Article

Morphology of the thoracic integument and appendages of adult *Deudorix isocrates* (Fab.)(Lepidoptera: Lycaenidae)

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Abstract

Deudorix isocrates (Fab.) is a serious pest of pomegranate causing remarkable economic loss and reported from most of the pomegranate growing countries. This pest is not morphologically studied in detail. The present study describes morphology of adult thorax on the basis of general and light microscopic observations. The thoracic integument of terga, pleura and sterna is subdivided in to various areas and sclerites due to different sutures. The prothoracic tergum has median bridge, anterior and posterior pronotal sclerite with their species specific shapes while from mesothoracic and metathoracic terga each one is divided in to prescutum, scutum and scutellum due to prescutum and scutoscutellar sutures. The integument of thoracic pleuron bears double basalare and subalare pleurites in dorsal membranous part while the pleural and precoxal sutures divide the ventral sclerotized part in to preepisternum, preepimeron. The anepisternum is disappeared in both the meso and metathoracic pleuron. The thoracic sterna shows basisternum, furcasternum, spina sternum and midventral suture with characteristic shapes and segment wise arrangement from prothorax to the posterior border of metathoracic sternum. The wings have species specific features of type and pattern of scales offer distinguishing characters for perfect identification of this pest, sexual dimorphism and classification of lycaenids. The reduced, single segmented tarsus without pretarsus of male prothoracic leg serves as sexual dimorphic feature in this species. Results of the present study add morphological understanding of adult thorax which is useful in further studies in endoskeleton anatomy, taxonomy and pest management.

Keywords *Deudorix isocrates*; pest; thoracic integument; thoracic appendage; morphology.

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1 Introduction

The morphological study of developmental stages including adult is significant to understand their metamorphic development, external key characters for perfect identification of the pests which is the fundamental need in pest management. Most cultivated plants are damaged and attacked by lepidopteran pests.

Lepidoptera is the second most diverse group of insect pests after Coleoptera (Rose and Singh, 2010). *Deudorix isocrates* (Fab.) Lepidoptera, Lycaenidae is a serious pest of pomegranate causing more than 50% yield loss (Balikai et al., 2011) and is, in fact, a polyphagous pest attacking a wide range of host plants, including anola, guava, citrus, litchi, peach, pear, apple, ber, tamarind and sapota (Atwal, 1976; Shevale, 1997; Khan, 2016; Arya and Dubey, 2017; Khandare et al., 2018; Devi et al., 2021). *D. isocrates* has been studied for a long time in terms of bio-ecological aspects and its management. During these studies few workers (Khan, 2016; Kumar et al., 2017; Chhetry et al., 2015) have reported very scanty information regarding general morphological features of this pest. The present study describes the detailed morphology of the thoracic region of adult *D.isocrates*. The morphology of the thoracic integument and appendages is important in taxonomic study because besides the appendages some integumental sclerites have been used to diagnose some families, as well as in the classification of Lepidoptera in general (Niculescu, 1978; Carneiro et al., 2013). The purpose of this study is to offer thorough thoracic morphology which will helpful to find morphological key characters for perfect identification of this pest, in taxonomic study of lepidopteran species and to study endoskeletal anatomy of *D. isocrates*.

2 Materials and Methods

The adults obtained by rearing the pupae of *D. isocrates* in the laboratory. The enclosed adults were preserved with dry preservation method while some were preserved in 10% formalin. The dry preserved specimens were used to describe general morphological features and body organizations whereas formalin preserved specimens were used to prepare permanent mounting of various parts of thorax to study their microscopic details. The preserved specimens were rinsed in distilled water, dissected to separate thoracic region and appendages and boiled in 10% KOH to make it translucent. The scales were removed by camel hairbrush and material was again rinsed in distilled water. Dehydration of the biological material was carried out using ascending grades (30%, 50%, 70%, 90% and 100%) of ethanol, cleared in xylene and mounted in DPX. The permanent mounting preparations were used to study microscopic morphological details using a light microscope. Camera Lucida and Micrometry were used to create the illustrations.

3 Results

3.1 General morphology

The thoracic region of the adult *D. isocrates* revealed characteristic pattern of scales and the sexual dimorphic features. Including prothoracic, mesothoracic and metathoracic segment the thorax bears three pairs of locomotary appendages and two pairs of wings. The thorax articulated to the head through the concealed cervix. The prothoracic segment is not visible distinctly from dorsal view due to its small size. It is densely clothed with brown scales. The mesothoracic region is distinct. The mesothoracic scutum is elevated dorsally. At the wing bases, laterally dark gray hairy scales cover the lateral margins of the mesothoracic tergum. The metathoracic tergum is relatively small and follows low contour than that of the mesothoracic tergum. Laterally distributed scales are similar to that of mesothoracic tergum. The thoracic pleura and sterna of all the segments are densely clothed with white scales.

