SP	27/11/2019	left
473	Dilophonotini	Dilophonotina	*Callionima*	*Callionima parce* (Fabricius, 1775)	F	MZSP 27023	SP	27/11/2019	left
39	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx alophus* (Boisduval, [1875])	M	MZSP 26881	RJ	26/02/2019	left
40	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx alophus* (Boisduval, [1875])	F	MZSP 05325	SC	26/02/2019	left
491	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx alophus* (Boisduval, [1875])	M	MZSP 05316	SC	12/12/2019	left
492	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx alophus* (Boisduval, [1875])	F	MZSP 05324	SC	12/12/2019	left
41	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 18898	RJ	26/02/2019	left
42	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	F	MZSP 05384	SP	26/02/2019	left
101	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	F	MZSP 05386	SP	07/07/2019	left
102	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	F	MZSP 05383	SP	07/07/2019	right
103	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	F	MZSP 25140	SP	07/07/2019	left
104	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 24740	SP	07/07/2019	left
105	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	F	MZSP 24741	SP	07/07/2019	left
106	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 25137	SP	07/07/2019	left
107	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 25135	SP	07/07/2019	left
108	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 27845	SP	07/07/2019	left
109	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 25139	SP	07/07/2019	left
110	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 26852	RJ	07/07/2019	left
111	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 25138	SP	07/07/2019	left
112	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 24819	SP	07/07/2019	left

113	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx continua continua* (Walker, 1856)	M	MZSP 25132	SP	07/07/2019	left
116	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	F	MZSP 24454	SP	07/07/2019	right
117	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	F	MZSP 24498	SP	07/07/2019	left
118	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	F	MZSP 24533	SP	07/07/2019	left
119	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	F	MZSP 05414	SP	07/07/2019	left
120	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	F	MZSP 05415	-	07/07/2019	left
121	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 25183	SP	07/07/2019	left
122	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 25182	SP	07/07/2019	left
123	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 19047	ES	07/07/2019	left
124	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 24733	SP	07/07/2019	left
125	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 24732	SP	07/07/2019	left
126	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 24734	SP	07/07/2019	left
127	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 24735	SP	07/07/2019	left
128	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 19048	ES	07/07/2019	left
129	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 25141	SP	07/07/2019	left
130	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx nictitans nictitans* Boisduval, [1875]	M	MZSP 24731	SP	07/07/2019	left
43	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx stuarti* (Rothschild, 1894)	M	MZSP 31836	AP	26/02/2019	left
44	Dilophonotini	Dilophonotina	*Nyceryx*	*Nyceryx stuarti* (Rothschild, 1894)	F	MZSP 05423	AM	26/02/2019	left
57	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia lusca* (Fabricius, 1777)	M	MZSP 31840	RR	27/02/2019	left
58	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia lusca* (Fabricius, 1777)	F	MZSP 06166	AM	27/02/2019	left
59	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia pallida* Rothschild & Jordan, 1903	M	MZSP 31844	PI	27/02/2019	left
60	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia pallida* Rothschild & Jordan, 1903	F	MZSP 06179	SP	27/02/2019	left
489	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia pallida* Rothschild & Jordan, 1903	M	MZSP 06174	ES	27/11/2019	left
490	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia pallida* Rothschild & Jordan, 1903	F	MZSP 18165	PI	27/11/2019	left
61	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia passerina* Boisduval, [1875]	M	MZSP 20679	SP	27/02/2019	left
62	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia passerina* Boisduval, [1875]	F	MZSP 18167	MS	27/02/2019	left
474	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 06260	SP	27/11/2019	left
475	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 20673	SP	27/11/2019	left
476	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 17253	SP	27/11/2019	left
477	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 06257	ES	27/11/2019	left
478	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 28346	RJ	27/11/2019	left
479	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 06240	SP	27/11/2019	left
480	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 06221	BA	27/11/2019	left
481	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 17252	SP	27/11/2019	left

482	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 06263	SP	27/11/2019	left
483	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	M	MZSP 06239	SP	27/11/2019	left
484	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	F	MZSP 06261	SP	27/11/2019	left
485	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	F	MZSP 06264	SC	27/11/2019	left
486	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	F	MZSP 06262	SP	27/11/2019	left
487	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	F	MZSP 06265	SP	27/11/2019	left
488	Dilophonotini	Dilophonotina	*Perigonia*	*Perigonia stulta* Herrich-Schäffer, [1854]	F	MZSP 06266	SP	27/11/2019	left
19	Dilophonotini	Dilophonotina	*Eupyrrhoglossum*	*Eupyrrhoglossum sagra* (Poey, 1832)	M	MZSP 05193	SP	14/02/2019	left
20	Dilophonotini	Dilophonotina	*Eupyrrhoglossum*	*Eupyrrhoglossum sagra* (Poey, 1832)	F	MZSP 05200	RJ	27/02/2019	right
99	Dilophonotini	Dilophonotina	*Eupyrrhoglossum*	*Eupyrrhoglossum sagra* (Poey, 1832)	M	MZSP 05194	MT	12/12/2019	left
100	Dilophonotini	Dilophonotina	*Eupyrrhoglossum*	*Eupyrrhoglossum sagra* (Poey, 1832)	F	MZSP 05203	RJ	12/12/2019	right
505	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos ceculus* (Cramer, 1777)	M	MZSP 03464	SC	12/12/2019	left
506	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos ceculus* (Cramer, 1777)	M	MZSP 06613	PA	12/12/2019	left
507	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos ceculus* (Cramer, 1777)	F	MZSP 03469	SC	12/12/2019	left
508	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos ceculus* (Cramer, 1777)	F	MZSP 03471	SP	12/12/2019	left
509	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos fadus* (Cramer, 1775)	M	MZSP 03482	MT	12/12/2019	left
510	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos fadus* (Cramer, 1775)	M	MZSP 03477	PR	12/12/2019	left
511	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos fadus* (Cramer, 1775)	F	MZSP 26861	RJ	12/12/2019	left
512	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos fadus* (Cramer, 1775)	F	MZSP 03509	AM	12/12/2019	left
513	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos tantalus* (Linnaeus, 1758)	M	MZSP 03511	RJ	12/12/2019	left
514	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos tantalus* (Linnaeus, 1758)	F	MZSP 03153	GO	12/12/2019	left
515	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos titan* (Cramer, 1777)	M	MZSP 03523	SP	12/12/2019	left
516	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos titan* (Cramer, 1777)	M	MZSP 03515	MG	12/12/2019	left
517	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos titan* (Cramer, 1777)	F	MZSP 03539	SP	12/12/2019	left
518	Dilophonotini	Dilophonotina	*Aellopos*	*Aellopos titan* (Cramer, 1777)	F	MZSP 03543	PA	12/12/2019	left
45	Dilophonotini	Dilophonotina	*Oryba*	*Oryba achemenides* (Cramer, 1779)	M	MZSP 05434	PA	26/02/2019	left
46	Dilophonotini	Dilophonotina	*Oryba*	*Oryba achemenides* (Cramer, 1779)	F	MZSP 05435	PA	26/02/2019	left
47	Dilophonotini	Dilophonotina	*Oryba*	*Oryba kadeni* (Schaufuss, 1870)	M	MZSP 05429	SP	26/02/2019	left
48	Dilophonotini	Dilophonotina	*Oryba*	*Oryba kadeni* (Schaufuss, 1870)	F	MZSP 19038	RJ	26/02/2019	left
493	Dilophonotini	Dilophonotina	*Oryba*	*Oryba kadeni* (Schaufuss, 1870)	M	MZSP 05428	AM	12/12/2019	left
494	Dilophonotini	Dilophonotina	*Oryba*	*Oryba kadeni* (Schaufuss, 1870)	F	MZSP 18695	SP	12/12/2019	right
55	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	M	MZSP 19031	RJ	27/02/2019	left
56	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	F	MZSP 05628	SP	27/02/2019	left
204	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	M	MZSP 19030	ES	06/08/2019	left

205	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	M	MZSP 19029	ES	06/08/2019	left
206	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	M	MZSP 18173	RO	06/08/2019	left
207	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	M	MZSP 18174	SP	06/08/2019	left
208	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	M	MZSP 18172	RO	06/08/2019	left
209	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	M	MZSP 18175	RO	06/08/2019	left
210	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	M	MZSP 20828	SP	06/08/2019	left
211	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	F	MZSP 06159	SP	06/08/2019	left
212	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	F	MZSP 05621	SP	06/08/2019	left
213	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	F	MZSP 06152	SP	06/08/2019	left
214	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	F	MZSP 06150	SP	06/08/2019	left
215	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	F	MZSP 18894	RJ	06/08/2019	left
216	Dilophonotini	Dilophonotina	*Pachylioides*	*Pachylioides resumens* (Walker, 1856)	F	MZSP 06156	SP	06/08/2019	left
33	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx bubastus* (Cramer, 1777)	M	MZSP 05301	SP	26/02/2019	left
34	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx bubastus* (Cramer, 1777)	F	MZSP 06611	PA	26/02/2019	left
499	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx bubastus* (Cramer, 1777)	M	MZSP 05299	SP	12/12/2019	left
500	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx bubastus* (Cramer, 1777)	F	MZSP 05302	SP	12/12/2019	right
35	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx oiclus* (Cramer, 1779)	M	MZSP 05305	-	26/02/2019	left
36	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx oiclus* (Cramer, 1779)	F	MZSP 05309	RJ	26/02/2019	left
37	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx plutonius* (Hübner, [1819])	M	MZSP 14126	RO	26/02/2019	left
38	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx plutonius* (Hübner, [1819])	F	MZSP 31500	SP	26/02/2019	left
501	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx plutonius* (Hübner, [1819])	M	MZSP 26674	PR	12/12/2019	left
502	Dilophonotini	Dilophonotina	*Madoryx*	*Madoryx plutonius* (Hübner, [1819])	F	MZSP 26676	PR	12/12/2019	left
21	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes longistriga* (Rothschild & Jordan, 1903)	M	MZSP 05203	SP	27/02/2019	left
22	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes longistriga* (Rothschild & Jordan, 1903)	F	MZSP 05210	SC	27/02/2019	left
23	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes ornatus* Rothschild, 1894	M	MZSP 26677	SC	19/02/2019	left
24	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes ornatus* Rothschild, 1894	F	MZSP 15307	PA	19/02/2019	left
495	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes ornatus* Rothschild, 1894	M	MZSP 05211	RJ	12/12/2019	left
496	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes ornatus* Rothschild, 1894	F	MZSP 05215	ES	12/12/2019	left
25	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes triptolemus* (Cramer, 1779)	M	MZSP 31829	AP	19/02/2019	left
26	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes triptolemus* (Cramer, 1779)	F	MZSP 26900	BA	19/02/2019	left
497	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes triptolemus* (Cramer, 1779)	M	MZSP 24695	SP	12/12/2019	left
498	Dilophonotini	Dilophonotina	*Hemeroplanes*	*Hemeroplanes triptolemus* (Cramer, 1779)	F	MZSP 05224	RJ	12/12/2019	left
5	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	M	MZSP 18971	RJ	07/02/2019	left
6	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	F	MZSP 04648	SP	07/02/2019	left

