

The system of plates in the basal part of the wing veins in Diptera (Insecta)

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Abstract: The sclerites (plates) from which the wing veins begin in the various families of Diptera are scrutinized. A general plan of the sclerites and their localization between the axillary area and the vein system are presented. Some morphological differences in 6 families are considered.

Key words: axillary and basal areas, ground-plan, Diptera.

Introduction

In Diptera, attention has been paid to the musculature and movement of the axillary sclerites in flight, while differences between the separate families have not been scrutinized (Myan & Ewing 1985; Ennos 1987; Wisser 1988; Balint & Dickinson 2001, 2004; Deora *et al.* 2017). Evolutionary, the axillary sclerites are considered to be more conservative than the plates distally located at the base of the veins (Brodsky 1988, 1989, 2022). These plates have been poorly studied compared to the axillary sclerites and the wing veins. The sclerites that connect the wings to the thorax have been presented schematically, with drawings and rarely with photographs of some species.

The aim of the work is to consider the plates distally to the axillary sclerites and to present some differences between in 6 families.

Material and Methods

Six families were scrutinized (Figures 1-6). The wings with the axillary sclerites were separated. They were washed with water, alcohol and xylol and placed between glass plates in Canada balsam. Thus, the specimens are close to the published two-dimensional schemes and suitable for the microscopic studies. The magnifications of the objective-oculars used were 31.5× and 63.0× (with a Zeiss-Ultraphod Mikro 527 microscope, 1937) and have changed according to the distance between the camera and the object. The photographs were taken with a Canon EOS 2000D from the dorsal part of the wings. The Helicon Focus program was used for processing the photographs. The designations of the figures are included in the text.

Results and Discussion

The wing is dorsally connected to the tergum via the first (1AX) and third (3AX) axillary sclerites. The connection is with the anterior (ANP), median (MNP) and posterior (PNP) notal wing process (Figures 1-6). Ventrally of the wing are the basisubcostale (BSC), second (2AX) and third (3AX) axillary sclerites. The basisubcostale (BSC) forms a joint with the basalar sclerite (BA), which is connected with the subalar sclerite (SA). Between them is the second axillary sclerite (2AX) which connects with the pleural wing process (PWP). Lateral to the proximal median plate (PMP) is the distal median plate (DMP), connected to

the base of the vena medialis (M) and close to the base of the radius system (R). The basisubcostale (BSC) passes into the vena subcostalis (Sc) and is connected with the base of the basiradiale (BR), from which the radius system (R) continues. The basicosta (BC) is connected to the vena costalis (C). The base of the cubitalis system (Cu) is usually located freely in the wing membrane.

The axillary region usually includes 3 (rarely 4) sclerites (Figures 1-6). The first axillary sclerite (1AX) consists of a body and a curved process at the anterior end. The process is proximally connected to the anterior notal wing process (ANP). The tip of the process is connected antero-distally to the basisubcostale (BSC) and latero-distally to the basiradiale (BR). The proximal side of the first axillary sclerite is connected to the median notal wing process (MNP) and the tergopleural muscles (Matsuda 1970). The distal side is connected to the second axillary sclerite (2AX). The latter is connected anteriorly to the basiradiale (BR), proximally to the first axillary sclerite (1AX), distally to the proximal median plate (PMP) and with its posterior tip to the third axillary sclerite (3AX). The latter has 3 arms – anterior, posterior and distal. The anterior arm is connected to the posterior tip of the second axillary sclerite (2AX). The posterior arm with its dorsal branch connects to the posterior notal wing process (PNP), and the ventral branch contacts with the subalar sclerite (SA). The anterior branch of the distal arm is connected to the distal median plate (DMP) and the base of the vena postcubitalis (Pcu). The posterior branch of the distal arm is connected to the common base of the anal veins (A). The tergopleural muscles are attached to the proximal side of the third axillary sclerite. The anterior side contacts with the posterior part of the proximal median plate (PMP).

In Diptera, a structure related (Figures 5, 6) to the third axillary sclerite (3AX) – fourth axillary sclerite (4AX, lateropostnotum – LPN) develops, a separated process from the posterior notal wing process (PNP), which controls the position of the calypteres and the wing movement (Matsuda 1970). In connection with the placement of the two apodemes on the first axillary sclerite (1AX) for attachment of the tergopleural muscles, the proximal end expands and the posterior end is displaced posterodistal and connects to the third axillary sclerite (3AX). The postmedian notal wing process (PMNP – Fig. 6) is formed.

In most families the tegula (TG) are more massive than the basicostale (BC). In Calliphoridae, Sarcophagidae and Tachinidae the basicostale is considerably enlarged and in Tachinidae (Fig. 5) it can reach large sizes and dominate the tegula. In Tabanidae, Bombyliidae, some Syrphidae and Tachinidae, active and fast fliers with diverse flight types, the vena costalis (C) has a massive and thick base after the basicostale (BC, Figures 4, 5).