The forewings of female (Fig. 1a) are dorsally clothed with dark brown scales. With changing the planes the dorsal surface of wings appears iridescent coppery blue. On dorsal surface of forewing the orange scales are localized to apically widen rectangular patch. The hind wings of female are also dark brown; however orange coloured scales are distributed sub marginally along the apical region of the wing. In the posterior part of hind wing there is an eyespot with black scales. It is encircled with a ring of orange scales. There is one more, small circular patch of light sky blue scales situated posterior to the eyespot. Posterior to Cu2, the wing

membrane is produced into a thin, delicate, tail like prolongation. It is clothed with black scales and white scales at the tip. The tornus of hindwing produced into a round lobe; the tornal lobe. The tornal lobe is clothed with black scales and white scales on peripheral edge. Ventrally, the forewings and hind wings are pale gray with intricate pattern of wavy dark brown and white streaks. The wingspan of female is larger than that of the male. The wingspan of female is 43.25 mm. It ranges between 32 mm and 50 mm (n = 10). In case of male, dorsally the forewings and hindwings are clothed with brown scales, which are much darker than that of the female. The orange scales are not present in case of fore and hind wings of the male (Fig. 1b). However, in eyespot of hind wing there is indistinct ring of orange scales. The ventral surface of fore wing of male is not different than that of the female. The wing span of male is 35.95 mm. It ranges between 30.5 mm and 42 mm (n = 10).

Three pairs of thoracic legs are articulated, one pair in each segment. The legs are clothed with white scales. The posterior edge of femur is clothed with white, much longer hairy scales. Morphologically, all the legs are similar in both the sexes except prothoracic legs of male. The prothoracic leg of male bears single, elongated tarsus without claws.

3.2 Microscopic morphological details

The thoracic segments are highly sclerotized. A number of sutures divide the terga, pleura and sterna of the thoracic segments.

The prothoracic tergum (Fig. 2) is divided into three sclerites: the median bridge, anterior pronotal sclerite and the posterior pronotal sclerite. The median bridge is situated dorsomedially, on the anterior edge of prothoracic collar. The prothoracic collar is composed of median bridge, anterior pleuron and a part of basisternum. The median bridge supports the prothoracic collar. The anterior pronotal sclerite is ‘T’ shaped structure. Its two transverse arms extend sideways over the prothoracic tergum whereas its slender single arm anteriorly rests on the median bridge. The anterior region of the anterior pronotal sclerite fuses with the median bridge. The posterior pronotal sclerite is roughly triangular plate, along with its median axis there is an incomplete unpigmented strip runs anterioposteriorly. The posterior apex of posterior pronotal plate is extended up to prescutum of the mesothoracic tergum. The anteriolateral parts adjoin to dorsolateral ends of anterior pronotal sclerite. The patagia are erected membranous lobes. They fuse with the base of the median bridge dorsally and prothoracic pleuron on ventral side.

The mesothoracic tergum (Fig. 2) has a number of sutures hence; it is differentiated into various sclerites. From anterior to posterior the mesothoracic tergum shows prescutum, scutum and scutellum. The prescutum is a small, transverse sclerite. It is not visible from dorsal view. The scutum lies posterior to the prescutum. The scutum is curved dorsally and attains highest contour of the mesothoracic tergum. Anteriorly, lateral to the scutum there is a Tegula which is laterally flattened elongated plate. The proximal portion of tegula is wider with curved edge. Distally the tegula tapers gradually and bluntly pointed. The tegula is completely clothed by scales. Posterior to the tegula the lateral margins of scutum are produced into well sclerotized processes, which are associated with articulation of forewing. According to their positions they are named as anterior notal wing process, median notal wing process and posterior notal wing process. The median notal wing process is conspicuous whereas the posterior notal wing process is slender arm like extension. The posterior part of scutum has the scutoscutellar suture which differentiates the scutum from scutellum. The scutellum is roughly triangular and convex. The lateral margins of scutellum give rise to thick, membranous axillary cord. The posterior notal wing process and the axillary cord run parallel to each other for some distance.

The metathoracic tergum (Fig. 2) is remarkably occupied by the scutum. The scutum appears like two dorsally elevated halves. The lateral margin of metathoracic scutum is produced anteriorly into anterior notal wing process and posteriorly into the posterior notal wing process. The posterior notal wing process is well

developed. It is sclerotized arm like structure, directed anteriorwards. Posterior to the scutum the metathoracic tergum is differentiated in to scutellum as a transverse plate. From the basal part of the scutellum arises an axillary cord on either side.

Fig.1 a) Fig. 1 b)

