MORPHOLOGY OF THE THORAX OF ARAEOPIDAE
(HOMOPTERA, FULGOROIDEA)

By

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The three species of Araeopidae (Delphacidae) included in the present study belong to two tribes, *viz.*, *Liburnia pallescens* (Distant), *Delphacodes propinqua* (Fieber) —tribe Delphacini—and *Purohita cervina* Distant—tribe Tropidocephalini, of the subfamily Araeopinae (Delphacinae) chosen especially to establish the relationship between these two tribes on the basis of their thorax.

There hardly exists any detailed account of the morphology of the thorax of araeopids except by Mathur and Joseph (1961). But workers like Myers (1928), Qadir and Aziz (1950) and Akbar (1957) have studied the morphology of the thorax of various bugs and others like Crampton (1909), Snodgrass (1909, 1935) and Martin (1916) etc. have dealt with the morphology of generalised insects.

The cervix :

In araeopids the cervix or neck is concealed beneath the overlapping anterior region of the pronotum dorsally as well as laterally. The anterior pair of cervical sclerites is obsolete in the insects under observation, this reduction can be correalted with the limited movements of the head. The posterior pair (Fig. 2, Cp) appears as small, sclerotised projections at the anterior margin of episterna of prothorax and touch the posterior margin of occipital foramen.

The prothorax :

Prothorax (Figs. 1, 2 and 3) is an independent segment, quite broad dorsally and narrow ventrally whose tergum, pleura and sternum are fused together. The tergopleural lines of fusion are distinct beneath the pronotum, but there are no traces of sternopleural lines.

The pronotum is collar-shaped and posteriorly roofs over the dorsal and lateral regions of mesothorax. Its anterior margin bears a thin ridge with which is attached the neck membrane. In *Purohita cervina* the lateral ends of pronotum are directed laterally whereas in the other two species they are facing ventrally. The pronotum is devoid of sutures unlike that of pterothoracic nota. It has three mediolongitudinal carinae or keels running from the anterior to the posterior margin. The keels are stout, highly developed and reach the hind margin in *Purohita cervina* but in *Liburnia pallescens* and *Delpacodes propinqua* the carinae are comparatively thin and only the median carina extends to the hind margin. The lateral carinae run divergently posterad and disappear before reaching the hind border. The lateral carinae gradually narrow down posteriorly in *Liburnia pallescnes* and *Delphacodes propinqua*, but in *Purohita cervina* they are almost of uniform thickness throughout their length.

The propleura and the prosternum are fused together to form the propectus occupying the ventral and ventrolateral regions of prothorax. The pleuron is

reduced and for a greater part is hidden beneath the laterally expanded region of the pronotum. The pleural region is membranised, especially that situated beneath the laterally projecting tergum. Along with this membranisation, the pleural suture becomes obsolete, but the pleural ridge is distinct which extends from the pleural articular process anteriorly and thus demarcating internally the pleural into the episternum and epimeron. The episternum bears at the anterior margin the posterior cervical apodeme and continues ventrally as a narorw sclerite, the precoxale, anterior to the coxal cavity to unite with the sternum. Similarly the epimeron joins with the sternum posterior to the coxal cavity by another narrow sclerite, the postcoxale. The leg is articulated medially to the pleural region by the pleural articular process. In addition to this, there is another anterolateral attachment by means of the trochantin, which is a small, distally tapering sclerite. It arises from the episternum where the two supracoxal arches meet or near the pleural ridge and curves round anteroventrally to articuate with the coxal rim. Internally the pleural ridge gives out the pleural apophylis, which is directed ventrally to meet with a corresponding apophysis to form the shoracic furca (Fig. 4). The prothoracic furca is smaller than the mesothoracic turca, but is much larger in proportion to the size of prothorax. It is more faterally orientated in *Purohita cervina* than in *Liburnia pallescens* and *Delphacodes* *propinqua* and is of uniform thickness throughout its length. In *Liburnia pallescens* and *Delphacodes propinqua* it is swollen medially and directed internally. The first spiracle is located laterally in the intersegmental membrane between the first and second thoracic segments roofed over by the laterally expanding protergum.