Basisubcostale (BSC) has a thick basal part, which narrows into the vena subcostalis (Sc). In the separate families, the length and sclerotization of this part varies. In Tipulidae and Bibionidae (Figures 1, 3) the basal part is significantly elongated. In the family Psychodidae, due to the complete lack of sclerotization, the basisubcostale is difficult to differentiate. In Brachycera (Figures 2, 4, 5, 6) a sclerotization and shortening occur, which develop in parallel with the costalization of the wings.

The basiradiale (BR) is the most massive and sclerotized structure at the base of the veins, connected with the axillary complex and surrounding system of plates (Figures 1-6). Its shape varies in the separate families. In Bibionidae and Micropezidae (Figures 2, 6) it is more elongated with a massive thickening before gradually passing into the vena radialis (R). As costalization develops in Brachycera, shortening and increased sclerotization occur (Figures 2, 4, 5, 6). Even in the absence of sclerotization, in Psychodidae, the basiradiale appears as a darkened and thickened plate.

The median plate is made up of 2 parts – proximal median plate (PMP) and distal median plate (DMP), located distal to the second axillary sclerite (2AX). In Tipulidae (Fig. 1) and Limoniidae the plates are strongly elongated, weakly sclerotized and triangular. In Bibionidae (Fig. 3) the plates are shorter, sclerotized and massive. In Brachycera the median

plates more often have a different from the triangular shape, complicated with three-dimensional structures and strong sclerotization (Figures 2, 4, 5, 6). From these plates begins the system of vena medialis (M) and in rare cases the common base of the median-cubital system (M+Cu, Fig. 1).

The basicubitale (BCU) is often not clearly defined. When developed, it is located postero-distal to the median plate (PMP and DMP) and antero-distal to the third axillary sclerite (3AX). Some authors consider it as a common base of the cubital-anal system (Stratiomyidae and Syrphidae – Figures 4, 6). Others accept that the beginning of the cubital system (Cu) is located freely in the wing membrane. They connect the base of the anal veins (A) with the third axillary sclerite (3AX). The question of the beginning of the cubital and anal systems is debatable (Schubnel *et al.* 2019), especially with regard to the vena postcubitalis (Pcu), considered by some authors to be part of the anal veins (A). In Psychodidae, the basicubitale (BCU) is localized despite the weak sclerotization and lack of a costalization in the wings.

The investigated structures are divided into 3 zones according to their evolutionary conservatism (Brodsky 1988): 1) proximal zone, the most conservative – includes basisubcostale (BSC) and basiradiale (BR); 2) middle zone, more variable – the bases of the vena radialis (R) and vena postcubitalis (Pcu), and the proximal median plate (PMP); 3) distal zone, most variable – the connection between the basal parts of the vena subcostalis (Sc) and vena radialis (R), distal median plate (DMP), the bases of the vena medialis (M) and vena cubitalis (Cu).

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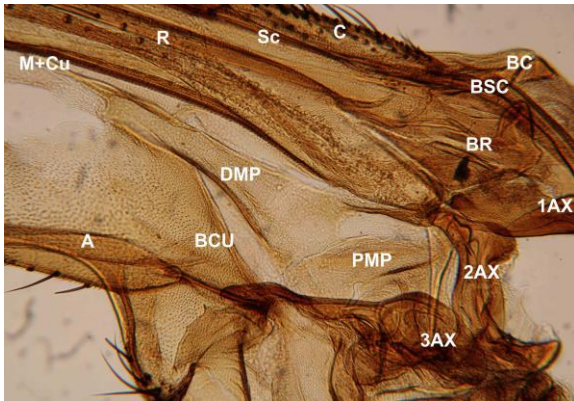


Fig. 1. Nematocera: Tipulomorpha: Tipulidae (*Tipula* sp.) – median plates (details).

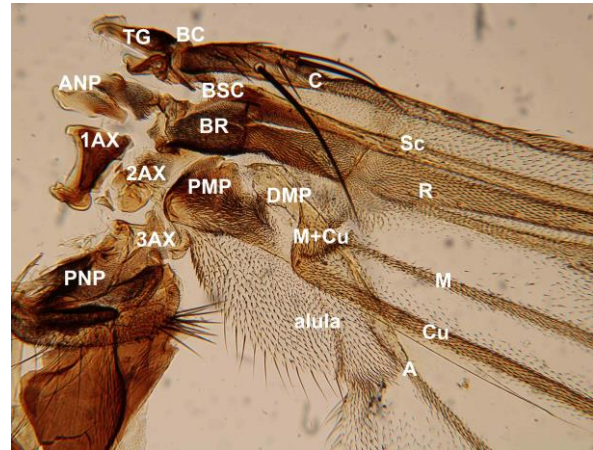


Fig. 2. Brachycera: Schizophora: Acalyptratae: Micropezidae [*Rainieria calceata* (Fallén, 1820)].