Fig. 1 Dorsal view of adult. Female (a) and Male (b) of *D. isocrates.*

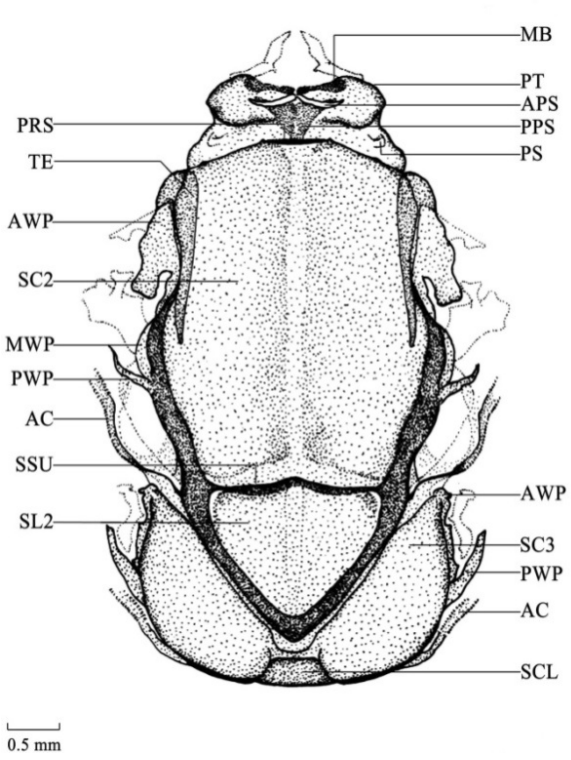


Fig. 2 Dorsal view of thoracic terga of adult *D.isocrates.* AC: Axillary cord, APS: Anterior pronotalsclerite, AWP: Anterior notal wing process, MB: Median bridge, MWP: Mediannotal wing process, PPS: Posterior pronotalsclerite, PRS: prescutum, PS: prothoracic spiracle, PT: Patagium, PWP: Posterior notal wing process, SC2: Mesothoracic scutum, SC3: Metathoracic scutum, SCL: Scutellum, SL2: Mesothoracic scutellum, SSU: Scutoscutellarsuture, TE: Tegula.

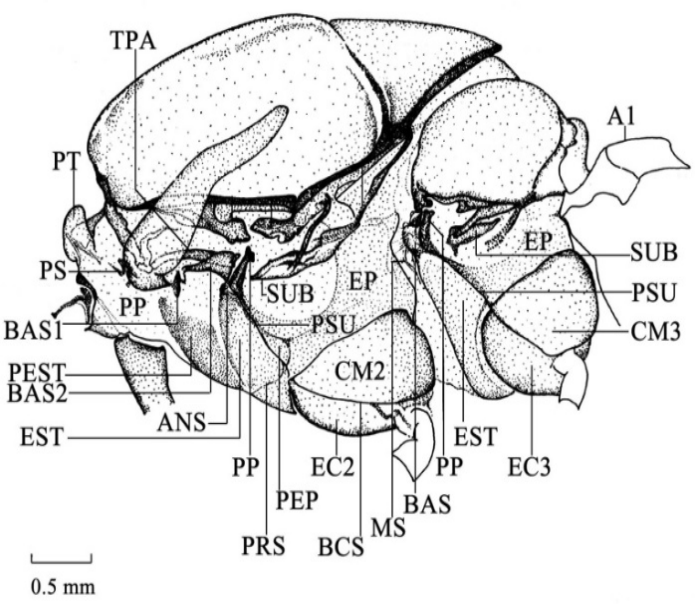


Fig. 3 Lateral view of thorax (appendages are removed) showing thoracic pleura of adult *D. isocrates.* A1: First abdominal segment, ANS: Anepisternalsuture, BAS: Basalare of metathorax,BAS1: First basalare of mesothorax, BAS2: Second basalare of mesothorax, BCS: Basicostal suture,CM2: Coxomeron of mesothoracic leg, CM3: Coxomeron of metathoracic leg, EC2: Eucoxa of mesothoracic leg, EC3: Eucoxa of metathoracicleg, EP: Epimeron, EST: Episternum, MS: Mesothoracicspiracle, PEP: Preepimeron, PEST: Preepisternum, PP: Pleural process, PS: Prothoracic spiracle, PT: Patagium, PRS: Precoxalsuture, PSU: Pleural suture, SUB: Subalare, TPA: Tergopleuralapodeme.

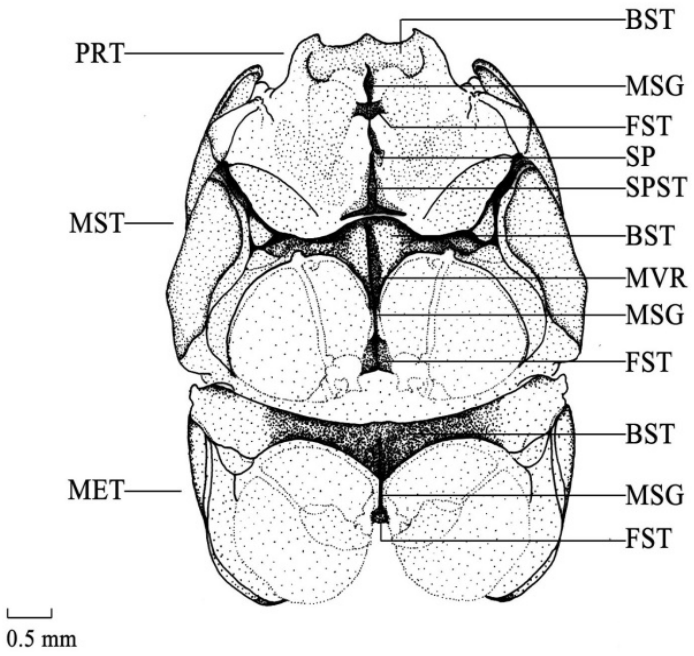


Fig. 4 Ventral view of thorax (appendages are removed) showing thoracic sterna of adult *D. isocrates.* BST: Basisternum, FST: Furcasternum, MET: Metathorax, MSG: Median sternal groove, MST: Mesothorax, MVR: Midventralridge, PRT: Prothorax, SP: Spina, SPST: Spinasternum.