The prosternum is a narrow transversely elongated plate extending between the pleura. It is divided into two by a faint transverse sternacostal suture, bearing internally the sternacosta and dividing the sternum into an anterior basisternum and a posterior sternellum. The sternal apophyses arise from the lateral sides of the sternacosta and extend dorsolaterally to unite with the pleural apophyses.

The mesothorax :

The mesothorax (Figs. 1, 2 and 3) constitutes the largest part of the thorax. There are distinct tergopleural sutures separating the tergum from the pleura, but the pleural and sternal regions are fused to form a mesopectus.

The mesonotum is a large arched plate pointed both anteriorly as well as posteriorly and telescoped anteriorly into the posteriorly projecting pronotum. It has three longitudinal carinae, one in the middle and the remaining two at the lateral sides and gradually narrowing from the proximal to the distal region. In *Liburnia pallescens* and *Purohita cervina* the carinae reach the hind border, in the former all the carinae and in the latter the median carina are faint posteriorly, whereas in *Delphacodes propinqua* they vanish before reaching the hind margin. The mesonotum can be primarily divided into an anterior large wing bearing alinotum and a posterior narrow postnotum. Towards the anterior end, the alinotum (Fig. 5) has a prescutal or transverse notal suture dividing the alinotum into an anterior narrow prescutum and a posterior large scutoscutellum. Internally, the prescutal suture bears a faint transverse notal ridge (Tnr.) The prescutum continues laterally towards the episternum anterior to the wing base as the prealare (Pr.) The prealare has a small, posteriorly directed projection in all the three species under observation which is more pointed and spine-like in *Purohita cervina*. There is a faint submarginal antecostal suture, anterior to the transverse notal suture, which cuts off a narrow acrotergite (Act). Internally the suture bears the antecosta (Ac) which expands ventrally to form the first phragma

(IPh). The first phragma is thin, feebly developed and deeply notched in the middle. It is comparatively well developed in the males of *Liburnia pallescens* and *Delphacodes propinqua* whereas it is uniformly developed in both the sexes of *Purohita cervina*. Besides these, there are two sutures (am, bm) lying at the anterior region of alinotum, taking their origin slightly posterior to the transverse notal suture. Of these, anterior one (am) arises near the transverse scutual suture, runs anterolaterally, crosses the latter suture after some distance and joins with the corresponding one from the opposite side. The other suture (bm) lies a little posterior to it and runs in the same direction as that of (am); it joins with the suture (am) after some distance in *Delphacodes propinqua*; in the other two species they vanish before joining with the anterior suture. The scutoscutellar suture is absent in araeopids and as a result of which the scutal and the scutellar regions are merged together. Posteriorly the alinotum bears a reversed notal or pseudo-scutoscutellar suture (Fig. 1, Rvs), the area included inside this suture is raised well above the two lateral areas. Internally the suture develops a corresponding feebly developed ridge. The lateral areas of the scutoscutellum are folded beneath the middle raised region and are V-shaped. Hence, in situ their median region is not visible. This folded area of the scutoscutellum is secondarily divided by a V-shaped suture (cm) running almost parallel to the pseudoscutoscutellar suture. The axillary cord of the tegmen is joined to the scutellum. The postnotum is in the form of a narrow plate fused with the alinotum, completely hidden beneath the scutoscutellum. Sometimes it is in a very reduced condition so much that it is mistaken as the secondarily divided V-shaped posteriormost region of the alinotum with which it is fused as in *Peregrinus maidis* (Mathur and Joseph, 1961). The postnotum is V-shaped and laterally continues as postalare to unite with the epimeron similar to that of prealare. The postnotum carries at its hind margin the second phragma (Fig. 6, IIPh), which consists of a pair of thin conical plates continuous basally in *Liburnia pallescens* and *Delphacodes propinqua*, while in *Purohita cervina* its separation into two plates is complete. In all the species under study it is thickly sclerotised at its basal region for about one third distance and gradually narrows distally to form a thin plate.