P37	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	F	P037 (material in envelope)	SP	08/07/2019	left
P39	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	M	P039 (material in envelope)	SP	08/07/2019	left
P40	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	M	P045 (material in envelope)	SP	08/07/2019	left
P45	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	M	P045 (material in envelope)	SP	08/07/2019	left
295	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	M	MZSP 04569	SP	17/09/2019	left
296	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	M	MZSP 04575	GO	17/09/2019	left
297	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	M	MZSP 04580	GO	17/09/2019	left
298	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	M	MZSP 04586	SP	17/09/2019	right
299	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	F	MZSP 04642	SP	17/09/2019	left
300	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	F	MZSP 04647	RD	17/09/2019	left
301	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	F	MZSP 04646	SP	17/09/2019	left
302	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	F	MZSP 09050	SC	17/09/2019	left
303	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis alope* (Drury, 1773)	F	MZSP 04645	SC	17/09/2019	left
7	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	M	MZSP 04695	SP	07/02/2019	left
8	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	F	MZSP 04711	SP	07/02/2019	left
304	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	M	MZSP 04650	SP	22/10/2019	left
305	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	M	MZSP 04666	SP	22/10/2019	left
306	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	M	MZSP 04657	SC	22/10/2019	left
307	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	M	MZSP 04683	PA	22/10/2019	left
308	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	M	MZSP 04673	SP	22/10/2019	left
309	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	M	MZSP 04676	ES	22/10/2019	left
310	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	M	MZSP 04677	SC	22/10/2019	left
311	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	F	MZSP 04717	SP	22/10/2019	left
312	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	F	MZSP 26856	MG	22/10/2019	left
313	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	F	MZSP 04714	SP	22/10/2019	left
314	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	F	MZSP 04715	ES	22/10/2019	left
315	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	F	MZSP 04718	RJ	22/10/2019	left
316	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis crameri* (Schaus, 1898)	F	MZSP 04719	SP	22/10/2019	left
9	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	M	MZSP 24912	SP	07/02/2019	left
10	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	F	MZSP 04912	SP	07/02/2019	left
P46	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	M	P046 (Material in envelope)	SP	08/07/2019	left
P47	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	M	P047 (Material in envelope)	SP	08/07/2019	left
317	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	M	MZSP 04767	SP	23/10/2019	left
318	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	M	MZSP 04775	PA	23/10/2019	left

319	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	M	MZSP 04787	AM	23/10/2019	left
320	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	M	MZSP 04788	AM	23/10/2019	left
321	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	M	MZSP 04795	GO	23/10/2019	left
322	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	F	MZSP 856	SP	23/10/2019	left
323	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	F	MZSP 04869	SP	23/10/2019	left
324	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	F	MZSP 04870	MT	23/10/2019	left
325	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	F	MZSP 04862	AM	23/10/2019	left
326	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	F	MZSP 04865	SP	23/10/2019	left
327	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis ello* (Linnaeus, 1758)	F	MZSP 04844	AM	23/10/2019	left
11	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	M	T4169	CE	27/02/2019	left
12	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	F	T2454	CE	07/02/2019	left
328	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	M	T148	CE	23/10/2019	left
329	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	M	T541	CE	23/10/2019	left
330	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	M	T725	CE	23/10/2019	left
331	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	M	T644	CE	23/10/2019	right
332	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	M	T941	CE	23/10/2019	left
333	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	M	T2633	CE	23/10/2019	left
334	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	M	T2483	CE	23/10/2019	left
335	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	F	T706	CE	23/10/2019	left
336	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	F	T2361	CE	23/10/2019	left
337	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	F	T3514	CE	23/10/2019	left
338	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	F	T4797	CE	23/10/2019	left
339	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	F	T3866	CE	23/10/2019	left
340	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis impunctata* Rothschild & Jordan, 1903	F	T3929	CE	23/10/2019	left
17	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	MZSP 24496	SP	14/02/2019	left
18	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	F	MZSP 04945	SP	14/02/2019	left
P43	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	P43 (material in envelope)	SP	08/07/2019	left
P44	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	P44 (material in envelope)	SP	08/07/2019	left
360	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	MZSP 04928	SP	29/10/2019	left
361	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	MZSP 04927	SP	29/10/2019	left
362	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	MZSP 04934	RJ	29/10/2019	left
363	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	MZSP 04935	PA	29/10/2019	left
364	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	MZSP 04037	PA	29/10/2019	left
365	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	F	MZSP 04943	SC	29/10/2019	left

366	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	F	MZSP 04944	SC	29/10/2019	left
367	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	F	MZSP 04942	SC	29/10/2019	left
368	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	F	MZSP 04947	SP	29/10/2019	left
369	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	F	MZSP 04946	SP	29/10/2019	left
370	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis lassauxii* (Boisduval, 1859)	M	MZSP 04941	GO	29/10/2019	left
15	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	M	T1203	CE	14/02/2019	left
16	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	F	T2558	CE	14/02/2019	left
347	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	M	T3919	CE	28/10/2019	left
348	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	M	T4772	CE	28/10/2019	left
349	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	M	T3169	CE	28/10/2019	left
350	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	M	T4795	CE	28/10/2019	left
351	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	M	T2808	CE	28/10/2019	left
352	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	M	T2303	CE	28/10/2019	left
353	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	M	T3702	CE	28/10/2019	left
354	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	F	T2809	CE	28/10/2019	left
355	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	F	T3079	CE	28/10/2019	left
356	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	F	T4122	CE	28/10/2019	left
357	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	F	T4134	CE	28/10/2019	left
358	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	F	T1935	CE	28/10/2019	left
359	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis obscura* (Fabricius, 1775)	F	T4183	CE	28/10/2019	left
13	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	M	T694	CE	14/02/2019	left
14	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	F	T1199	CE	14/02/2019	left
P31	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	F	P31 (material in envelope)	SP	08/07/2019	left
P32	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	F	P32 (material in envelope)	SP	08/07/2019	left
P33	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	F	P33 (material in envelope)	SP	08/07/2019	left
P34	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	F	P34 (material in envelope)	SP	08/07/2019	left
P35	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	F	P35 (material in envelope)	SP	08/07/2019	left
P36	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	F	P36 (material in envelope)	SP	08/07/2019	left
P49	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	M	P49 (material in envelope)	SP	08/07/2019	left
341	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	M	MZSP 05110	SP	23/10/2019	left
342	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	M	MZSP 05091	RJ	23/10/2019	left
343	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	M	MZSP 05097	MG	23/10/2019	left
344	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	M	MZSP 05089	PA	23/10/2019	left
345	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	M	MZSP 05111	ES	23/10/2019	left

346	Dilophonotini	Dilophonotina	*Erinnyis*	*Erinnyis oenotrus* (Cramer, 1780)	M	MZSP 05112	RJ	23/10/2019	left
29	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus allamandae* Clark, 1920	M	T2841	CE	26/02/2019	left
30	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus allamandae* Clark, 1920	F	T4474	CE	26/02/2019	left
269	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	M	T269	CE	03/09/2019	left
270	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	M	T3130	CE	03/09/2019	left
271	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	M	T4770	CE	03/09/2019	left
272	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	M	T3832	CE	03/09/2019	left
273	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	M	T1933	CE	03/09/2019	left
274	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	M	T3233	CE	03/09/2019	left
275	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	M	T3934	CE	03/09/2019	left
276	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	F	T4720	CE	03/09/2019	left
277	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	F	T3143	CE	03/09/2019	left
278	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	F	T4737	CE	03/09/2019	left
279	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	F	T4380	CE	03/09/2019	left
280	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	F	T2647	CE	03/09/2019	left
281	Dilophonotini	Dilophonotina	Isognathus	*Isognathus allamandae* Clark, 1920	F	T2590	CE	03/09/2019	left
31	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	M	T1732	CE	26/02/2019	left
32	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	F	T2298	CE	26/02/2019	left
282	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	M	MZSP 05234	PA	17/09/2019	left
283	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	M	MZSP 05238	SP	17/09/2019	left
284	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	M	MZSP 05240	MG	17/09/2019	left
285	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	M	MZSP 05242	PA	17/09/2019	left
286	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	M	MZSP 05235	SP	17/09/2019	left
287	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	M	MZSP 05246	SP	17/09/2019	left
288	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	M	MZSP 18170	MG	17/09/2019	left
289	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	F	MZSP 05252	SP	17/09/2019	left
290	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	F	MZSP 05255	SP	17/09/2019	left
291	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	F	MZSP 05257	SP	17/09/2019	left
292	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	F	MZSP 05259	GO	17/09/2019	left
293	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	F	MZSP 05258	SP	17/09/2019	left
294	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus caricae* (Linnaeus, 1758)	F	MZSP 18171	MA	17/09/2019	left
27	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus menechus* (Boisduval, [1875])	M	MZSP 42647	CE	19/02/2019	left
28	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus menechus* (Boisduval, [1875])	F	MZSP 42664	CE	19/02/2019	left
256	Dilophonotini	Dilophonotina	*Isognathus*	*Isognathus menechus* (Boisduval, [1875])	M	MZSP 42716	CE	03/09/2019	left

257	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	M	MZSP 42715	CE	03/09/2019	left
258	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	M	MZSP 42710	CE	03/09/2019	left
259	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	M	MZSP 42693	CE	03/09/2019	left
260	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	M	MZSP 42704	CE	03/09/2019	left
261	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	M	MZSP 42698	CE	03/09/2019	left
262	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	M	MZSP 42694	CE	03/09/2019	left
263	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	F	MZSP 42706	CE	03/09/2019	left
264	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	F	MZSP 42659	CE	03/09/2019	left
265	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	F	T3113	CE	03/09/2019	left
266	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	F	T2680	CE	03/09/2019	left
267	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	F	T398	CE	03/09/2019	left
268	Dilophonotini	Dilophonotina	Isognathus	*Isognathus menechus* (Boisduval, [1875])	F	T3296	CE	03/09/2019	left
63	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	M	MZSP 25010	SP	27/02/2019	left
64	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	F	MZSP 31499	SP	27/02/2019	left
371	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	M	MZSP 06288	SP	29/10/2019	left
372	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	M	MZSP 06304	SP	29/10/2019	left
373	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	M	MZSP 06305	RJ	29/10/2019	left
374	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	M	MZSP 06294	SP	29/10/2019	left
375	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	M	MZSP 06306	MG	29/10/2019	left
376	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	M	MZSP 06298	SP	29/10/2019	left
377	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	M	MZSP 06291	PA	29/10/2019	left
378	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	F	MZSP 06360	SP	29/10/2019	left
379	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	F	MZSP 06362	SP	29/10/2019	left
380	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	F	MZSP 06375	SP	29/10/2019	left
381	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	F	MZSP 06366	RJ	29/10/2019	left
382	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	F	MZSP 06367	RJ	29/10/2019	left
383	Dilophonotini	Dilophonotina	*Pseudosphinx*	*Pseudosphinx tetrio* (Linnaeus, 1771)	F	MZSP 06364	BA	29/10/2019	left
519	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron carinata* (Walker, 1856)	M	MZSP 04050	AM	12/12/2019	left
520	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron carinata* (Walker, 1856)	F	MZSP 04052	SP	12/12/2019	left
521	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron chloroptera* (Perty, [1833])	M	MZSP 04056	SP	12/12/2019	left
522	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron chloroptera* (Perty, [1833])	F	MZSP 04063	SP	12/12/2019	left
523	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron iphis* (Walker, 1856)	M	MZSP 04068	SP	12/12/2019	left
524	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron iphis* (Walker, 1856)	M	MZSP 18182	RO	12/12/2019	left
525	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron iphis* (Walker, 1856)	F	MZSP 04070	AM	12/12/2019	right