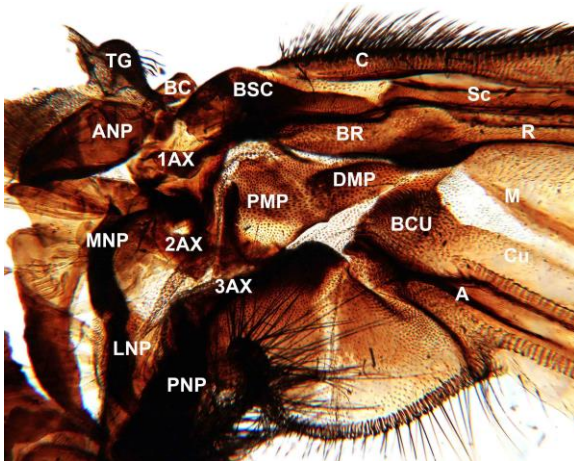


Fig. 3. Nematocera: Bibionomorpha: Bibionidae (*Bibio* sp.).

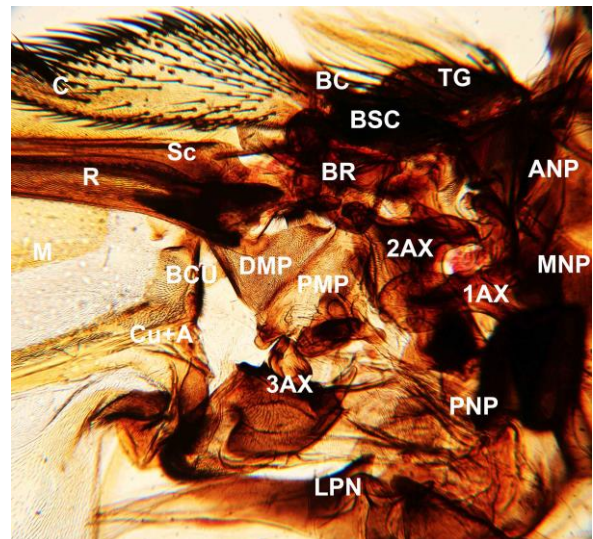


Fig. 4. Brachycera: Cyclorrhapha: Aschiza: Syrphidae (*Eristalis* sp.).

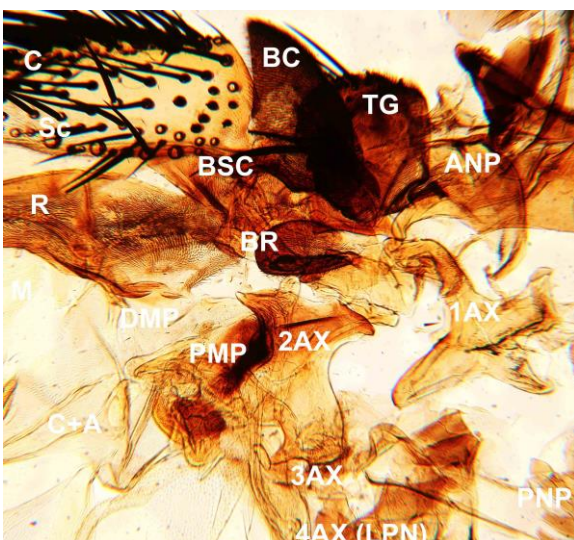


Fig. 5. Brachycera: Schizophora: Calypttratae: Tachinidae [(*Exorista larvarum* (Linnaeus, 1758)].

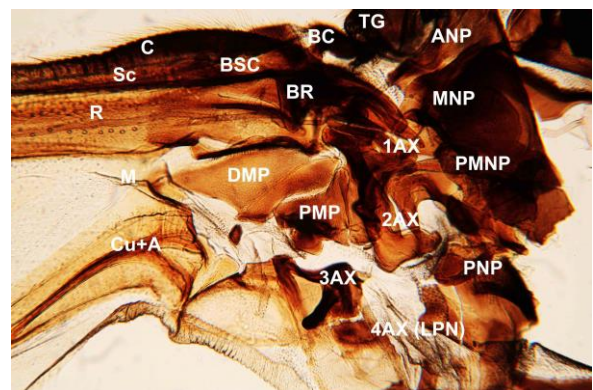


Fig. 6. Brachycera: Orthorrhapha: Stratiomyomorpha: Stratiomyidae (*Chloromyia* sp.).