The pleural suture arises from the pleural articular process and extends upto the wing base. It takes an oblique course and in the middle it is slightly curved anteriorly. It divides the pleuron into an anterior large episternum and a posterior small epimeron. The episternum joins the sternum by a large precoxale, while the epimeron by a narrow postcoxale. The pleural suture internally develops the pleural ridge which gives out an apodeme to meet the corresponding apodeme coming from the sternum to form the mesothoracic furca (Fig. 7), similar to that of prothoracic furca. A little anterior to it, the pleural ridge gives rise to another small conical apodeme running parallel to the pleural apophysis. The mesopleuron develops secondary sutures (Fig. 3) in varying degree in different species studied. In *Liburnia pallescens* there is a suture (dm) originating a little posterior to the pleural suture and runs obliquely to join the anterior margin. In *Purohita cervina* this suture is short and does not extend more than half of the area of episternum. In *Delphacodes propinqua* the suture disappears a little before reaching the anterior boundary. Besides this, there is another suture (em) in this species starting from the pleural suture near its middle and joining to the suture (dm). Dorsal to the episternum, near the pleural suture, there is a small crescent-shaped basalare and similarly the epimeron has a small subalare. The second thoracic spiracle is located at the lateral side of the mesothorax at the junction between the tergum and the posterior corner of the epimeron. The trochantin is similar to that of the prothoracic segment in origin, attachment and shape, but has proportionately increased in size along with the large size of mesothorax.