526	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron iphis* (Walker, 1856)	F	MZSP 09761	SC	12/12/2019	left
527	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron neglectum* Rothschild & Jordan, 1903	M	MZSP 43812	MS	12/12/2019	left
528	Dilophonotini	Dilophonotina	*Aleuron*	*Aleuron neglectum* Rothschild & Jordan, 1904	F	MZSP 43815	MS	12/12/2019	left
65	Dilophonotini	Dilophonotina	*Unzela*	*Unzela japix discrepans* Walker, 1856	M	MZSP 06402	SP	27/02/2019	left
66	Dilophonotini	Dilophonotina	*Unzela*	*Unzela japix discrepans* Walker, 1856	F	MZSP 06393	RJ	27/02/2019	left
503	Dilophonotini	Dilophonotina	*Unzela*	*Unzela japix discrepans* Walker, 1856	M	MZSP 06403	SP	12/12/2019	left
504	Dilophonotini	Dilophonotina	*Unzela*	*Unzela japix discrepans* Walker, 1856	F	MZSP 09049	SC	12/12/2019	left
1	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	M	MZSP 18888	RJ	07/02/2019	left
2	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	F	MZSP 31493	SP	07/02/2019	left
388	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	M	MZSP 09196	AC	05/11/2019	left
389	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	M	MZSP 24679	SP	05/11/2019	left
390	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	M	MZSP 04441	RJ	05/11/2019	left
391	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	M	MZSP 04408	SP	05/11/2019	left
392	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	M	MZSP 04383	SP	05/11/2019	left
393	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	M	MZSP 04404	SP	05/11/2019	left
394	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	M	MZSP 04379	MG	05/11/2019	left
395	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	F	MZSP 04483	SP	05/11/2019	left
396	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	F	MZSP 04480	SP	05/11/2019	left
397	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	F	MZSP 04445	SP	05/11/2019	left
398	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	F	MZSP 04475	SP	05/11/2019	left
399	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	F	MZSP 04483	MG	05/11/2019	left
400	Dilophonotini	Dilophonotina	*Enyo*	*Enyo lugubris* (Linnaeus, 1771)	F	MZSP 04476	MT	05/11/2019	left
3	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	M	MZSP 31883	MT	07/02/2019	left
4	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	F	MZSP 18886	RJ	07/02/2019	left
401	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	M	MZSP 18881	RJ	25/11/2019	left
402	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	M	MZSP 04520	AM	25/11/2019	left
403	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	M	MZSP 04516	PA	25/11/2019	left
404	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	M	MZSP 04506	RJ	25/11/2019	left
405	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	M	MZSP 04512	SP	25/11/2019	left
406	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	M	MZSP 04524	SP	25/11/2019	left
407	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	M	MZSP 04511	MT	25/11/2019	left
408	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	F	MZSP 15619	MG	25/11/2019	left
409	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	F	MZSP 04535	SP	25/11/2019	left
410	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	F	MZSP 04542	MG	25/11/2019	left

411	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	F	MZSP 04545	AM	25/11/2019	left
412	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	F	MZSP 04549	ES	25/11/2019	left
413	Dilophonotini	Dilophonotina	*Enyo*	*Enyo ocypete* (Linnaeus, 1758)	F	MZSP 18885	RJ	25/11/2019	left
384	Dilophonotini	Dilophonotina	*Enyo*	*Enyo gorgon* (Cramer, 1777)	M	MZSP 31501	SP	05/11/2019	left
385	Dilophonotini	Dilophonotina	*Enyo*	*Enyo gorgon* (Cramer, 1777)	M	MZSP 04314	SP	05/11/2019	left
386	Dilophonotini	Dilophonotina	*Enyo*	*Enyo gorgon* (Cramer, 1777)	F	MZSP 43832	MS	05/11/2019	left
387	Dilophonotini	Dilophonotina	*Enyo*	*Enyo gorgon* (Cramer, 1777)	F	MZSP 04376	SP	05/11/2019	left
67	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	M	MZSP 31534	SP	27/02/2019	left
68	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	F	MZSP 24724	SP	27/02/2019	left
161	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	M	MZSP 06430	SC	26/07/2019	left
162	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	M	MZSP 06428	SP	26/07/2019	left
163	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	M	MZSP 06426	SP	26/07/2019	left
164	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	M	MZSP 06427	SP	26/07/2019	left
165	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	M	MZSP 06428	SP	26/07/2019	left
166	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	M	MZSP 06420	SP	26/07/2019	left
167	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	M	MZSP 06434	SP	26/07/2019	left
168	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	F	MZSP 06455	SP	26/07/2019	left
169	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	F	MZSP 06448	SP	26/07/2019	left
170	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	F	MZSP 06453	RJ	26/07/2019	left
171	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	F	MZSP 06451	RJ	26/07/2019	left
172	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	F	MZSP 06450	SP	26/07/2019	left
173	Philampelini	Philampelina	*Eumorpha*	*Eumorpha analis* (Rothschild & Jordan, 1903)	F	MZSP 06449	SC	26/07/2019	left
69	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	M	MZSP 06456	-	16/07/2019	left
70	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	M	MZSP 06458	SP	16/07/2019	left
71	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	M	MZSP 06457	SP	16/07/2019	left
72	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	M	MZSP 06464	PA	16/07/2019	left
73	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	M	MZSP 06463	PA	16/07/2019	left
74	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	M	MZSP 06467	PA	16/07/2019	left
75	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	M	MZSP 06466	RJ	16/07/2019	left
76	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	M	MZSP 06461	AM	16/07/2019	left
77	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	F	MZSP 06543	MG	16/07/2019	left
78	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	F	MZSP 06544	-	16/07/2019	left
79	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	F	MZSP 09184	SC	16/07/2019	left
80	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	F	MZSP 06541	RJ	16/07/2019	left

81	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	F	MZSP 06545	SP	16/07/2019	left
82	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	F	MZSP 06538	SP	16/07/2019	left
83	Philampelini	Philampelina	*Eumorpha*	*Eumorpha anchemolus* (Cramer, 1779)	F	MZSP 06537	PA	16/07/2019	left
131	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	M	MZSP 06558	GO	25/07/2019	left
132	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	M	MZSP 06550	SP	25/07/2019	left
133	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	M	MZSP 06557	SP	25/07/2019	left
134	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	M	MZSP 06554	SP	25/07/2019	left
135	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	M	MZSP 06565	RJ	25/07/2019	left
136	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	M	MZSP 06562	-	25/07/2019	left
137	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	M	MZSP 06563	SP	25/07/2019	left
138	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	M	MZSP 06552	SP	25/07/2019	left
139	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	F	MZSP 06590	SP	25/07/2019	left
140	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	F	MZSP 06589	SP	25/07/2019	left
141	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	F	MZSP 06585	SP	25/07/2019	left
142	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	F	MZSP 06581	SP	25/07/2019	left
143	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	F	MZSP 06582	SP	25/07/2019	left
144	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	F	MZSP 06580	SP	25/07/2019	left
145	Philampelini	Philampelina	*Eumorpha*	*Eumorpha fasciatus* (Sulzer, 1776)	F	MZSP 06586	SP	25/07/2019	left
84	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	M	T4155	CE	24/07/2019	left
85	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	M	T4381	CE	24/07/2019	left
86	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	M	T3024	CE	24/07/2019	left
87	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	M	T4351A	CE	24/07/2019	left
88	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	M	T3055	CE	24/07/2019	right
89	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	M	T3028	CE	24/07/2019	left
90	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	M	T2839	CE	24/07/2019	left
91	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	M	T1688	CE	24/07/2019	left
92	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	F	T2977	CE	24/07/2019	left
93	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	F	T2050	CE	24/07/2019	left
94	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	F	T2720	CE	24/07/2019	left
95	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	F	T4400	CE	24/07/2019	left
96	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	F	T3032	CE	24/07/2019	left
97	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	F	T2966	CE	24/07/2019	left
98	Philampelini	Philampelina	*Eumorpha*	*Eumorpha labruscae* (Linnaeus, 1758)	F	T3159	CE	24/07/2019	left
174	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	M	MZSP 06680	RS	26/07/2019	left

175	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	M	MZSP 06678	RJ	26/07/2019	left
176	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	M	MZSP 06689	SP	26/07/2019	left
177	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	M	MZSP 06685	RJ	26/07/2019	left
178	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	M	MZSP 06687	SP	26/07/2019	left
179	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	M	MZSP 06686	ES	26/07/2019	left
180	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	M	MZSP 06683	-	26/07/2019	left
181	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	M	MZSP 06684	SP	26/07/2019	left
182	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	F	MZSP 06679	SC	26/07/2019	left
183	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	F	MZSP 06692	SC	26/07/2019	left
184	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	F	MZSP 06693	SP	26/07/2019	right
185	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	F	MZSP 06691	SP	26/07/2019	left
186	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	F	MZSP 06695	RJ	26/07/2019	left
187	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	F	MZSP 06694	SP	26/07/2019	left
188	Philampelini	Philampelina	*Eumorpha*	*Eumorpha megaeacus* (Hübner, [1819])	F	MZSP 06690	SC	26/07/2019	left
114	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	F	MZSP 08429	SP	24/07/2019	left
115	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	F	MZSP 08430	SP	24/07/2019	left
P14	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	F	P14 (material in envelope)	SP	08/07/2019	left
P15	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	F	P15 (material in envelope)	SP	08/07/2019	left
P16	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	F	P16 (material in envelope)	SP	08/07/2019	left
P29	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	F	P29 (material in envelope)	SP	08/07/2019	left
P30	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	F	P30 (material in envelope)	SP	08/07/2019	left
P17	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	M	P17 (material in envelope)	SP	08/07/2019	left
P21	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	M	P21 (material in envelope)	SP	08/07/2019	left
P22	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	M	P22 (material in envelope)	SP	08/07/2019	left
P23	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	M	P23 (material in envelope)	SP	08/07/2019	left
P24	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	M	P24 (material in envelope)	SP	08/07/2019	left
P25	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	M	P25 (material in envelope)	SP	08/07/2019	left
P26	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	M	P26 (material in envelope)	SP	08/07/2019	left
P27	Philampelini	Philampelina	*Eumorpha*	*Eumorpha obliquus* Rothschild & Jordan, 1903	M	P27 (material in envelope)	SP	08/07/2019	left
189	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	M	MZSP 26774	SP	06/08/2019	left
190	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	M	MZSP 26775	SP	06/08/2019	left
191	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	M	MZSP 26394	RJ	06/08/2019	left
192	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	M	MZSP 19011	ES	06/08/2019	left
193	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	M	MZSP 24670	SP	06/08/2019	left

194	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	M	MZSP 26773	SP	06/08/2019	left
195	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	M	MZSP 26772	SP	06/08/2019	left
196	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	M	MZSP 26395	RJ	06/08/2019	left
197	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	F	MZSP 24669	SP	06/08/2019	left
198	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	F	MZSP 08507	MS	06/08/2019	left
199	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	F	MZSP 08506	SC	06/08/2019	left
200	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	F	MZSP 08503	SP	06/08/2019	left
201	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	F	MZSP 08504	SP	06/08/2019	left
202	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	F	MZSP 08505	SP	06/08/2019	left
203	Philampelini	Philampelina	*Eumorpha*	*Eumorpha translineatus* (Rothschild, 1895)	F	MZSP 08508	SP	06/08/2019	left
146	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	M	MZSP 42784	CE	25/07/2019	left
147	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	M	MZSP 42783	CE	25/07/2019	right
148	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	M	MZSP 42787	CE	25/07/2019	left
149	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	M	MZSP 42782	CE	25/07/2019	right
150	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	M	MZSP 42799	CE	25/07/2019	left
151	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	M	MZSP 42794	CE	25/07/2019	left
152	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	M	MZSP 42792	CE	25/07/2019	left
153	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	M	MZSP 42795	CE	25/07/2019	left
154	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	F	MZSP 42807	CE	25/07/2019	left
155	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	F	MZSP 42798	CE	25/07/2019	left
156	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	F	MZSP 42815	CE	25/07/2019	left
157	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	F	MZSP 42790	CE	25/07/2019	left
158	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	F	MZSP 42788	CE	25/07/2019	left
159	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	F	MZSP 42812	CE	25/07/2019	left
160	Philampelini	Philampelina	*Eumorpha*	*Eumorpha vitis* (Linnaeus, 1758)	F	MZSP 42811	CE	25/07/2019	left

Codes with MZSP: Samples deposited at the Museum of Zoology –University of São Paulo.