The prothoracic pleuron (Fig. 3) is completely membranous. It is obliquely folded. The prothoracic spiracle is situated in this fold and concealed under the base of tegula. The pleural suture extends from median bridge of prothoracic collar to the base of the coxa of 1st thoracic appendage. The part of pleuron, which is anterior to pleural suture; the episternum is continued with poorly sclerotized basisternum.

The mesothoracic pleuron (Fig. 3) is membranous dorsally while ventrally it exhibits different sutures and sclerites. The membranous dorsal region of the mesothoracic pleuron divides in to basalare membrane, which lies anterior to the wing process and the subalare membrane lies posterior to the wing process. There are distinct sclerites commonly called as epipleurites situated in these regions. The epipleurite localized in basalare region is the basalare. Similarly the epipleurite situated in subalare membrane is the subalare. There are two basalare sclerites. The first basalare is small, vertical sclerotized plate. It is connected to the anteriorly projected apex of second basalare. The second basalare is triangular sclerite. Its posterior wider portion is adjacent to the pleural ridge. In subalare membrane there is a conspicuous, spatula like subalare. It projects towards the pleural process. Anteriorly the subalare on dorsal surface has a lengthwise wide depression. In between basalare and the subalare there is awell sclerotized arm like tergopleural apodeme (‘tegular arm’ by Nuesch, 1953; Richards and Davies, 1977) projects from pleural process and runs anterior to the second basalare. The ventral sclerotized part of mesothoracic pleuron is divided into anterior episternum and posterior epimeron due to the pleural suture. The pleural suture traverses the mesopleuron vertically from pleural wing process up to the coxa of the 2nd thoracic appendage. The episternum shows two sutures: the anepisternal suture and precoxal sutures which further divides the episternum. The anepisternal suture arises anterior to the dorsal bent of the pleural sutureand divides the episternum in to dorsal unsclerotized anepisternum and ventral sclerotized preepisternum. In *D. isocrates* the anepisternal sclerite is disappeared due to lack of sclerotization. Thus the episternum lies posterior to the preepisternum. The precoxal suture arises from the ventral portion of pleural suture. It arises after a short distance dorsal to the coxa and runs towards the anterior margin of basisternum. Like to the episternum, the epimeron is also subdivided into two parts, the preepimeron and the epimeron. There is a suture sets from the bent of pleural suture and runs posteriorly; aftertaking smooth turn it merges in to pleural suture again. The area enclosed by this suture is the preepimeron. The epimeron lies posterior to the preepimeron.

The metathoracic pleuron (Fig. 3) dorsally shows the basalare (basalar pad; Shepard, 1930) which is situated anterioventral to the pleural process. It is present in the form of round swelling. The basalare bears numerous, uniformly distributed short, sharply pointed translucent hair. The majorportion of pleuron lies posterior to pleural ridge is membranous which is referred as the subalare membrane. There is a subalare situated in subalare membrane. The subalare is well sclerotized plate, which widens at its anterior portion.Ventral sclerotized portion of metapleuron is divided in to epistemum and epimeron, which lies anterior and posterior to the pleural suture, respectively. There is a mesothoracic spiracle situated in the membrane between mesothoracic epimeron and metathoracic episternum. Particularly, the spiracle is placed adjacent to the anterior basalare.

The sternum of prothorax (Fig. 4) includes the basisternum and furcasternum. The basisternum is anteriorly involved in prothoracic collar. The furcasternum is comparatively highly sclerotized region. Internally it bears an endosternal apodeme; the furca. Internally, there is a median ridge, which runs from base of furca up to the basisternum. The median ridge is externally marked by dark brown median sternal groove (‘mid ventral suture’ by Shepard, 1930). Anterioposteriorly, the sternum of the mesothoracic segment (Fig. 4) consists of sequentially located spinasternum, basisternum and furcasternum. Spinasternum is highly sclerotized “T’ shaped plate situated along median axis of sternum. Its single arm is directed anteriorly, internally it bears a spina. The lateral arms are not deeply forked and appear as the horizontal arm of “T’ which

rest along anterior border of basisternum. The spinasternum is followed by basisternum. Comparatively it is large transversely placed, sclerotized plate. It has posteriorly directed blunt apex on central axis. Posterior to the basisternite is the furcasternum. It is small sclerite placed in between coxae of 2nd thoracic legs. The furcasternum internally bears a conspicuous fork; the furca. Similarly, a median ridge extends anteriorly from furcasternum up to basisternum. The median ridge is externally marked by median sternal groove.

The metathoracic sternum (Fig. 4) consists of basisternum and furcasternum. The basisternum is wider and arranged transversely. The furcasternum lies posterior to the basisternum. Internally, the furcasternum bears a furca. The median ridge arises from the base of furca and runs anterior up to the basisternum. Externally, the median ridge is marked by median sternal groove.

