

Study of wing venation in *Zygogramma bicolorata* Pallister (Coleoptera, Chrysomelidae) in Dehradun of Uttarakhand, India

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ABSTRACT: Costa and sub costa veins are found in the wings of *Zygogramma bicolorata*. They appear as dark coloured markings. The wing comprises three margins namely anterior margin, posterior margin and Apex. Coastal margin is another name for anterior margin. There are coastal margins on the wings' front or first side. The posterior margin is located towards the back of the wing, whereas the apex or apical margin is located at the pointed end of the wing. The anal margin is another name for the posterior edge. The veins in the wing are further divided into two parts which is proximal and distal. The veins are denoted with the help of vein coordinates ranging from one to thirty-six. Vein coordinates help in denoting the exact location of the veins which form the basic framework of the hind wings. From the current analysis it was concluded that the veins found on the hind wing of *Z. bicolorata* are as follows costa, subcosta anterior, subcosta, radius, radius basal, radius anterior, subcosta posterior, radius posterior, radius (2-3), radius (4-5), media anterior (1-2), media posterior (1-2), media posterior (3-4), medial, cubital, cubitus anterior (1-2), base of cubitus (3-4), auxillary (1-3) and radio-medial cross vein. Costa is represented by C and represents the rib portion, subcosta is represented by Sc and is found below the rib portion, radius is represented by R representing the forearm region, media is represented by M which represents the middle portion, cubitus is represented by Cu, which represents the elbow region and anal veins is represented by A, which represents the posterior position. All these are the main longitudinal veins found from the anterior margin towards the posterior margin of the wing.

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KEY WORDS: Hind wings, Mexican beetle, vein coordinates, costa, sub costa

INTRODUCTION

Parthenium hysterophorus is an internationally, widespread, hazardous weed and it has an exclusive host called *Zygogramma bicolorata* Pallister 1953 (Coleoptera, Chrysomelidae), known as Parthenium beetle or Mexican beetle (Jayanth, 1987). The origin

of the beetles goes back to Mexico. It is a small beetle comprising of a brown coloured head, yellow coloured graduated pronotum and has yellow or cream coloured elytra marked with long brown stripes which also happens to be a its characteristic feature (Mehta and Raghuraman, 2019). This beetle has been named as *Zygogramma bicolorata*

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by Pallister in 1953. It is host specific and is an exclusive feeder of *P. hysterophorus* (Tripathi and Tripathi, 2021) and can be used as an effective bio control agent against *P. hysterophorus*.

Wings of any insect play a crucial role in their identification, differentiation from other insects and studying about the characteristic features. The hind wing of *Z. bicolorata* is also known as the flight wing as it is mainly used by the beetle for flight mode. It is found in pairs below the elytra (forewings) which are hard coverings and provide protection to the hind wings and abdomen region of the beetle. The sub coastal and coastal veins present in the hind wings of *Z. bicolorata* appear as dark brown, the red coloured markings when observed. The hind wing is divided into two parts proximal and distal. Proximal parts represent the anterior portion of the wing and distal part represents the posterior portion of the wing. The wing is also divided into three margins which are as follows Anterior margin which is known as Costal margin which lies on the front side, Apex is called the Apical margin which is found at the edge pr pointed end of the wing and Posterior margin which is also known as the Anal margin and is found at back side. Variation in the venation pattern helps to study the evolution and life-cycle parameters of the insect with respect to its environment. Wing venation not only provides the basic structural framework to the wings, but also helps in circulation, gaseous exchange, navigator help and sensory aid to the body of the beetle.

MATERIALS AND METHODS

Parthenium beetle is widely available in India during the months of July to October. It has a characteristic identifying feature elytra, which are forewings modified into hard protective outgrowths and is creamish in appearance with prominent deep brown markings. The study area is Dehradun District of Uttarakhand state of India. It is a valley region surrounded by the Himalayan foothills. It is situated between 30° 01'N and 31° 2'N latitude and 77° 34'E and 78° 18'E longitude. The identification of the beetle was done from the department of entomology at Forest Research Institute, Dehradun by Dr. Arvind Kumar.