Codes with T-Number: Samples acquired of Talitha Rocchane Abreu da Costa (PhD project).

Codes with P-Number: Samples acquired of Pedro Ivo Machado (Master's project).

APPENDIX C. List of examined species, sex (M: Male, F: Female), type of microscopy used to examination (S: stereomicroscope, SEM: scanning electron microscopy) and characters coded to each species. Gray: Epiphysis' characters; white: Acanthae' characters.

Species	Sex	S	SEM	Characters																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Cephonodes hylas (Linnaeus, 1771)	M	X	X	a	a	a	a	-	a	-	-	a	-	-	b	a	a	a	b	a	b	a	b	b	a
Cephonodes hylas (Linnaeus, 1771)	F	X	X	a	a	a	a	-	a	-	-	a	-	-	d	c1	a	a	b	a	b	a	b	b	a
Hemaris diffinis (Boisduval, 1836)	M	X	X	a	d	b	b	b	-	-	-	a	-	-	b	a	a	a	b	a	b	a	c	b	a
Hemaris diffinis (Boisduval, 1836)	F	X	X	a	d	b	b	c	-	-	-	a	-	-	b	c1	b	a	b	a	b	b	c	b	a
Hemaris croatica (Esper, 1800)	M	X		a	d	b	b	b	b	b	a	b	a	a	-	-	-	-	-	-	-	-	-	b	a
Hemaris croatica (Esper, 1800)	F	X		a	d	b	b	b	b	d	a	b	a	a	-	-	-	-	-	-	-	-	-	b	a
Pachylia darceta Druce, 1881	M	X	X	b	d	b	b	a, b	b	d, d1	a	b, c	a	a	d	c1	a	a	b	a	b	a	b	b	a
Pachylia darceta Druce, 1881	F	X	X	b	d	b	b	b	b	d	a	b, c	a	a	d	a	a	a	a	a	a	a	b	a, b	a
Pachylia ficus (Linnaeus, 1758)	M	X		b	a	b	b	b	b	c, c1	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Pachylia ficus (Linnaeus, 1758)	F	X		b	a	b	b	b	b	c, c2	-	c	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Pachylia syces (Hübner, [1819])	M	X		b	a	b	b	b	b	c1, d	-	b	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Pachylia syces (Hübner, [1819])	F	X		b	a	b	b	a, b	b	c	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Callionima guiarti (Debauche, 1934)	M	X		b	d	b	b	b	b	c, d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	a
Callionima guiarti (Debauche, 1934)	F	X		b	a	b	b	b, c	b	c, d	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Callionima innus Rothschild & Jordan, 1903	M	X		b	d	b	b	b	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	a	a
Callionima innus Rothschild & Jordan, 1903	F	X		b	a	b	b	b	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	a	a
Callionima nomius (Walker, 1856)	M	X		b	d	b	b	b	b	d	-	c	b	-	-	-	-	-	-	-	-	-	-	a	a
Callionima nomius (Walker, 1856)	F	X		b	d	b	b	b	b	d	-	c	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Callionima parce (Fabricius, 1775)	M	X	X	b	d	b	b	b	b	c, d	a	b, c	a, b	a	c	a	a	a	a	a	a	a	c	a	a
Callionima parce (Fabricius, 1775)	F	X	X	b	a	b	b	b	b	c, d	a	c	a, b	a	d	b	b	b	a	a	a	b	c	a	a
Nyceryx alophus (Boisduval, [1875])	M	X		b	a	b	b	b	b	c, d	-	c	b	-	-	-	-	-	-	-	-	-	-	b	a
Nyceryx alophus (Boisduval, [1875])	F	X		b	a	b	b	b	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	b	a
Nyceryx continua continua (Walker, 1856)	M	X		b	b	b	b	a, b	b	d	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	b	b
Nyceryx continua continua (Walker, 1856)	F	X		b	b	b	b	b	b	a	-	c	a	-	-	-	-	-	-	-	-	-	-	b	a
Nyceryx nictitans nictitans Boisduval, [1875]	M	X	X	b	d	b	b	b	b	d	a	b, c	a	a	e	b	b	a	b	b	b	b	d	b	a

Species	Sex	S	SEM	Characters																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Nyceryx nictitans nictitans Boisduval, [1875]	F	X	X	b	a	b	b	a, c	b	a, d	a	c	a	a	d	b	b	a	b	a	b	a	c	b	a
Nyceryx stuarti (Rothschild, 1894)	M	X		b	a	b	b	c	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	b	a
Nyceryx stuarti (Rothschild, 1894)	F	X		b	a	b	b	c	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	b	a
Perigonia lusca (Fabricius, 1777)	M	X		b	d	b	b	b	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	b	a
Perigonia lusca (Fabricius, 1777)	F	X		b	a	b	b	b	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	b	a
Perigonia pallida Rothschild & Jordan, 1903	M	X		b	a	b	b	c	b	d	-	c	b	-	-	-	-	-	-	-	-	-	-	a	b
Perigonia pallida Rothschild & Jordan, 1903	F	X		b	a	b	b	a	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	a	a
Perigonia passerina Boisduval, [1875]	M	X		b	d	b	b	b	b	c	-	b	b	-	-	-	-	-	-	-	-	-	-	b	c
Perigonia passerina Boisduval, [1875]	F	X		b	f	b	b	b	b	d	-	c	b	-	-	-	-	-	-	-	-	-	-	b	a
Perigonia stulta Herrich-Schäffer, [1854]	M	X		b	a	b	b	b, c	b	c, d	a	b, c	a, b	a	d	c1	a	a	a	a	b	a	c	a, b	a
Perigonia stulta Herrich-Schäffer, [1854]	F	X		b	a	b	b	b	b	c1, d	a	b, c	a, b	a	d	c1	b	a	b	a	b	a	c	a, b	a
Eupyrrhoglossum sagra (Poey, 1832)	M	X		b	a	b	b	b	b	c	a	b	b	a	a	c1	a	a	b	b	b	c	c	a	a
Eupyrrhoglossum sagra (Poey, 1832)	F	X		b	a	b	b	b	b	a	a	b	a	a	e	c1	a	a	b	a	b	a	b	a	a
Aellopos ceculus (Cramer, 1777)	M	X		b	a	b	b	a	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	a
Aellopos ceculus (Cramer, 1777)	F	X		b	a	b	b	a	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	a
Aellopos fadus (Cramer, 1775)	M	X	X	b	a	b	b	b	b	c	b	b	a	b	d	c2	b	a	a	b	a	a	c	a	c
Aellopos fadus (Cramer, 1775)	F	X	X	b	a	b	b	b	b	c	a	c	a	b	d	c2	b	a	b	a	b	a	c	a	a
Aellopos tantalus (Linnaeus, 1758)	M	X		b	d	b	b	b	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	a
Aellopos tantalus (Linnaeus, 1758)	F	X		b	a	b	b	b	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	c
Aellopos titan (Cramer, 1777)	M	X		b	e	b	b	b	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	a	b
Aellopos titan (Cramer, 1777)	F	X		b	e	b	b	b	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	b
Oryba achemenides (Cramer, 1779)	M	X		c	d	b	b	b	b	d	-	c	b	-	-	-	-	-	-	-	-	-	-	b	a
Oryba achemenides (Cramer, 1779)	F	X		c	d	b	b	b	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	b	a
Oryba kadeni (Schaufuss, 1870)	M	X	X	c	a	b	b	b	b	c	a	c	b	a	e	c1	b	a	a	a	a	a	a	a	a
Oryba kadeni (Schaufuss, 1870)	F	X	X	b	a	b	b	b, c	b	d	a	b, c	b	a	e	c1	b	a	a	a	a	a	a	a	a
Pachylioides resumens (Walker, 1856)	M	X	X	b	d	b	b	b	b	d	a	b	a, b	a	d	c1	a	a	b	a	a	a	b	a	a
Pachylioides resumens (Walker, 1856)	F	X	X	b	d	b	b	b	b	c, d	a	b	a, b	a	d	c1	b	a	a	a	a	a	a	a	a
Madoryx bubastus (Cramer, 1777)	M	X		b	a	b	b	b	b	c, d	-	b	b	-	-	-	-	-	-	-	-	-	-	b	a

Species	Sex	S	SEM	Characters																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Madoryx bubastus (Cramer, 1777)	F	X		b	f	b	b	a	b	c, d	-	c	a	-	-	-	-	-	-	-	-	-	-	b	a
Madoryx oiclus (Cramer, 1779)	M	X		b	a	b	b	b	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	b	a
Madoryx oiclus (Cramer, 1779)	F	X		b	a	b	b	b	b	c	-	c	a	-	-	-	-	-	-	-	-	-	-	b	a
Madoryx plutonius (Hübner, [1819])	M	X	X	b	a	b	b	a, b	b	d	a	c	a, b	a	d	c1	a	a	a	b	a	a	b	b	a
Madoryx plutonius (Hübner, [1819])	F	X	X	b	f	b	b	b	b	d	a	c	a	a	d	c5	a	a	a	b	a	a	b	b	a
Hemeroplanes longistriga (Rothschild & Jordan, 1903)	M	X		b	a	b	b	b	b	c	-	c	b	-	-	-	-	-	-	-	-	-	-	a	a
Hemeroplanes longistriga (Rothschild & Jordan, 1903)	F	X		b	a	b	b	b	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	a
Hemeroplanes ornatus Rothschild, 1894	M	X	X	b	a	b	b	b	b	d	a	c	b	a	d	c4	a	a	a	a	a	b	b	a	a
Hemeroplanes ornatus Rothschild, 1894	F	X	X	b	a	b	b	b	b	c, d	a	c	a, b	a	d	c4	a	a	a	a	b	a	b	a	a
Hemeroplanes triptolemus (Cramer, 1779)	M	X		b	a	b	b	b	b	c, d	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Hemeroplanes triptolemus (Cramer, 1779)	F	X		b	a	b	b	b	b	d	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Erinnyis alope (Drury, 1773)	M	X		b	b	b	b	b	b	d	-	b, c	b	-	-	-	-	-	-	-	-	-	-	a, b	a
Erinnyis alope (Drury, 1773)	F	X		b	d	b	b	b	b	c, d	-	c	a, b	-	-	-	-	-	-	-	-	-	-	b	a
Erinnyis crameri (Schaus, 1898)	M	X		b	a	b	b	b	b	d, d1	-	b	b	-	-	-	-	-	-	-	-	-	-	b	a
Erinnyis crameri (Schaus, 1898)	F	X		b	a	b	b	b, c	b	d, d1	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	b	a
Erinnyis ello (Linnaeus, 1758)	M	X		b	b	b	b	b	b	d	-	b	b	-	-	-	-	-	-	-	-	-	-	a, b	a
Erinnyis ello (Linnaeus, 1758)	F	X		b	d	b	b	b	b	c	-	b. c	a, b	-	-	-	-	-	-	-	-	-	-	b	a
Erinnyis impunctata Rothschild & Jordan, 1903	M	X		b	d	b	b	b	b	d	-	b. c	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Erinnyis impunctata Rothschild & Jordan, 1903	F	X		b	d	b	b	a	b	b	-	b	a	-	-	-	-	-	-	-	-	-	-	b	a
Erinnyis lassauxii (Boisduval, 1859)	M	X		b	b	b	b	b	b	c,c1,d	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	a, b	a
Erinnyis lassauxii (Boisduval, 1859)	F	X		b	d	b	b	a, b	b	d	-	b, c	a	-	-	-	-	-	-	-	-	-	-	b	a
Erinnyis obscura (Fabricius, 1775)	M	X		b	b	b	b	b	b	c, d	-	b	a	-	-	-	-	-	-	-	-	-	-	b	a
Erinnyis obscura (Fabricius, 1775)	F	X		b	d	b	b	b	b	d	-	b, c	b	-	-	-	-	-	-	-	-	-	-	b	a
Erinnyis oenotrus (Cramer, 1780)	M	X	X	b	d	b	b	b	b	c, d	a	b, c	b	a	d	c5	a	a	b	b	b	b	c	a	a
Erinnyis oenotrus (Cramer, 1780)	F	X	X	b	a	b	b	b	b	d	a	c	a, b	a	d	c5	a	a	b	b	b	a	b	a, b	a
Isognathus allamandae Clark, 1920	M	X		b	d	b	b	b	b	c, d	-	c	b	-	-	-	-	-	-	-	-	-	-	a, b	a
Isognathus allamandae Clark, 1920	F	X		b	a	b	b	b	b	d	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Isognathus caricae (Linnaeus, 1758)	M	X		b	d	b	b	b	b	d, d1	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	b	a