Thoracic appendages include dorsally situated two pairs of wings and ventrally situated three pairs of thoracic legs.

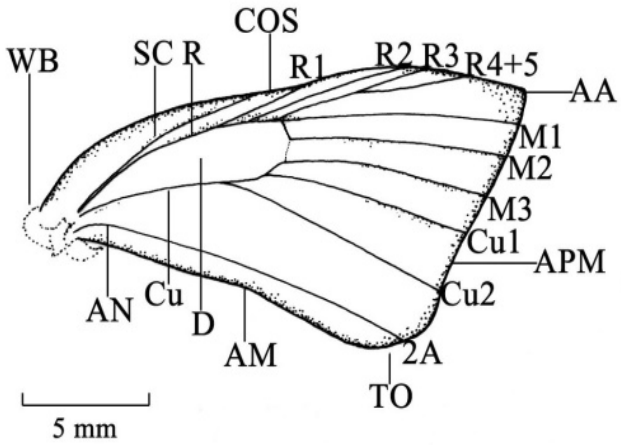


Fig. 5a

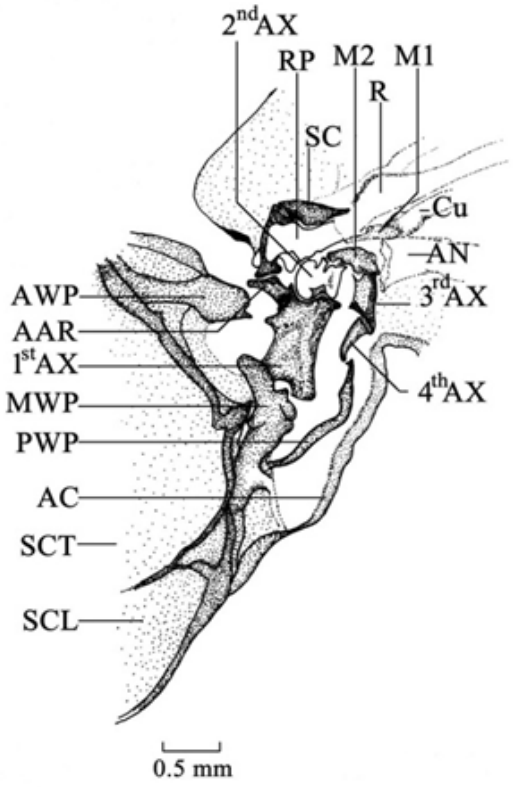


Fig. 5b

Fig. 5 Whole mounts of forewing (a) and forewing base (b) of *D. isocrates.* AA: Apical angle, AN: Anal vein, APM: Apical margin, 2A: 2nd anal vein, AM: Anal margin, AAR: Anterior arm of 1staxillary, AC: Axillary cord, 1stAX: First axillary, 2ndAX: Second axillary, 3rdAX: Third axillary, 4thAX: Fourth axillary, AWP: Anteriornotal wing process, COS: Costal margin, Cu, Cu1, Cu2: Cubitalbranches, D: Discal cell, M1, M2, M3: Branches of median vein, MWP: Median notal wing process, PWP: Posterior notal wing process, R, R1, R2, R3, R4+5: Branches of radial vein, RP: Radial plate, Sc: Subcosta, SCL: Mesothoracicscutellum, SCT: Mesothoracicscutum, WB: Wingbase

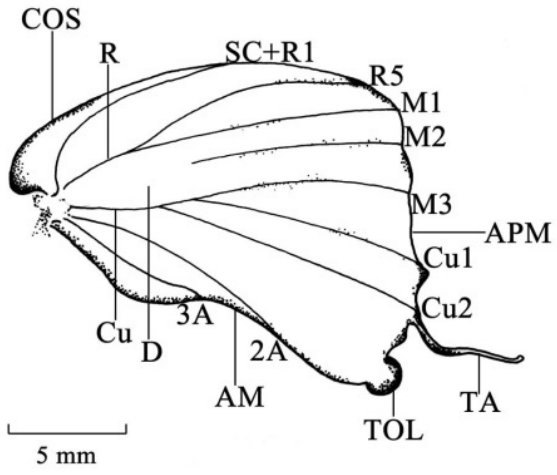


Fig. 6a

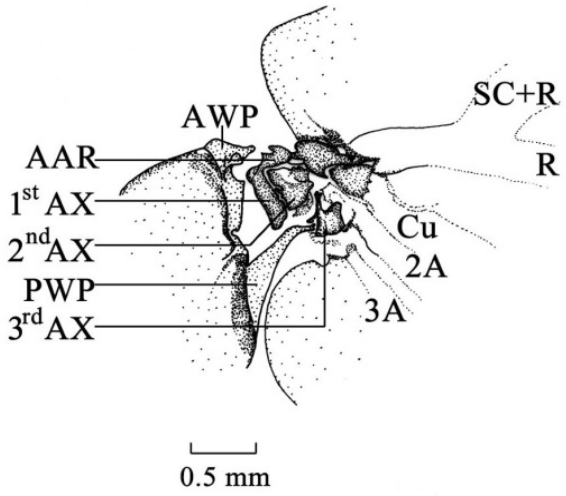


Fig. 6b

Fig. 6 Whole mounts of hindwing (a) and hindwing base (b) of *D. isocrates.* 2A, 3A: Branches of anal vein, AAR: Anterior arm of first axillary, APM: Apical margin, AWP: Anterior notal wing process, 1st AX: First axillary, 2nd AX: Second axillary, 3rd AX: Third axillary, COS: Costal margin ,Cu, CU1, Cu2: Branches of cubitalvein D: Discal cell, M1, M2, M3: Branches of median vein, PWP: Posterior notal wing process, R, R5: Branches of radial vein, Sc+R1: Fused subcostal and radial vein, TA: Analtail, TOL: Tornal lobe.