Three beetles were collected from each of the selected sites (Garhi Cantt, Kaulagarh, Raipur, Rajpur, Doiwala, Sahastradhara, Prem Nagar, Jamunwala, Anarwala and Jhajra) all over Dehradun region and labelled separately. Cotton plugs dipped in 30 percent absolute alcohol are used to kill the collected beetles. After being killed, the beetles were dissected using needle and forceps. Hind wings were gently removed using forceps and placed on a slide. As a fixative, Canada Balsam was used. The slides were observed under stereo zoom microscope. Pictures of high resolution were captured using Nikon D5600 camera. Coloured images of the hind wings are then scanned to study the venation system (Ren *et al.*, 2017; Sun and Bhushan, 2012; Bethoux, 2005). The entire experimental work was done at the Department of Zoology, Shri Guru Ram Rai University, Dehradun, Uttarakhand.

RESULTS AND DISCUSSION

The hind wings or flight wings comprise of three margins, namely, anterior margin, posterior margin and apex (Fig. 2). Anterior margin is also known as coastal margin. Coastal margins present on the first or front side of the wings. Apex or apical margin is found at the pointed end of the wing while the posterior margin is found towards the backside of the wing. Posterior margin is also known as the anal margin. Margins of insect wings are basically edges which give shape to the structure and interior margin or coastal margin is primarily the leading edge of the wings. As the insect flies, the leading part of the wings forms the coastal margin. Apical margin or apex forms the edge of the wing or the outermost part at the tip of the wing. Anal margin, also known as posterior margin is the part of the wing, which lies closest to the insects' body. The venation system of *Z. bicolorata* (Fig. 1, Table 1) comprises of an intense network of veins, comprising of Costa, represented by "C", sub costa anterior represented by "ScA", sub costa represented by "Sc", radius represented by "R", radius basal represented by "RB", radius anterior represented by "RA", sub costa posterior represented by "ScP", radius posterior represented by "RP", radius (2-3) represented by R(R2-R3),

Table 1. Abbreviations used in Fig. 1

Symbol	Vein name
C	Costa
ScA	Subcosta Anterior
Sc	Subcosta
R	Radius
RB	Radius Basal
RA	Radius Anterior
ScP	Subcosta Posterior
RP	Radius Posterior
R(R2-R3)	Radius (2-3)
R(R4-R5)	Radius (4-5)
Ma (Ma1-Ma2)	Media Anterior (1-2)
Mp(Mp1-Mp2)	Media Posterior (1-2)
Mp(Mp3-Mp4)	Media Posterior (3-4)
M	Medial
Cu	Cubital
CuA (CuA1-CuA2)	Cubitus Anterior (1-2)
CuB (CuB3-CuB4)	Base of Cubitus (3-4)
A (A1-A3)	Auxillary (1-3)
Rp-Mp	Radio-Medial cross vein

radius (4-5) represented by R(R4-R5), media anterior (1-2) represented by Ma(Ma1-Ma2), media posterior (1-2) represented by Ma(Ma1-Ma2), media posterior (3-4) represented by Mp(Mp3-Mp4), medial represented by “M”, cubital represented by “C”, cubitus anterior (1-2) Represented by CuA (CuA1 - CuA2), Base of cubitus (3-4) represented by CuB (CuB3-CuB4), auxillary (1-3) represented by A(A1-A3) and radio medial cross vein represented by (Rp-Mp). The wings venation of *Z. bicolorata* is analysed in two portions. The veins have been depicted via Numbers ranging from 1 to 36 (Fig. 3, Table 2, 3). The veins lying in the proximal part are as follows, 1 representing humeral plate’s proximal anterior point, 2 representing Costa and sub Costa’s crossing point, 3 representing sub Costa bifurcating into sub costa anterior and sub costa posterior, 4 representing crossing point of sub Costa posterior and radius anterior, 6 representing crossing