Species	Sex	S	SEM	Characters																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Isognathus caricae (Linnaeus, 1758)	F	X		b	a	b	b	b	b	d	-	b	b	-	-	-	-	-	-	-	-	-	-	b	a
Isognathus menechus (Boisduval, [1875])	M	X	X	b	d	b	b	b	b	d	a	c	b	a	d	c5	a	a	b	a	b	a	c	a	a
Isognathus menechus (Boisduval, [1875])	F	X	X	b	a	b	b	b	b	d	a	b, c	b	a	e	c5	a	a	b	a	b	a	c	a	a
Pseudosphinx tetrio (Linnaeus, 1771)	M	X	X	b	b	b	b	b, c	b	c, d	a	b, c	b	a	d	c5	a	a	b	b	b	c	c	b	a
Pseudosphinx tetrio (Linnaeus, 1771)	F	X	X	b	b	b	b	a, b	b	c	a	c	b	a	d	c5	a	a	b	a	b	a	b	b	a
Aleuron carinata (Walker, 1856)	M	X		b	a	b	b	a	b	b	-	c	a	-	-	-	-	-	-	-	-	-	-	a	a
Aleuron carinata (Walker, 1856)	F	X		b	f	b	b	b	b	d	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Aleuron chloroptera (Perty, [1833])	M	X		b	d	b	b	b	b	d	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Aleuron chloroptera (Perty, [1833])	F	X		b	b	b	b	b	b	d	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Aleuron iphis (Walker, 1856)	M	X	X	b	d	b	b	b	b	b	b	c	a	a	d	c3	b	b	b	a	b	a	b	a	a
Aleuron iphis (Walker, 1856)	F	X	X	b	a	b	b	a	b	d	b	c	a	a	d	c1	b	a	b	a	b	a	b	a	a
Aleuron neglectum Rothschild & Jordan, 1903	M	X		b	d	b	b	b	b	d	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Aleuron neglectum Rothschild & Jordan, 1903	F	X		b	a	b	b	a	b	d	-	b	a	-	-	-	-	-	-	-	-	-	-	a	a
Unzela japix discrepans Walker, 1856	M	X	X	b	a	b	b	b	b	d	b	c	b	a	d	c1	b	a	b	a	b	b	c	a	a
Unzela japix discrepans Walker, 1856	F	X	X	b	a	b	b	a, b	b	d	b	b	a	a	e	c1	a	a	b	a	b	a	c	a	a
Enyo lugubris (Linnaeus, 1771)	M	X	X	b	f	b	b	a, b	b	d, d1	b	b	a	b	d	c1	a	a	a	a	a	a	b	a	a
Enyo lugubris (Linnaeus, 1771)	F	X	X	b	f	b	b	a, b	b	d, d1	b	b, c	b	b	d	a	a	a	a	a	a	a	b	a	a
Enyo ocypete (Linnaeus, 1758)	M	X		b	a	b	b	b	b	d, d1	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Enyo ocypete (Linnaeus, 1758)	F	X		b	a	b	b	b	b	d1	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Enyo gorgon (Cramer, 1777)	M	X		b	a	b	b	a	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	a
Enyo gorgon (Cramer, 1777)	F	X		b	f	b	b	a	b	c	-	b	a	-	-	-	-	-	-	-	-	-	-	b	a
Eumorpha analis (Rothschild & Jordan, 1903)	M	X		b	a	b	b	b	b	c, c1	-	c	b	-	-	-	-	-	-	-	-	-	-	a	a
Eumorpha analis (Rothschild & Jordan, 1903)	F	X		b	a	b	b	b	b	d	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	a, b	a
Eumorpha anchemolus (Cramer, 1779)	M	X		b	a	b	b	b	b	d1	-	b	b	-	-	-	-	-	-	-	-	-	-	a	a
Eumorpha anchemolus (Cramer, 1779)	F	X		b	a	b	b	b	b	d	-	c	a	-	-	-	-	-	-	-	-	-	-	a	a
Eumorpha fasciatus (Sulzer, 1776)	M	X		b	a	b	b	b	b	c, c1	-	b, c	b	-	-	-	-	-	-	-	-	-	-	a, b	a
Eumorpha fasciatus (Sulzer, 1776)	F	X		b	a	b	b	b	b	c, d1	-	b	b	-	-	-	-	-	-	-	-	-	-	a, b	a
Eumorpha labruscae (Linnaeus, 1758)	M	X		b	a	b	b	b	b	b, c, d, d1	-	c	a	-	-	-	-	-	-	-	-	-	-	b	a

Species	Sex	S	SEM	Characters																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Eumorpha labruscae (Linnaeus, 1758)	F	X		b	a	b	b	b, c	b	c	-	c	a	-	-	-	-	-	-	-	-	-	-	b	a
Eumorpha megaeacus (Hübner, [1819])	M	X		b	a	b	b	b	b	c1, d, d1	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	a, b	a
Eumorpha megaeacus (Hübner, [1819])	F	X		b	a	b	b	a, b	b	c1, d, d2	-	b, c	a	-	-	-	-	-	-	-	-	-	-	b	a
Eumorpha obliquus Rothschild & Jordan, 1903	M	X	X	b	a	b	b	b	b	c1, c3, d	a	b, c	b	a	d	c1	b	a	b	b	b	b	c	a	a
Eumorpha obliquus Rothschild & Jordan, 1903	F	X	X	b	a	b	b	b	b	c1, c2	a	b, c	b	a	d	c1	b	a	a	a	a	b	b	a	a
Eumorpha translineatus (Rothschild, 1895)	M	X		b	d	b	b	b	b	c, c1, d	-	b, c	b	-	-	-	-	-	-	-	-	-	-	a	a
Eumorpha translineatus (Rothschild, 1895)	F	X		b	a	b	b	b	b	c, d, d1	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	b	a
Eumorpha vitis (Linnaeus, 1758)	M	X		b	a	b	b	b	b	d, d1	-	b, c	a, b	-	-	-	-	-	-	-	-	-	-	a	a
Eumorpha vitis (Linnaeus, 1758)	F	X		b	a	b	b	b, c	b	d, d2	-	c	a, b	-	-	-	-	-	-	-	-	-	-	a	a

APPENDIX D. All measurements by species and sex.

Species	n by sex	Epiphysis length (mm)		Epiphysis width (mm)		Position (mm)		Foretibia length (mm)	
		mean	sd	mean	sd	mean	sd	mean	sd
Cephonodes hylas	2 ♂	1.660	0.025	0.220	0.043	1.064	0.013	3.511	0.029
	2 ♀	1.725	0.071	0.174	0.053	1.119	0.024	3.582	0.022
Hemaris croatica	1 ♂	1.604	NA	0.196	NA	0.780	NA	2.715	NA
	1 ♀	1.372	NA	0.237	NA	0.715	NA	2.532	NA
Hemaris diffinis	1 ♂	1.643	NA	0.080	NA	0.586	NA	2.984	NA
	1 ♀	1.552	NA	0.176	NA	0.527	NA	2.401	NA
Pachylia darceta	8 ♂	2.491	0.139	0.531	0.051	1.643	0.113	5.459	0.281
	7 ♀	2.732	0.198	0.680	0.182	1.820	0.169	6.081	0.354
Pachylia ficus	8 ♂	3.328	0.140	0.605	0.067	1.865	0.190	6.068	0.627
	7 ♀	2.794	0.186	0.512	0.032	2.026	0.264	5.936	0.337
Pachylia syces	8 ♂	2.818	0.338	0.569	0.107	1.600	0.199	5.106	0.492
	7 ♀	2.705	0.167	0.643	0.175	1.959	0.198	5.756	0.482
Callionima guiarti	8 ♂	1.950	0.099	0.308	0.014	1.095	0.055	3.758	0.142
	7 ♀	1.776	0.059	0.278	0.042	1.177	0.067	3.758	0.067
Callionima innus	9 ♂	2.083	0.136	0.328	0.040	1.220	0.055	4.120	0.146
	6 ♀	2.049	0.133	0.306	0.040	1.219	0.086	3.987	0.217
Callionima nomius	8 ♂	2.207	0.144	0.372	0.042	1.078	0.053	3.926	0.246
	7 ♀	2.280	0.130	0.410	0.065	1.253	0.074	4.270	0.228
Callionima parce	8 ♂	2.131	0.066	0.291	0.039	1.250	0.068	4.329	0.164
	7 ♀	1.838	0.125	0.262	0.022	1.287	0.157	4.115	0.391
Nyceryx alophus	2 ♂	1.757	0.110	0.305	0.037	0.960	0.004	3.183	0.002
	2 ♀	1.633	0.168	0.238	0.007	0.959	0.071	3.183	0.251
Nyceryx continua continua	10 ♂	1.890	0.257	0.325	0.028	0.864	0.062	3.269	0.107
	5 ♀	1.734	0.107	0.385	0.144	0.928	0.107	3.311	0.152
Nyceryx nictitans nictitans	10 ♂	1.854	0.080	0.377	0.046	1.047	0.063	3.562	0.120
	5 ♀	1.595	0.136	0.350	0.048	1.093	0.077	3.439	0.148