Pl.I
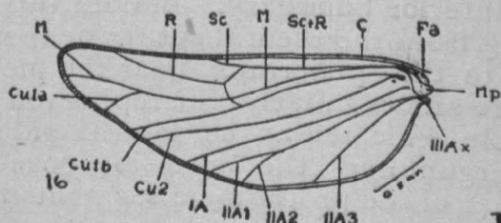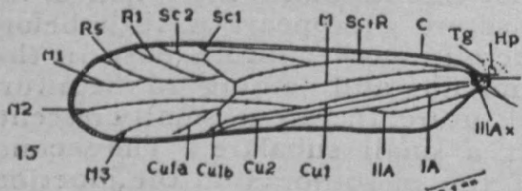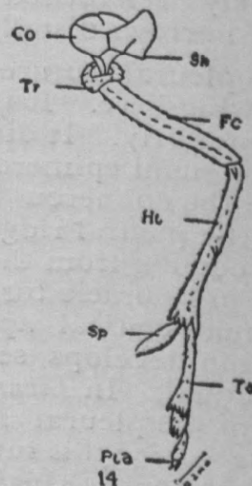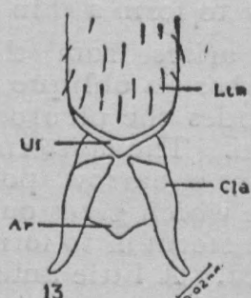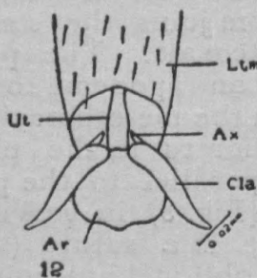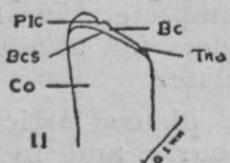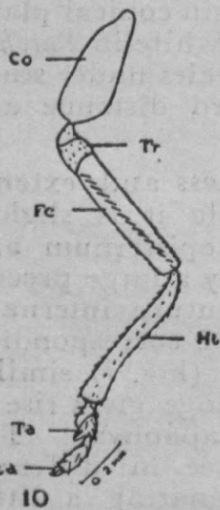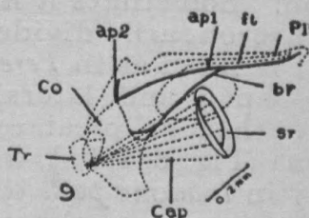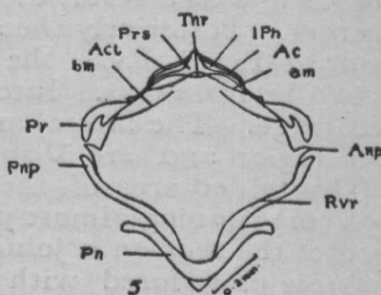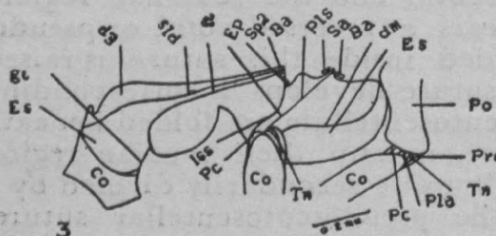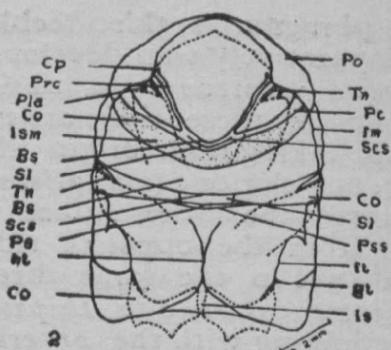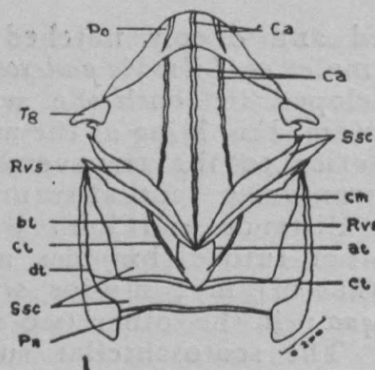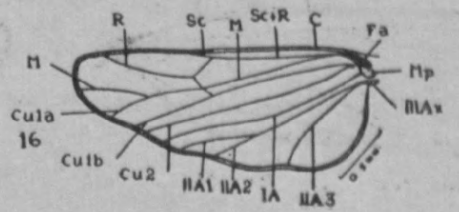