point radio medial cross vein and radius anterior, 23 representing anterior point of media cubital, cross vein , 24 representing crossing point of radio medial Cross vein and media posterior, 26 representing posterior point of media cubital cross vein, 27 representing point of anal anterior bifurcation, 28 representing point of anal anterior (1+2) almost joining with cubitus anterior (3+4), 29 representing anal anterior (3+4)’s posterior point, 30 representing medial Cross vein , 31 representing posterior part of anal anterior (1+2), 32 representing cubitus anterior (1+2) and media posterior 4’s anterior point, 33 representing medial cross vein’s distal point, 34 representing cubitus anterior (1+2) and media posterior 4’s posterior point, 35 representing anal posterior (3+4)’s base point and 36 representing posterior point of anal posterior (3+4). The veins lying in the distal part of the wing are as follows, 5 representing crossing point of sub costa anterior and radius anterior, 7 representing radial cell’s proximal anterior point, 8 representing radial cell’s distal anterior point, 9 representing radial cell’s distal posterior point, 10 representing radial Cross vein 4’s anterior point , 11 representing radial cell’s proximal posterior point, 12 representing radial Cross vein 3’s proximal point, 13 representing apical hinge point, 14 representing anterior point of triangular area of radial cells’ distal side, 15 representing posterior point of triangular area of radial cells’ distal side, 16 representing proximal point triangular area of radial cells’ distal side, 17 representing distal point of radius anterior four, 18 representing distal point of radius anterior one, 19 representing distal point of radius posterior two, 20 representing point of medial posterior (1+2) bifurcation, 22 representing proximal point of radial posterior and 25 representing posterior point of medial spur.

Ren *et al.* (2017), studied about the geometric morphometrics of flight wings (hind wings) found in leaf beetles. Sun and Bhushan (2012) analysed the mechanical and structural properties of beetle wings and how they aid in flight. Bethoux (2005) studied about the wing venation system of Plecoptera order and analysed their hind wings in detail. The analysis on the wing venation of hind wing of *Z. bicolorata* in all the samples collected throughout the region of Dehradun indicated as that