Nyceryx stuarti	1 ♂	1.834	NA	0.298	NA	1.231	NA	3.699	NA
	1 ♀	1.775	NA	0.337	NA	1.146	NA	3.431	NA
Perigonia lusca	1 ♂	1.889	NA	0.386	NA	1.091	NA	3.710	NA
	1 ♀	1.750	NA	0.291	NA	1.245	NA	3.815	NA
Perigonia pallida	2 ♂	1.631	0.081	0.290	0.022	0.896	0.084	2.967	0.131
	2 ♀	1.530	0.057	0.309	0.120	1.104	0.024	3.246	0.029
Perigonia passerina	1 ♂	2.141	NA	0.434	NA	0.986	NA	3.524	NA
	1 ♀	1.456	NA	0.269	NA	1.118	NA	3.007	NA
Perigonia stulta	10 ♂	1.617	0.073	0.229	0.019	1.043	0.073	3.341	0.177
	5 ♀	1.515	0.096	0.248	0.030	1.082	0.044	3.262	0.278
Eupyrrhoglossum sagra	2 ♂	1.967	0.080	0.479	0.114	1.171	0.012	3.661	0.057
	2 ♀	1.763	0.017	0.420	0.161	1.130	0.013	3.548	0.117
Aellopos ceculus	2 ♂	1.696	0.137	0.272	0.036	1.054	0.102	3.470	0.373
	2 ♀	1.439	0.122	0.222	0.018	1.119	0.065	3.266	0.236
Aellopos fadus	2 ♂	1.685	0.228	0.341	0.073	1.145	0.063	3.578	0.039
	2 ♀	1.668	0.147	0.236	0.060	1.251	0.001	3.610	0.015
Aellopos tantalus	1 ♂	1.518	NA	0.398	NA	0.922	NA	3.301	NA
	1 ♀	1.402	NA	0.386	NA	1.203	NA	3.665	NA
Aellopos titan	2 ♂	1.716	0.012	0.466	0.032	1.436	0.328	3.984	0.157
	2 ♀	1.504	0.235	0.261	0.173	1.690	0.063	3.944	0.121
Oryba achemenides	1 ♂	2.909	NA	0.777	NA	2.082	NA	7.080	NA
	1 ♀	2.866	NA	0.536	NA	1.986	NA	6.930	NA
Oryba kadeni	2 ♂	2.885	0.165	0.592	0.175	2.142	0.039	6.701	0.040
	2 ♀	2.790	0.247	0.416	0.028	2.272	0.126	6.551	0.790
Pachylioides resumens	8 ♂	2.389	0.064	0.434	0.041	1.533	0.064	5.227	0.311
	7 ♀	2.302	0.137	0.481	0.083	1.515	0.070	5.104	0.271
Madoryx bubastus	2 ♂	2.194	0.265	0.579	0.137	1.717	0.054	4.982	0.576
	2 ♀	2.150	0.198	0.424	0.141	1.853	0.020	5.188	0.317
Madoryx plutonius	2 ♂	2.683	0.092	0.559	0.056	1.939	0.011	5.651	0.166
	2 ♀	2.418	0.010	0.452	0.004	1.933	0.300	5.226	0.606
Madoryx oiclus	1 ♂	2.366	NA	0.540	NA	1.543	NA	4.824	NA

	1 ♀	2.373	NA	0.612	NA	1.775	NA	5.327	NA
Hemeroplanes longistriga	1 ♂	2.503	NA	0.889	NA	1.595	NA	5.311	NA
	1 ♀	2.374	NA	0.730	NA	1.683	NA	4.919	NA
Hemeroplanes ornatus	2 ♂	2.735	0.050	0.605	0.052	1.727	0.096	5.498	0.066
	2 ♀	2.329	0.156	0.487	0.015	1.845	0.016	5.432	0.361
Hemeroplanes triptolemus	2 ♂	2.480	0.181	0.487	0.045	1.537	0.241	4.914	0.345
	2 ♀	2.309	0.121	0.432	0.021	1.521	0.086	4.620	0.371
Erinnyis alope	8 ♂	2.806	0.098	0.659	0.188	1.611	0.070	6.162	0.200
	7 ♀	2.556	0.199	0.653	0.146	1.688	0.145	6.093	0.584
Erinnyis crameri	8 ♂	2.311	0.084	0.580	0.135	1.585	0.133	5.247	0.333
	7 ♀	2.168	0.116	0.416	0.059	1.648	0.103	5.315	0.249
Erinnyis ello	8 ♂	2.275	0.165	0.468	0.056	1.493	0.159	5.413	0.452
	7 ♀	2.128	0.154	0.474	0.092	1.562	0.217	5.437	0.604
Erinnyis impunctata	8 ♂	2.339	0.163	0.446	0.047	1.392	0.091	5.010	0.221
	7 ♀	2.112	0.164	0.361	0.039	1.513	0.104	5.050	0.354
Erinnyis lassauxii	9 ♂	2.856	0.140	0.731	0.234	1.623	0.106	6.176	0.366
	6 ♀	2.664	0.095	0.627	0.253	1.786	0.116	6.215	0.225
Erinnyis obscura	8 ♂	2.043	0.087	0.387	0.024	0.980	0.043	4.025	0.115
	7 ♀	1.827	0.086	0.346	0.032	1.175	0.137	4.088	0.337
Erinnyis oenotrus	8 ♂	2.493	0.106	0.530	0.081	1.490	0.111	5.421	0.354
	7 ♀	2.409	0.190	0.442	0.062	1.567	0.081	5.335	0.400
Isognathus allamandae	8 ♂	2.069	0.044	0.399	0.029	1.179	0.077	4.256	0.204
	7 ♀	1.895	0.101	0.349	0.023	1.318	0.142	4.469	0.197
Isognathus caricae	8 ♂	2.654	0.168	0.691	0.154	1.618	0.057	5.525	0.274
	7 ♀	2.384	0.128	0.771	0.224	1.625	0.100	5.270	0.195
Isognathus menechus	8 ♂	2.387	0.095	0.488	0.023	1.603	0.120	5.410	0.333
	7 ♀	2.391	0.148	0.573	0.059	1.736	0.162	5.547	0.314
Pseudosphinx tetrio	8 ♂	3.436	0.190	0.808	0.075	1.765	0.111	7.378	0.364
	7 ♀	3.356	0.097	0.765	0.114	1.962	0.181	7.603	0.464
Aleuron carinata	1 ♂	2.671	NA	0.598	NA	1.460	NA	4.796	NA
	1 ♀	2.162	NA	0.633	NA	1.641	NA	4.453	NA

Aleuron chloroptera	1 ♂	1.995	NA	0.708	NA	1.190	NA	4.034	NA
	1 ♀	1.803	NA	0.437	NA	0.700	NA	2.920	NA
Aleuron iphis	2 ♂	2.143	0.045	0.452	0.016	1.057	0.192	3.774	0.508
	2 ♀	1.745	0.137	0.342	0.011	1.334	0.130	3.929	0.285
Aleuron neglectum	1 ♂	2.108	NA	0.480	NA	1.070	NA	3.753	NA
	1 ♀	1.611	NA	0.408	NA	1.052	NA	3.277	NA
Unzela japix	2 ♂	1.911	0.017	0.470	0.020	1.016	0.057	3.256	0.070
	2 ♀	1.574	0.152	0.365	0.120	1.159	0.016	3.455	0.123
Enyo gorgon	2 ♂	2.080	0.045	0.357	0.036	1.353	0.089	4.049	0.106
	2 ♀	1.855	0.002	0.302	0.031	1.392	0.008	3.749	0.054
Enyo lugubris	8 ♂	1.790	0.100	0.361	0.135	1.485	0.164	3.976	0.336
	7 ♀	1.613	0.148	0.319	0.048	1.443	0.111	3.755	0.278
Enyo ocypete	8 ♂	1.728	0.101	0.393	0.096	1.359	0.097	3.874	0.251
	7 ♀	1.579	0.104	0.280	0.085	1.163	0.057	3.462	0.214
Eumorpha analis	8 ♂	3.355	0.210	0.739	0.069	1.934	0.190	6.050	0.476
	7 ♀	2.974	0.310	0.657	0.092	1.824	0.114	5.518	0.448
Eumorpha anchemolus	8 ♂	3.874	0.118	0.890	0.108	2.375	0.185	7.442	0.246
	7 ♀	3.526	0.156	1.195	0.191	2.335	0.145	6.764	0.211
Eumorpha fasciatus	8 ♂	2.806	0.163	0.800	0.141	1.714	0.101	5.330	0.314
	7 ♀	2.618	0.157	0.726	0.057	1.825	0.135	5.359	0.453
Eumorpha labruscae	8 ♂	3.111	0.178	0.656	0.062	1.868	0.079	5.679	0.293
	7 ♀	2.914	0.187	0.567	0.035	1.986	0.129	5.539	0.319
Eumorpha megaeacus	8 ♂	2.976	0.127	0.685	0.114	1.838	0.135	5.597	0.154
	7 ♀	2.914	0.180	0.833	0.125	1.790	0.183	5.380	0.526
Eumorpha obliquus	8 ♂	3.414	0.187	0.833	0.062	1.839	0.164	5.775	0.354
	7 ♀	3.276	0.091	0.809	0.121	1.894	0.194	5.776	0.437
Eumorpha translineatus	8 ♂	3.149	0.214	0.622	0.048	1.626	0.108	5.470	0.408
	7 ♀	3.029	0.109	0.778	0.107	1.718	0.095	5.620	0.263
Eumorpha vitis	8 ♂	2.582	0.184	0.530	0.062	1.592	0.092	4.779	0.288
	7 ♀	2.549	0.191	0.486	0.047	1.710	0.117	5.008	0.267

APPENDIX E. Antenna length by genus, species and sex.

Genus	Species	By Genus			By Species			By Sex		
		n	mean	sd	n	mean	sd	n	mean	sd
Cephonodes	*Cephonodes hylas*	4	12.13	0.629	4	12.13	0.629	2 ♂	12.50	0.707
								2 ♀	11.75	0.354
Hemaris	*Hemaris croatica*	4	11.00	0.816	2	10.50	0.707	1 ♂	10.00	NA
								1 ♀	11.00	NA
	Hemaris diffinis				2	11.50	0.707	1 ♂	12.00	NA
								1 ♀	11.00	NA
Pachylia	*Pachylia darceta*	45	21.48	2.911	15	20.73	2.008	8 ♂	19.19	0.651
								7 ♀	22.50	1.443
	Pachylia ficus				15	24.60	1.404	8 ♂	24.63	1.302
								7 ♀	24.57	1.618
	Pachylia syces				15	19.10	1.882	8 ♂	18.13	1.575
								7 ♀	20.21	1.629
Callionima	*Callionima guiarti*	60	14.23	1.366	15	13.44	0.670	8 ♂	13.44	0.623
								7 ♀	13.44	0.770
	Callionima innus				15	13.59	0.940	9 ♂	13.50	1.061
								6 ♀	13.72	0.801
	Callionima nomius				15	15.99	0.892	8 ♂	15.56	0.943
								7 ♀	16.47	0.553
	Callionima parce				15	13.92	1.100	8 ♂	14.35	0.968
								7 ♀	13.43	1.097
Nyceryx	*Nyceryx alophus*	36	12.01	0.638	4	11.25	0.957	2 ♂	12.00	0.707
								2 ♀	10.50	0.000
	Nyceryx continua continua				15	12.29	0.467	10 ♂	12.28	0.442
								5 ♀	12.30	0.570
	Nyceryx nictitans nictitans				15	11.96	0.512	10 ♂	12.10	0.562
								5 ♀	11.68	0.249
	Nyceryx stuarti				2	11.75	1.061	1 ♂	12.50	NA
								1 ♀	11.00	NA
Perigonia	*Perigonia lusca*	23	11.54	0.914	2	11.70	0.990	1 ♂	12.40	NA

								1 ♀	11.00	NA
	Perigonia pallida				4	11.00	0.408	2 ♂	11.25	0.354
								2 ♀	10.75	0.354
	Perigonia passerina				2	12.00	1.414	1 ♂	13.00	NA
								1 ♀	11.00	NA
	Perigonia stulta				15	11.61	0.971	10 ♂	11.83	1.049
								5 ♀	11.16	0.673
Eupyrrhoglossum	*Eupyrrhoglossum sagra*	4	13.00	0.707	4	13.00	0.707	2 ♂	13.50	0.000
								2 ♀	12.50	0.707
Aellopos	*Aellopos ceculus*	14	12.81	1.182	4	11.88	0.750	2 ♂	12.50	0.000
								2 ♀	11.25	0.354
	Aellopos fadus				4	13.38	0.854	2 ♂	14.00	0.707
								2 ♀	12.75	0.354
	Aellopos tantalus				2	11.75	0.354	1 ♂	11.50	NA
								1 ♀	12.00	NA
	Aellopos titan				4	13.70	1.152	2 ♂	14.15	0.212
								2 ♀	13.25	1.768
Oryba	*Oryba achemenides*	6	20.67	1.941	2	22.25	0.354	1 ♂	22.50	NA
								1 ♀	22.00	NA
	Oryba kadeni				4	19.88	1.931	2 ♂	19.50	2.121
								2 ♀	20.25	2.475
Pachylioides	*Pachylioides resumens*	15	17.97	1.008	15	17.97	1.008	8 ♂	18.38	1.094
								7 ♀	17.50	0.707
Madoryx	*Madoryx bubastus*	10	16.00	1.972	4	15.50	2.041	2 ♂	13.75	0.354
								2 ♀	17.25	0.354
	Madoryx oiclus				2	13.75	0.354	1 ♂	13.50	NA
								1 ♀	14.00	NA
	Madoryx plutonius				4	17.63	0.479	2 ♂	17.25	0.354
								2 ♀	18.00	0.000
Hemeroplanes	*Hemeroplanes longistriga*	10	19.37	1.446	2	18.80	0.283	1 ♂	19.00	NA
								1 ♀	18.60	NA
	Hemeroplanes ornatus				4	20.63	1.493	2 ♂	21.25	1.768
								2 ♀	20.00	1.414