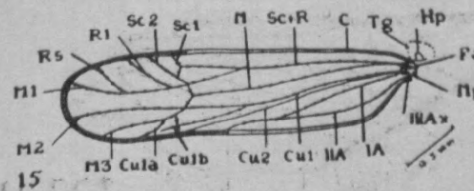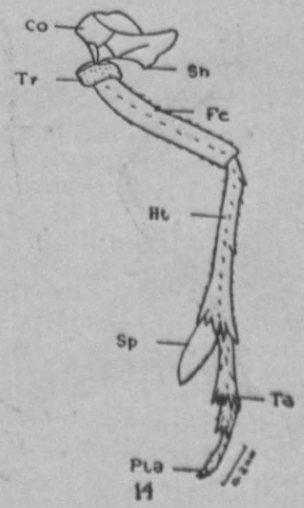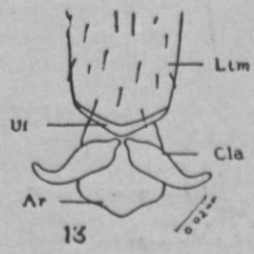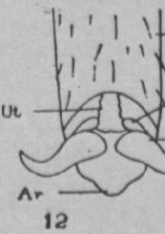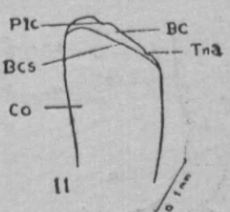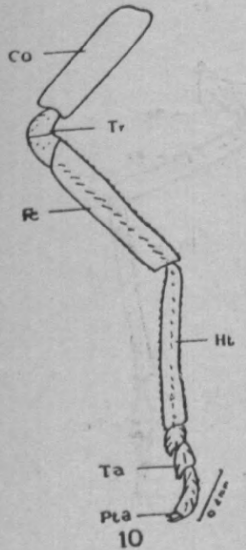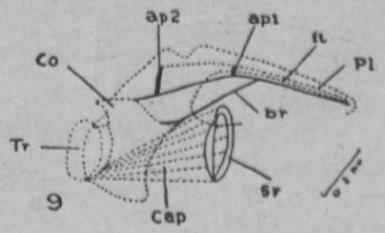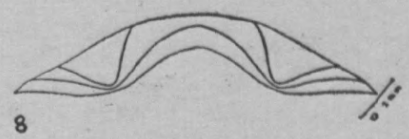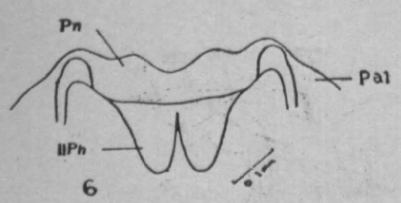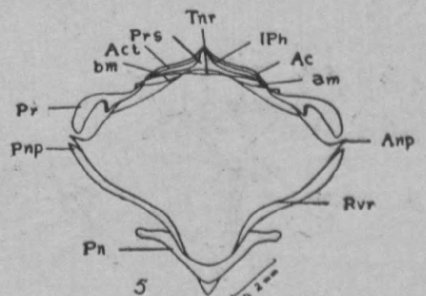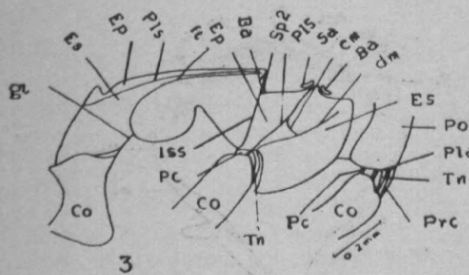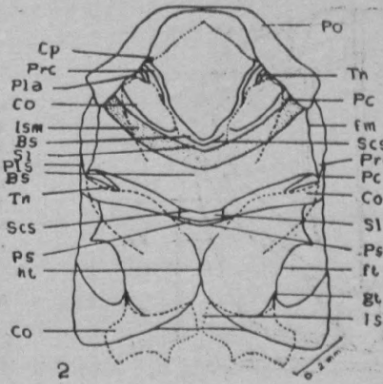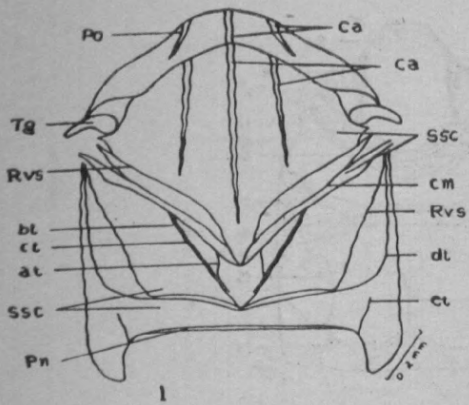