Two pairs of wings: the fore wings and the hind wings are articulated dorsolateral to meso and metathoracic segments. Roughly triangular forewing (Fig. 5a) along withits costal margin, apical margin and anal margin bears the apical angle, the tornusand the humeral angle. The number of transverse as well as cross veins has been minimized in the fore wing. The subcosta is free from discal cell and lies between discal cell and the costa. Radius is branched in to R1, R2, R3 and R4+R5. The basal portion of media is atrophied, which result into formation of discal cell at the central portion of wing. The M1 is stalked with radius while M2 arises from the middle of the apex of the discal cell. Thus the cubitus forming the posterior side of discal cell appears branched. These branches are M3, Cu1 and Cu2. 1A is atrophied in the fore wing. The fore wing is articulated to mesothorax. It is facilitated by anterior notal wing process, median notal wing process and posterior notal wing process. The fore wing base (Fig. 5b) exhibits a number of sclerites, like first axillary, second axillary, third axillary, radial plate, first median plate and second median plate.

The hind wing (Fig. 6a) is peculiar for sharply arched costa at the humeral angle, tail and tornal lobes at the posterior part. The apical angle is much wider. The apical margin runs posteriorwards with zigzag pattern and bears a tail like prolongation a bit anterior to anal angle or tornal lobe. In general number of wing veins of the hindwing is also reduced. The Sc + R1 and R are fused at the base of wing. The basal portion of media is atrophied which result in to formation of discal cell at the central portion of wing. M2 arises from middle of the apex of discal cell. The cubitus forming the posterior side of discal cell appears three branched. These branches are M3, Cu1 and Cu2. 1A is atrophied while 2A and 3A are present.

The hind wing base (Fig. 6b) is simple as compared to that of the forewing. Anterioposteriorly the first axillary is elongated while proximodistally it is narrow. The distal part of first axillary produced into anterior arm. The anterior arm of first axillary slightly turned outward with roughly round end and associates with fused Sc + R and R. Second axillary is a single, Stout plate. It traverses the thickness of wing base and reaches on ventral surface of the wing. Lengthwise, to the first axillary, there is articulation between first axillary and

proximal edge of second axillary. The third axillary is simple. It is associated with anal veins. The third axillary articulates with posterior notal wing process where the third axillary passes over the ventral surface. The fourth axillary, which is seen in forewing, is not present in hind wing base. The wing base is delimited posteriorly by the axillary cord.