	Hemeroplanes triptolemus				4	18.40	0.668	2 ♂	18.65	0.495
								2 ♀	18.15	0.919
Erinnyis	*Erinnyis alope*	105	16.61	2.132	15	18.83	1.496	8 ♂	19.56	0.729
								7 ♀	18.00	1.756
	Erinnyis crameri				15	16.57	0.884	8 ♂	16.94	0.563
								7 ♀	16.14	1.029
	Erinnyis ello				15	15.93	1.474	8 ♂	16.56	1.294
								7 ♀	15.21	1.410
	Erinnyis impunctata				15	16.40	1.168	8 ♂	16.81	1.163
								7 ♀	15.93	1.058
	Erinnyis lassauxii				15	18.73	1.116	9 ♂	19.06	1.102
								6 ♀	18.25	1.037
	Erinnyis obscura				15	13.37	0.760	8 ♂	13.83	0.625
								7 ♀	12.86	0.556
	Erinnyis oenotrus				15	16.43	1.860	8 ♂	17.13	0.791
								7 ♀	15.64	2.445
Isognathus	*Isognathus allamandae*	45	19.08	2.218	15	16.32	0.824	8 ♂	16.60	0.771
								7 ♀	16.00	0.816
	Isognathus caricae				15	20.80	0.902	8 ♂	21.00	1.069
								7 ♀	20.57	0.673
	Isognathus menechus				15	20.13	1.202	8 ♂	19.50	1.069
								7 ♀	20.86	0.945
Pseudosphinx	*Pseudosphinx tetrio*	15	26.07	1.083	15	26.07	1.083	8 ♂	25.63	0.954
								7 ♀	26.57	1.058
Aleuron	*Aleuron carinata*	10	14.40	2.536	2	18.50	0.707	1 ♂	19.00	NA
								1 ♀	18.00	NA
	Aleuron chloroptera				2	14.50	2.121	1 ♂	16.00	NA
								1 ♀	13.00	NA
	Aleuron iphis				4	12.38	0.750	2 ♂	13.00	0.000
								2 ♀	11.75	0.354
	Aleuron neglectum				2	14.25	1.061	1 ♂	15.00	NA
								1 ♀	13.50	NA
Unzela	*Unzela japix*	4	13.00	0.707	4	13.00	0.707	2 ♂	13.50	0.000

								2 ♀	12.50	0.707
Enyo	*Enyo gorgon*	34	11.95	1.274	4	13.65	0.929	2 ♂	14.40	0.566
								2 ♀	12.90	0.141
	Enyo lugubris				15	11.05	0.765	8 ♂	11.38	0.835
								7 ♀	10.69	0.508
	Enyo ocypete				15	12.39	1.079	8 ♂	13.00	1.069
								7 ♀	11.69	0.555
Eumorpha	*Eumorpha analis*	120	21.57	2.887	15	22.40	1.805	8 ♂	23.63	0.954
								7 ♀	21.00	1.500
	Eumorpha anchemolus				15	26.60	1.724	8 ♂	27.75	1.389
								7 ♀	25.29	0.951
	Eumorpha fasciatus				15	18.58	0.718	8 ♂	18.72	0.818
								7 ♀	18.43	0.607
	Eumorpha labruscae				15	21.17	1.780	8 ♂	19.56	1.294
								7 ♀	19.07	0.976
	Eumorpha megaeacus				15	22.33	2.024	8 ♂	21.94	0.623
								7 ♀	20.29	2.289
	Eumorpha obliquus				15	19.17	1.520	8 ♂	22.88	2.151
								7 ♀	21.71	1.822
	Eumorpha translineatus				15	19.33	1.144	8 ♂	23.56	1.178
								7 ♀	22.36	0.690
	Eumorpha vitis				15	23.00	1.134	8 ♂	18.94	1.294
								7 ♀	19.43	1.813

APPENDIX F. Comparison Matrix Kruskall-Wallis Chi.

	Aellopos	*Aleuron*	*Callionima*	*Cephonodes*	*Enyo*	*Erinnyis*	*Eumorpha*	*Eupyrrhoglossum*	*Hemaris*	*Hemeroplanes*	*Isognathus*	*Madoryx*	*Nyceryx*	*Oryba*	*Pachylia*	*Pachylioides*	*Perigonia*	*Pseudosphinx*
Aleuron	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Callionima	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cephonodes	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enyo	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Erinnyis	0.00232	1	2.60E-05	0.5253	1.20E-05	-	-	-	-	-	-	-	-	-	-	-	-	-
Eumorpha	9.70E-13	2.20E-05	<2.00E-16	0.00019	<2.00E-16	7.50E-11	-	-	-	-	-	-	-	-	-	-	-	-
Eupyrrhoglossum	1	1	1	1	1	1	0.01982	-	-	-	-	-	-	-	-	-	-	-
Hemaris	1	1	1	1	1	0.08529	1.20E-05	1	-	-	-	-	-	-	-	-	-	-
Hemeroplanes	0.05017	1	0.19544	0.47553	0.03937	1	1	1	0.09962	-	-	-	-	-	-	-	-	-
Isognathus	0.00163	1	0.00016	0.31477	3.50E-05	1	0.00019	1	0.0497	1	-	-	-	-	-	-	-	-
Madoryx	0.18405	1	0.80356	1	0.17812	1	1	1	0.24014	1	1	-	-	-	-	-	-	-
Nyceryx	1	1	1	1	1	4.10E-11	<2.00E-16	1	1	0.00047	1.30E-09	0.00317	-	-	-	-	-	-
Oryba	0.00015	0.03106	0.00044	0.006	8.50E-05	0.95796	1	0.14488	0.00092	1	1	1	8.70E-07	-	-	-	-	-
Pachylia	5.40E-09	0.00131	1.30E-14	0.00175	5.10E-14	0.00143	1	0.10657	0.00015	1	0.22621	1	<2.00E-16	1	-	-	-	-
Pachylioides	0.26291	1	1	1	0.20772	1	0.02943	1	0.39976	1	1	1	0.00181	1	0.70871	-	-	-
Perigonia	1	1	0.65259	1	1	2.20E-09	<2.00E-16	1	1	0.00026	1.10E-08	0.00167	1	4.90E-07	<2.00E-16	0.00108	-	-
Pseudosphinx	2.10E-11	3.60E-06	4.20E-14	1.30E-05	1.40E-14	6.60E-06	1	0.00142	8.50E-07	0.35882	0.00045	0.10238	<2.00E-16	-	1	0.00265	<2.00E-16	-
Unzela	1	1	1	1	1	1	0.00283	1	1	1	1	1	1	0.03784	0.0192	1	1	0.00019

Highlighted values represent $p<0.001$

APPENDIX G. Discriminant Analysis followed by a leave-one-out cross-validation test among genera

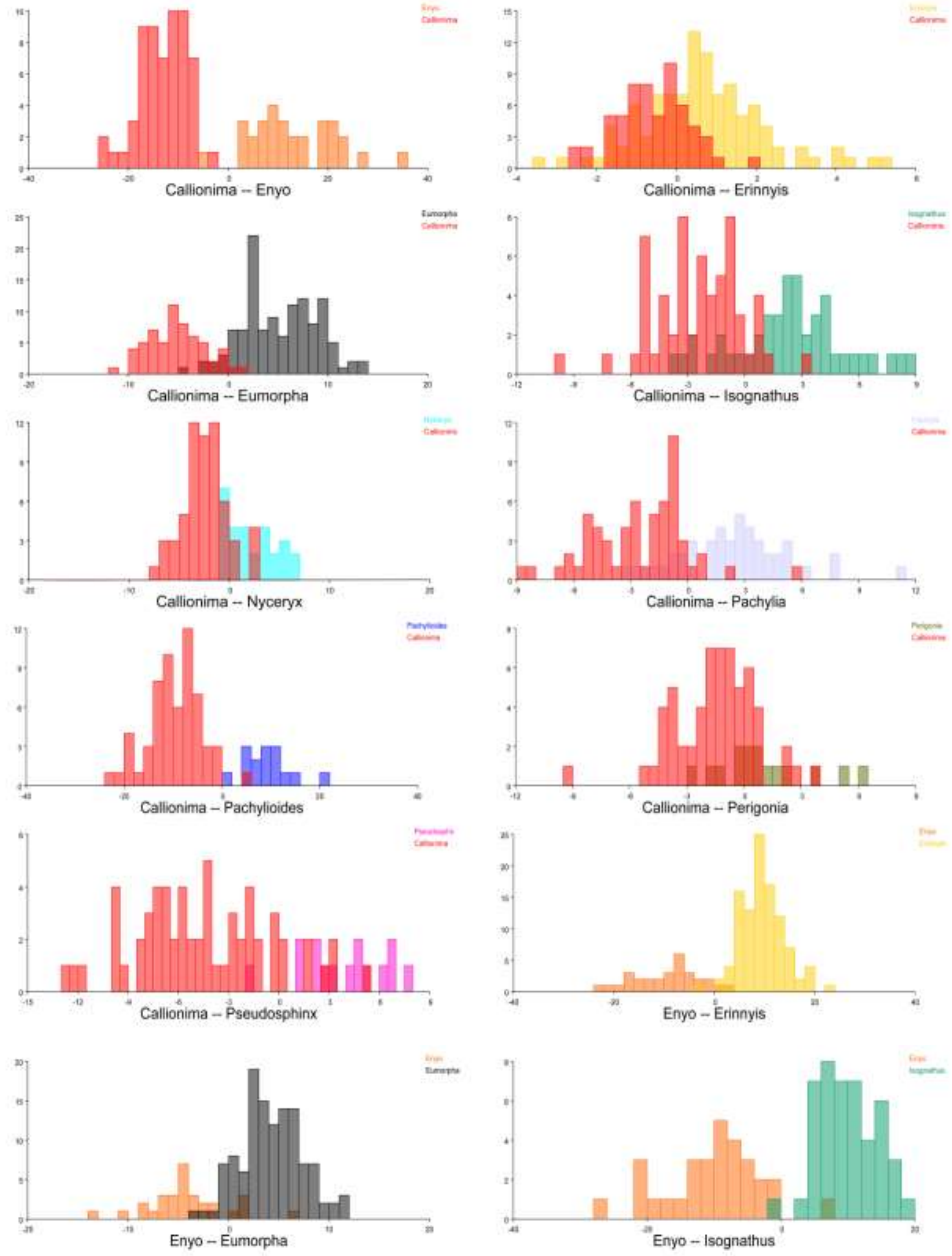


Plate I – *Callionima* and *Enyo*.