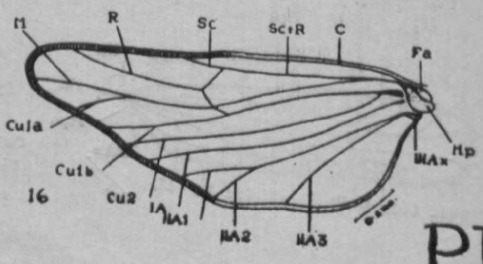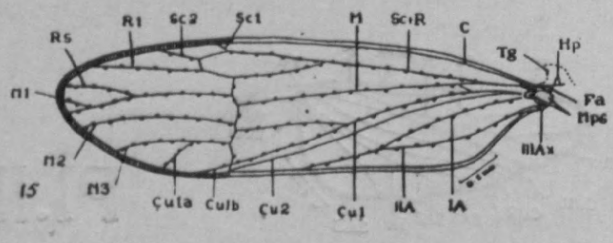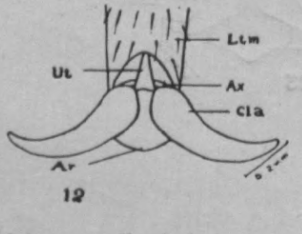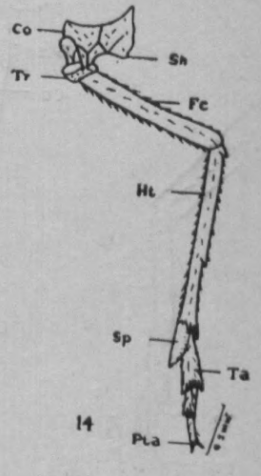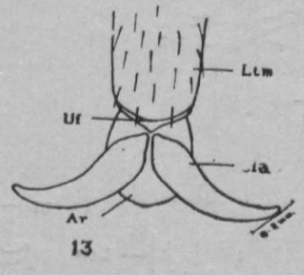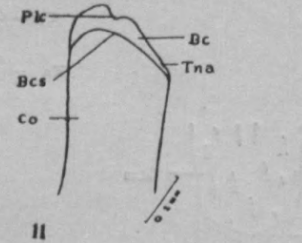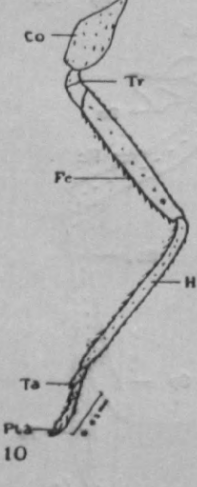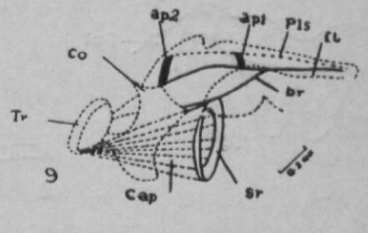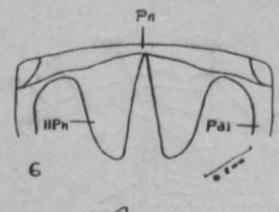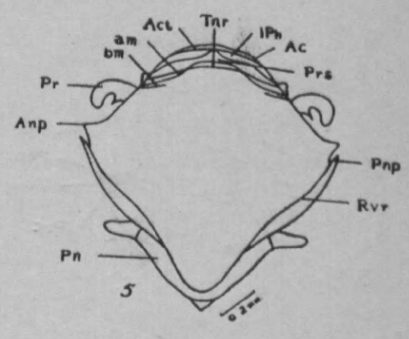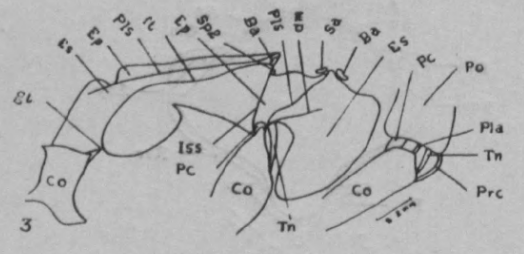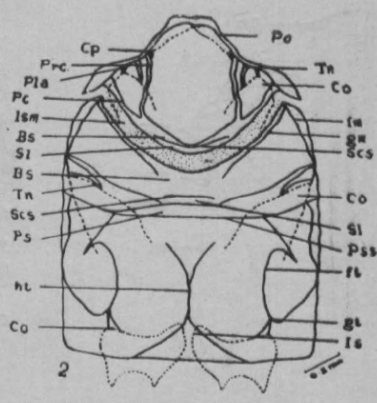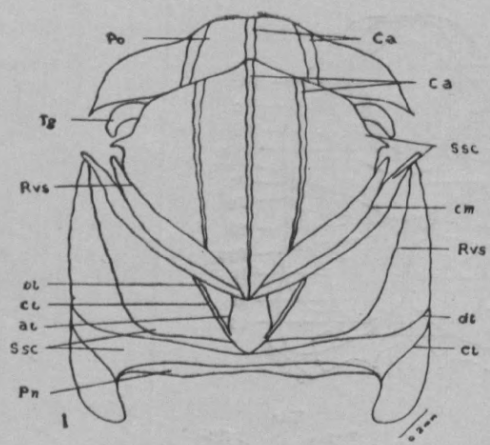
Pl.II