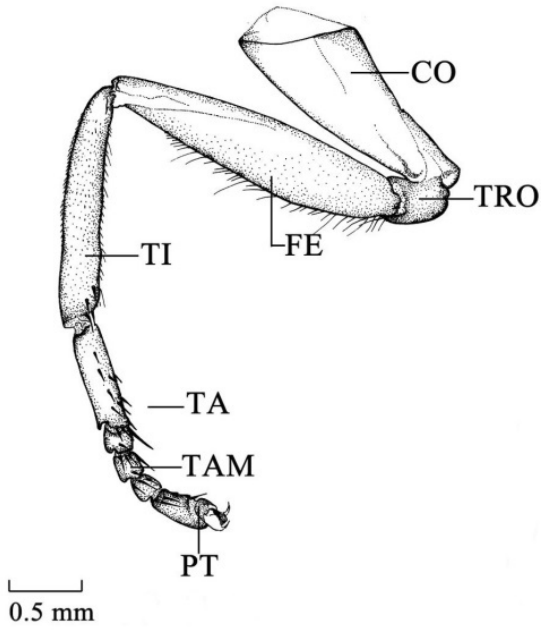


Fig. 7a

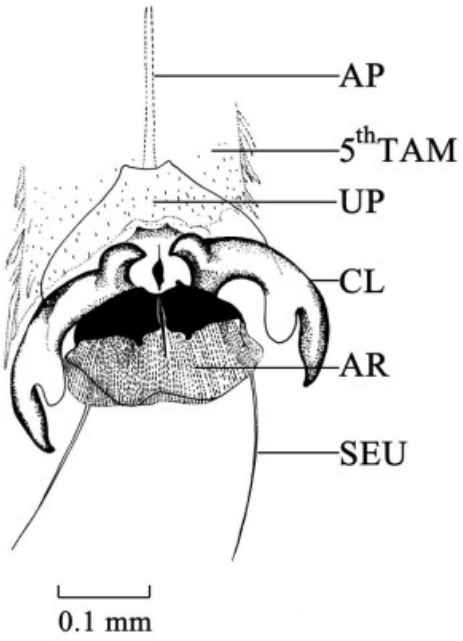
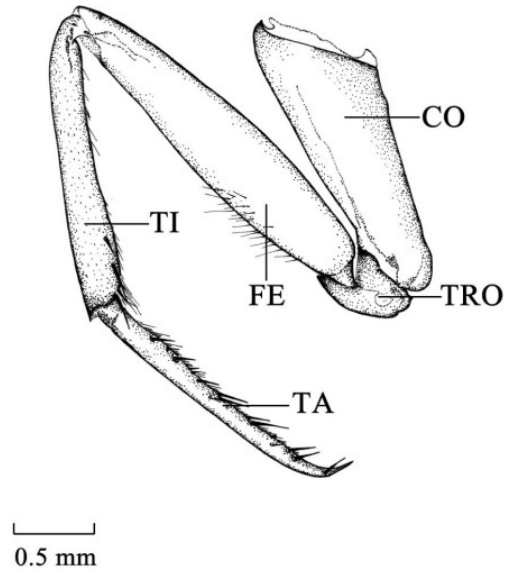


Fig. 7b

Fig. 7 Whole mounts of prothoracic leg of female (a) and magnified view of its pretarsus (b) of adult *D. isocrates.* AP: Apodeme, AR: Arolium, CO: Coxa, CL: Claw, FE: Femur, PT: Pretarsus, TA: Tarsus, TAM: Tarsomere, 5th TAM: Fifth tarsomere, TI: Tibia, TRO: Trochanter, SEU: Seta of unguifer, UP: Unguitracter plate.

Each thoracic leg is articulated to pleuron of the respective segment via coxa. The thoracic legs have usual segments such as coxa, trochanter, femur, tibia and the tarsus having five distinct tarsomeres. The coxae show basicostal suture which divides the coxa in to anterior eucoxa and posterior coxomeron (Fig. 3). In male *D.isocrates*, the prothoracic coxa is elongated, slender and without basicostal suture. Except prothoracic legs of male the distal most tarsomere bears the pretarsus (Fig. 7a and b) with a pair of equal sized claws and membranous arolium. The membranous fold like arolium is placed between the pair of claws. The dorsal wall of distal most tarsomere is extended as a sclerotized ungifer. There are two long setae like hair, which arise from unguifer and projecting much anterior to the claws and arolium. Proximal to the pretarsal elements like claws and arolium there is a wider plate which is extended in distal end of distal most tarsomere. This plate is the unguitractor plate. The tendon like apodeme arises on its proximal edge. In the male *D. isocrates* the prothoracic tarsus is reduced and without pretarsus (Fig. 8a and b). The prothoracic tibia in both the sexes bears a stout, sclerotized hair. The tibiae of meso and metathoracic legs have pair of long and stiff spurs at the distal tip. The spurs are completely clothed with white scales.



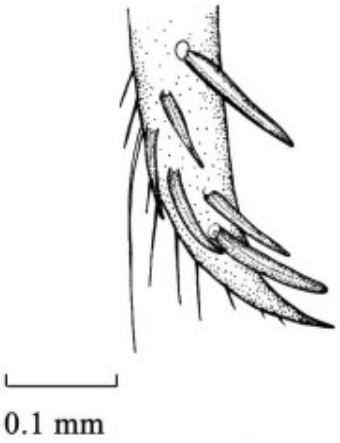


Fig. 8a Fig.8b

Fig. 8 Whole mounts of prothoracic leg of male (a) and magnified view of its pretarsus (b) of adult *D. isocrates.* CO: Coxa, FE: Femur, TA: Tarsus, TI: Tibia, TRO: Trochanter.

4 Discussion

The general morphology of thorax of adult *D. isocrates* provides some key features for perfect identification of this pest. Particularly, it includes the densely clothed forewings of female with dark brown iridescent coppery blue scales and remarkable rectangular patch of orange scales which widens towards the apical margin, black eyespot which is encircled with orange scale on the posterior part of hindwing, light sky blue circular patch adjacent to the eyespot, tornal lobe clothed with black scales and white scales on peripheral edge and posterior to Cu2, the wing membrane is produced into a thin, delicate, tail like prolongation of the hindwing. Some of these features, however not in detail have been reported earlier (Shevale, 1997; Kumar et al., 2017) during ecobiological and pest studies of this species. Besides the different pattern of scale in male and female, the large wing span in female (Chhetry etal.,2015) than that of the male, pale gray with intricate pattern of wavy dark brown and white streaks underside the forewing and hindwing are the species specific characters of *D. isocrates* reported in present study. The reduced, single segmented tarsus of the prothoracic leg of the male *D.isocrates* is the common lycaenid character (Brues et al., 1954; Borror and Delong, 1955; Richards and Davies, 1977).