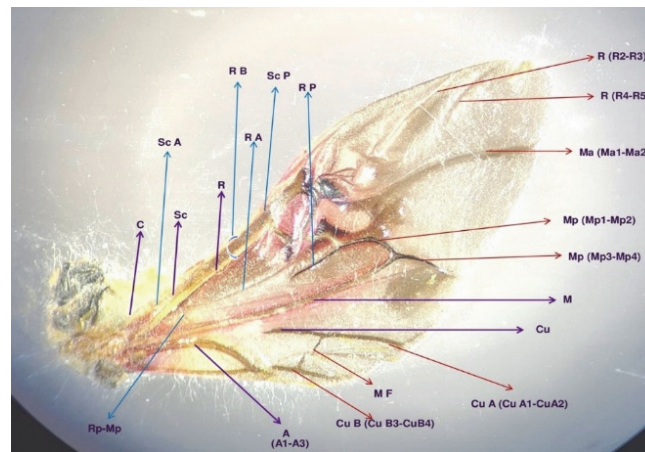


Fig. 1 Morphometric parameters studied in wing venation of *Z. bicolorata*

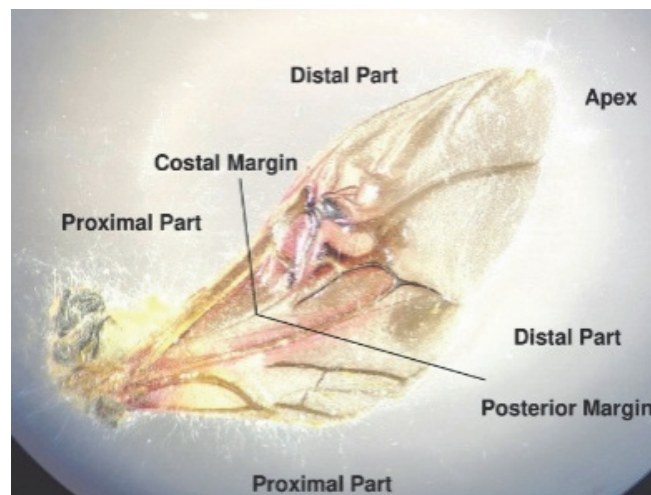


Fig. 2 Different regions in the wing venation of *Z. bicolorata*

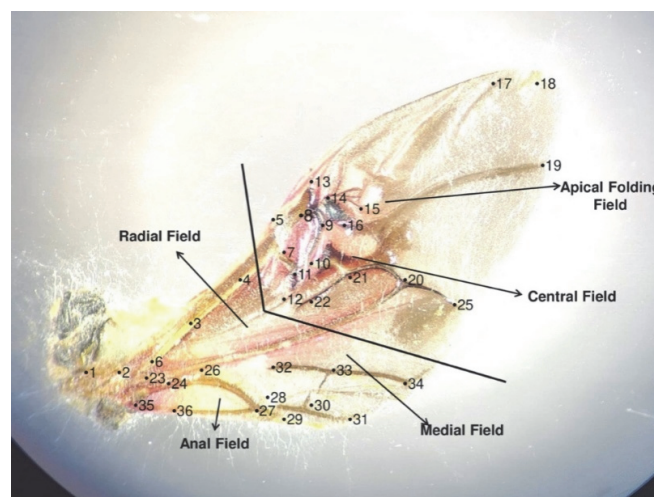


Fig. 3 Geometric morphometric analysis of wing venation of *Z. bicolorata*

Table 2. Description of vein coordinates marked in Fig. 3 veins in proximal part of the wing

coordinates	Vein
1	Humeral plate's proximal anterior point
2	costa and subcosta crossing point
3	Subcosta bifurcating into subcosta anterior and subcosta posterior
4	Crossing point of subcosta posterior and radius anterior
5	Crossing point of subcosta anterior and radius anterior
6	Crossing point of radiomedial cross vein and radius anterior
7	Radial cell's proximal anterior point
8	Radial cell's distal anterior point
9	Radial cell's distal posterior point
10	Radial cross vein 4's anterior point
11	Radial cell's proximal posterior point
12	Radial cross vein 3's proximal point
13	Apical hinge point
14	Anterior point of triangular area of radial cell's distal side
15	Posterior point of triangular area of radial cell's distal side
16	Proximal point of triangular area of radial cell's distal side
17	Distal point of radius anterior 4
18	Distal point of radius anterior 1
19	Distal point of radius posterior 2
20	Point of medial posterior (1+2) bifurcation
21	Posterior point of radial cross vein 4
22	Proximal point of radial posterior
23	Anterior point of media-cubital cross vein
24	Crossing point of radio-medial cross vein and media posterior
25	Posterior point of medial spur
26	Posterior point of media-cubital cross vein
27	Point of anal anterior bifurcation
28	Point of anal anterior (1+2) almost joining cubitus anterior (3+4)
29	Anal anterior (3+4)'s posterior point
30	Medial cross vein

31	Posterior point of anal anterior (1+2)
32	Cubitus anterior (1+2)'s anterior point of and media posterior 4
33	Medial cross vein's distal point
34	Cubitus anterior (1+2)'s posterior point and media posterior 4
35	Anal posterior (3+4)'s base point
36	Anal posterior (3+4)'s posterior point

all of them belonged to the same species *Z.bicolorata*. The study of hind wings of *Zygogramma bicolorata* has been done in accordance with the Comstock- Needham system (Comstock and Needham, 1898; Fraser, 1938). Similar studies have been done on the wing venation of other insects. Rattanawanee *et al.* (2010) and Hadis Gomeh *et al.* (2016) did a comparative study on honey bees by comparing different morphometric methods to differentiate between them in a given population. Namgung *et al.* (2022) analysed the wings of aphids by studying their morphometric features. Analysis of butterflies wing venation was done by Patil and Magdum (2017) in Gujrat region of India. Wahid *et al.* (2023) also studied about the morphology of butterfly wings belonging to the genus *Graphium*. Another remarkable study on the wing venation and shape of Diptera insects was done by Belyaev and Farisenkov (2019). Hind wings of *Plesispa reichei*, beetle found on coconut leaves were also studied by Manseguias *et al.* (2015). The wing venation of mosquito was also studied by Zhou *et al.* (1985) using their digitalized pictures and studied about their veins in detail. Understanding of the venation system is crucial in learning about the structural aspects of the hind wing.

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