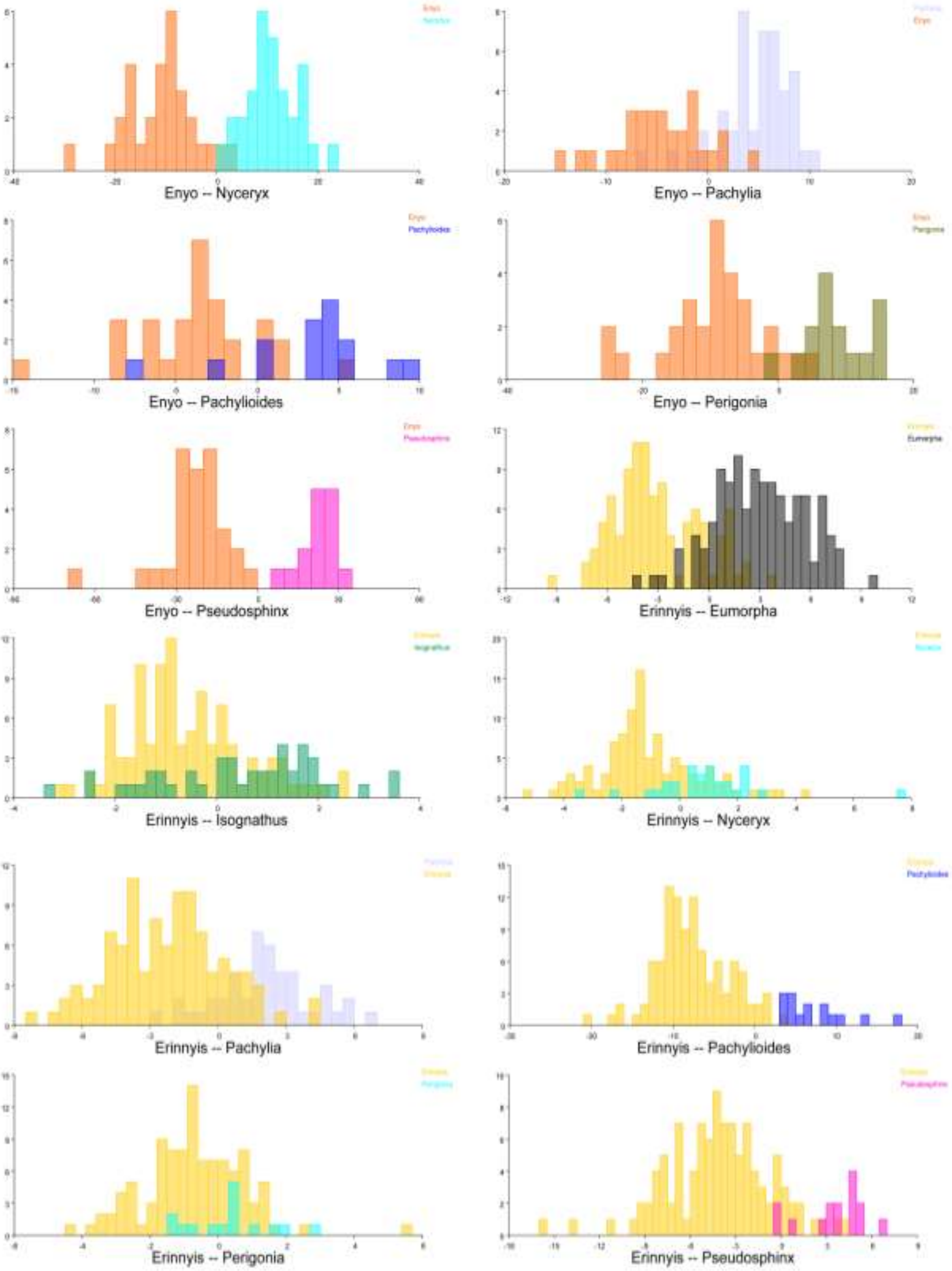


Plate II –*Enyo* and *Erinnyis*.

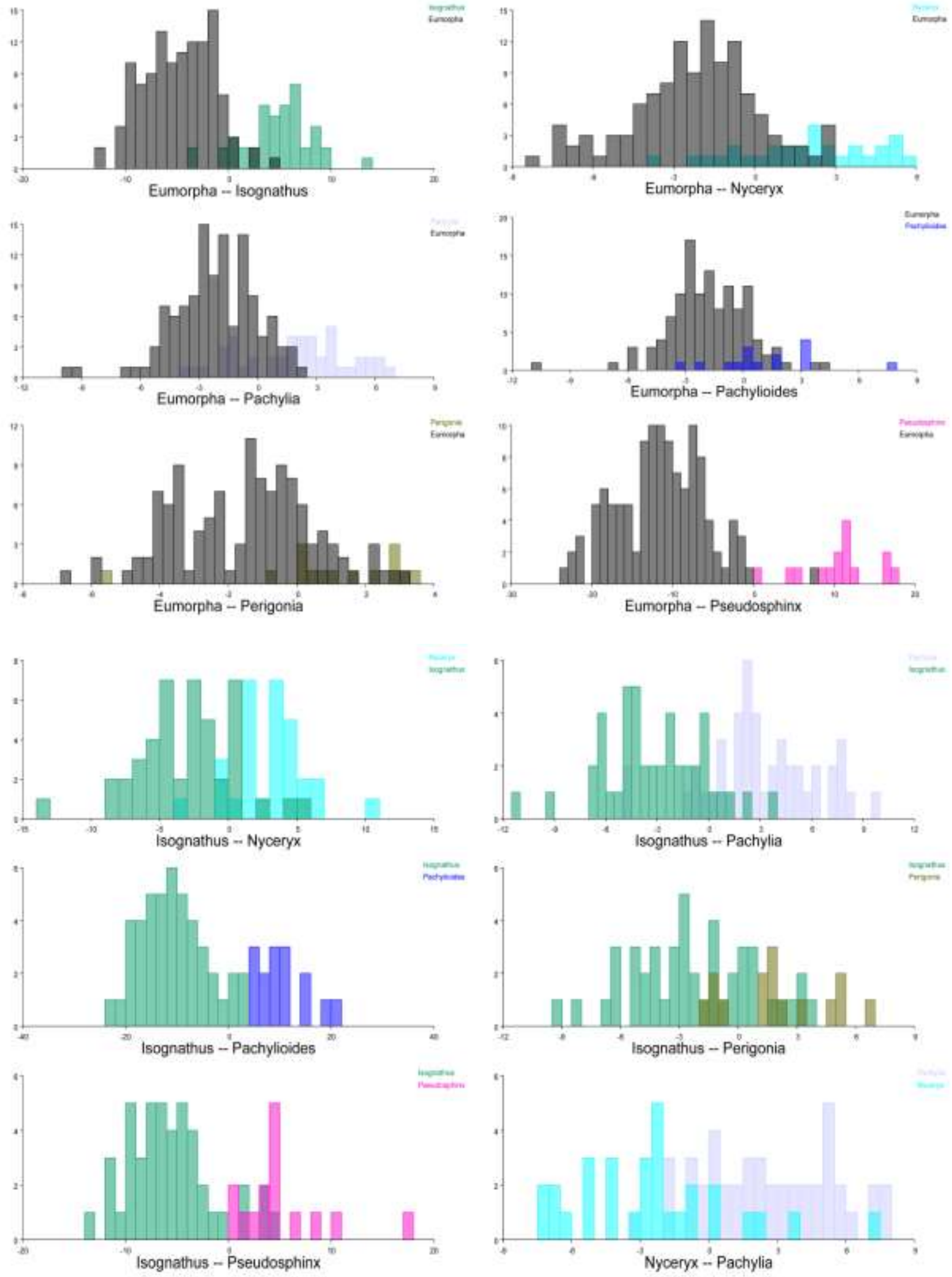


Plate III – *Eumorpha*, *Isognathus* and *Nyceryx*.

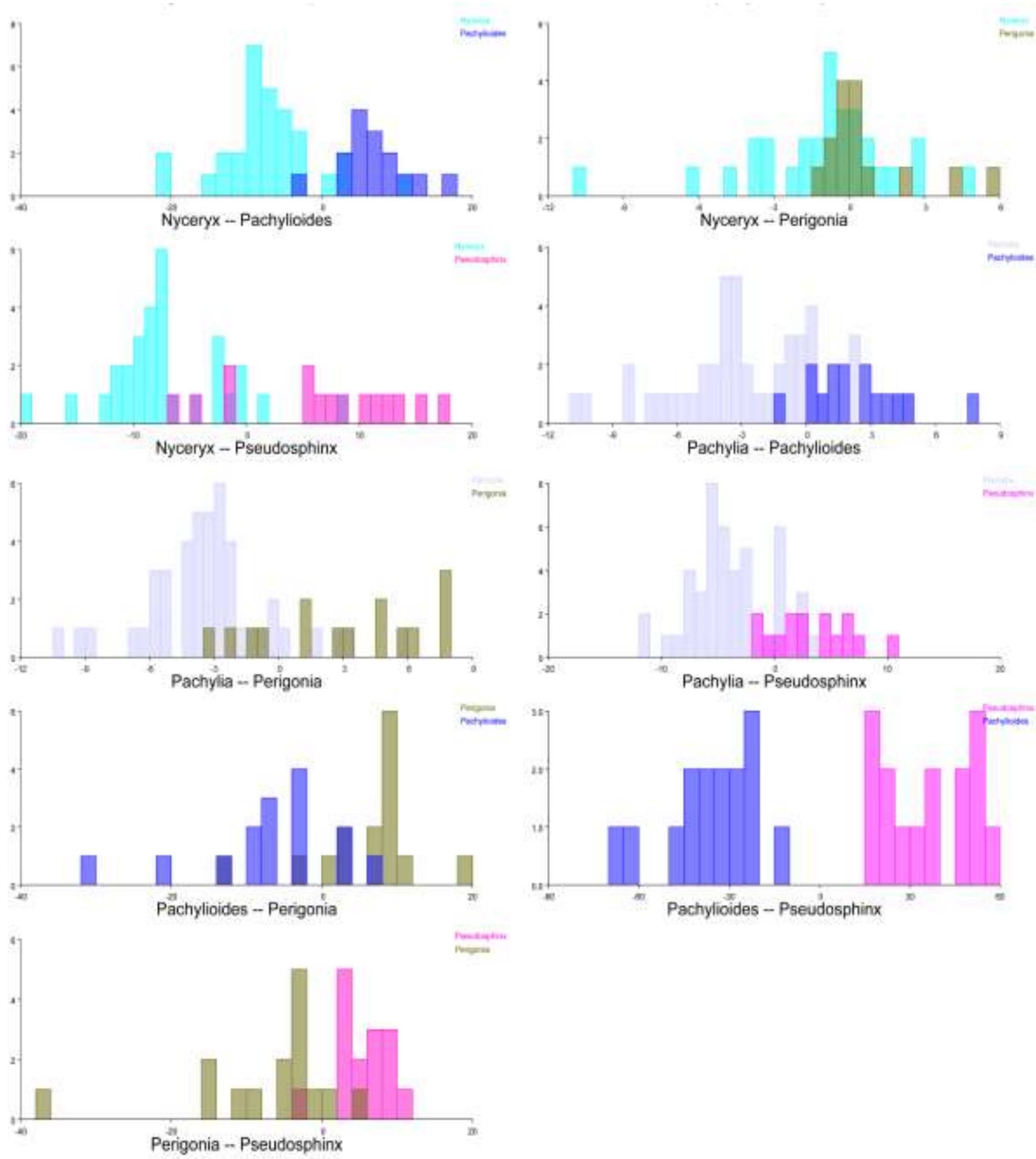


Plate IV – *Nyceryx*, *Pachylia*, *Pachylioides* and *Perigonia*.