Present study is the first report on microscopic details of the thoracic integument of adult *D. isocrates*. The reduced collar like prothorax (Richards and Davies, 1977) with patagia of this species is the common feature of the Rhopalocera (Talbot, 1939), Lycaenidae (Sorensen, 1980) and Riodinidae (Santos et al., 2016). Thepronotal sclerites: median bridge, anterior pronotal sclerite and posterior pronotal scleriteare similar to that present in *A. Albeolana* (Adamski and Michael, 1982) however, the shapes of sclerite vary. The basisternum and furca sternum (Snodgrass, 1935) forms the prothoracic sternum of *D. isocrates.* The mesothoracic tergum is typical in majority of lepidopteran insect. It consists of small, transverse prescutum, conspicuous, dominating scutum and rhomboidal scutellum (Richards and Davies, 1977; Bonfantii et al., 2015). The lateral sides of scutum develop into anterior and posterior notal wing processes in general insects (Snodgrass, 1935) and various families of the Lepidoptera (Richards and Davies, 1977; Queiroz-santos, 2018). There is also a

median notal wing process in Ditrysia (Sharplin, 1963). The tergal sclerites and processes in present study are similar to above said features with species specific size and shapes. The mesopleural features like pleural suture,disappeared anepisternum, presence of the preepisternum, preepimeron and precoxal suture, which connects with anterior margin of the basisternum in *D.isocrates* are similar to that reported in another lycaenid species; *H. hypophlaeas* (Shepard, 1930) and *G.lygdamus* (Soren, 1980). These features have also been reported in Geometridae (Liu et al., 2017) and other lepidopteran families. Presence of epipleurites like basalare and subalare is one of the important features of insect pleuron (Snodgrass, 1935). The present work revealeddouble basalare and the first basalare is completely detached from anepisternumsimilar to that present in *P. brassicae* (Sharplin, 1963). The presence of tergopleural apodeme in the basalare region is as a definitive and diagnostic character of the Lepidoptera (Sharplin, 1964). Sometimes the tergopleural apodeme is termed as tegular arm (Nuesch, 1953; Richard and Davis, 1977). In *D.isocrates* the tergopleural apodeme projects anteriorly from the pleural ridge in the mesothorax and terminates anteriodorsal to the basalar sclerite.

The mesosternum is divided in to basisternum, furcasternum and spina sternum where the spinasternum is present in majority of lepidopterous species including family Lycaenidae (Shepard, 1930, Sorensen, 1980). The median sternal groove (Snodgrass, 1935) runs anterioposteriorly along with the median axis of basisternum and furcasternum. These elements of mesosternum in *D. isocrates* show their presence with species specific shapes. The metathorax in *D. Isocrates* is relatively small and compressed as compared to mesothorax which is reported as a common lepidopterist feature (Richards and Davies, 1977). The metathoracic scutum looks like two divided lateral halves. This characteristic of metathoracic scutum is similar to that reported in Nymphalidae (Kawahara, 2012). In general, the tergal peculiarities in respect to notal sclerites, notal wing processes, axillary cords in *D. isocrates*, under present studies have been found similar to that in *S. purpurascens*, *A. populi* and *C. relicta* (Sharplin, 1963). In *D. isocrates* apart from episternum and epimeron of the metathoracic pleuron theepipleurites appeared very characteristic. The basalare is present in the form of anteriorly curved bulge bearing short, straight, translucent, sharply pointed hair. The basalare with the similar characteristics has been reported in other species of Lycaenidae and termed as basalar pad (Sorensen, 1980). The same has been illustrated in *H. hanno* (Duarte, 2007), and *Dynamine postverta* (Leite, 2013) from other lepidopteran families. The subalare is distinct plate, which is placed in dorsal membranous portion of pleuron, behind the pleural process. The divisions of metasternum in to basisternum, furcasternum are the typical sternites (Adamski and Michael, 1982) present in this thoracic segment. The median sternal suture is clearly marked in case of metasternum similar to the mesosternum.

The wings in Lepidoptera have taxonomic importance and also help in understanding the sexual dimorphism (Win, 2005). The slender tail of hind wing and forewing venation are used as taxonomic characters to distinguish Lycaenidae from others (Brues et al., 1954; Borror and Delong, 1955). The wing venation of *D. isocrates* is reported following that present in the genus *Lycaena* (Borror and Delong, 1955). The wing base structure including notal wing processes and axillaries in *D. isocrates*have been observed similar to that reported in papillionidae and higher ditrysian Lepidoptera (Sharplin, 1963).

The prothoracic legs in *D. isocrates* have reduced, single segmented tarsus without claws. These characters have been used as the taxonomic as well as sexual dimorphic character in earlier studies (Talbot, 1939; Borror and Delong, 1955). The conspicuous coxae of meso and metathoracic legs in both the sexes of *D. isocrates* have basic ostal suture, which subdivides the coxa into anterior, the eucoxa and posterior, the coxomeron (Shepard, 1930; Santos et al., 2016). It is a general lepidopteran character. The eucoxa and coxomeron are also termed as coxagenuina and the meron (Adamski and Michael, 1982), anterior coxagenuina and posterior coxa genuine (Soren, 1980), anterior eucoxa and posterior meron (Queiroz-santos, 2018). The present morphological description of thoracic integument and appendages provides key characters for perfect

identification and sexual dimorphism of *D. isocrates*. It is important in taxonomic study of lycaenids and Lepidoptera in general. This study also provides integumental details for the study of internal anatomy of this species.

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