Pl. III

EXPLANATION OF PLATES

Plate I, *Liburnia pallescens*.
Plate II, *Delphacodes propinqua*.
Plate III, *Purohita cervina*.

Fig. 1. Dorsal view of thorax.
Fig. 2. Ventral view of thorax.
Fig. 3. Lateral view of thorax.
Fig. 4. Prothoracic furca.
Fig. 5. Inner view of mesonotum.
Fig. 6. Inner view of postnotum of meso-thorax showing the phragma.
Fig. 7. Mesothoracic furca.
Fig. 8. Third phragma.

Fig. 9. Lateral view of metapleuron showing the internal ridge and the apodeme projecting into the thorax from the trochanter.
Fig. 10. Fore leg.
Fig. 11. Basal region of precoxa enlarged.
Fig. 12. Ventral view of pretarsus.
Fig. 13. Dorsal view of pretarsus.
Fig. 14. Hind leg.
Fig. 15. Tegmen.
Fig. 16. Hind wing.

ABBREVIATIONS

IA. first anal ; IIA. second anal ; IIA 1. first branch of second anal ; IIA 2. second branch of second anal ; IIA 3. third branch of second anal ; Ac. antecosta ; Act. acrotergite : amis secondary suture of mesothorax ; Anp. anterior notal wing process ; ap 1. first apophysi from the pleural suture to the pleural ridge ; ap 2. second apophysis from the pleura-suture to the pleural ridge ; Ar. arolium ; at. secondary suture of metathorax ; Ax. aux. ilia ; IIIAx. third axillary ; Ba. basalare ; Bc. basicoxite ; Bcs. basicostal suture ; bm; secondary suture of mesothorax ; br. branch of metathoracic pleural ridge ; Bs. basisternum bt. secondary suture of metathorax ; C. costa ; Ca. carinae ; Cap. sclerotised projection extending from the hind trochanter into the thorax ; Cla. claw ; cm. secondary suture of mesothorax ; Co. coxa ; Cp. cervical apodeme ; ct. secondary suture of metathorax ; Cu 1. cubitus one ; Cu 1a. first branch of cubitus one ; Cu 1b. second branch of cubitus one ; Cu 2. cubitus two ; dm. secondary suture of mesothorax ; dt. secondary suture of metathorax ; em. secondary suture of mesothorax ; Ep. epimeron ; Es. episternum ; et. secondary suture of metathorax ; Fa. fused first and second axillaries ; Fe. femur ; fm. se-condary suture of mesothorax ; ft. secondary suture of metathorax ; gm. secondary suture of mesothorax ; gt. secondary suture of metathorax ; Hp. humeral plate ; ht. secondary suture of metathorax ; Ht. tibia ; Iss. intersternite ; Ism. intersegmental membrane between the pro and mesosternum ; Iss. intersegmental suture between the meso and metapleura ; Ltm. last tarsomere ; M. media ; M 1. first branch of media ; M 2. second branch of media ; M 3. third branch of media ; Mp median Plate ; Mps. median plates ; Pal. postalare ; Pc. postcoxale ; IPh. first phragma ; IIPh. second phragma ; Pla. pleural articulation ; Plc. concavity at the proximal margin of coxa for articulation of pleural process ; Pls. pleural suture ; Pn postnotum ; Pnp. posterior notal wing process ; Po. pronotum ; Pr. prealare ; Prc. precoxale ; Prs. prescutum ; Ps. pre-sternum ; Pss. pre-sternal suture ; Pta pretarsus ; R. radius ; R 1. radial one ; Rs. radial sector ; Rvr. reversed notal ridge ; Rvs. reversed notal suture ; Sa. subalare ; Sc. sub-costa ; Sc 1. first branch of subcosta ; Sc 2. second branch of subcosta ; Sc + R. subcosta plus radi-us ; Scs. sternacostal suture ; Sh. spine at the distal margin of coxa of metathora-cic leg ; Sl. sternellum ; Sp. spur ; Sp 2. second thoracic spiracle ; sr. sclerotised rim at the margin of the apodeme projecting into the metathorax from the hind trochanter ; Ssc. scutoscutellum ; Ta. tarsus ; Tg. tegula ; Tn. trochantin ; Tna cavity at the proximal margin of coxa for the articulation of trochantin ; Tnr. transverse notal ridge ; Tr. tro-chanter ; Uf. unguifer ; Ut. unguitractor.

The eusternum (Fig. 2) is limited posteriorly by the intersegmental groove between the meso and metathorax. The sternacostal suture is a short, transverse suture in *Liburnia pallescens* and *Delphacodes propinqua*; it joins laterally with the posterior boundary of mesothorax to form a small rectangular sternellum and a large basisternum. In *Purohita cervina* the sternacostal suture is free from the posterior boundary of mesothorax and so the sternellum is not marked as a rectangular area. The sternacostal suture internally carries the sternacostal ridge whose lateral ends give out the sternal apophyses. In all the three species the mesopectus carries a pair of longitudinal sutures (fm), one on either side of the lateral margin extending from the coxal cavity near the pleural suture upto the anterior margin. In *Purohita cervina* the anterior margin of the basisternum has two submarginal sutures (gm) one on either side running parallel to the anterior margin of the eusternum and directed posteriorly near the middle.

The metathorax :

The metathorax (Figs. 1, 2 and 3) is highly modified in Araeopids, especially the metapleuron, as a special leaping mechanism is developed in this segment. Curiously enough, it has no furca. The metathorax has distinct tergopleural lines to separate the notum from the pleura. Similar to that of pro and mesothorax, the pleura and sternum are united to form a metapectus.

The metanotum is V-shaped anteriorly and lies between the mesonotum and the first abdominal tergum. Laterally it is joined to the pleura by the tergopleural suture. It is divisible into a large wing bearing alinotum and a posterior narrow postnotum, situated between the corners of the posterolaterally projecting areas of the notum. Like that of the alinotum of mesothorax, the metanotum is devoid of a scutoscutellar suture but is devided by a V-shaped pseudoscutoscutellar suture arising from the anterolateral corner of the alinotum. There are a number of secondary sutures displayed on the alinotum (Fig. 1). The dorsomedian area of alinotum bears a pair of sutures on either side and another one outer to these sutures forming a complete V-shaped suture. The innermost one (at) begins slightly lateral to the dorsomedian line, runs convergingly for a short distance and joins with another suture (bt.) The latter suture begins lateral to the former and takes a similar course. The combined suture thus formed runs for a short distance and abruptly ends there. Immediately outer to the suture (bt) and parallel to it runs the third suture (ct) which meets its fellow from the opposite side to give a V-shaped suture. The area included in between the sutures (bt) and (ct) is raised as a ridge which continues beyond the combined (at) and (bt) to the tip of (ct). Outer to it and well apart from this runs the pseudoscutoscutellar suture. External to the latter suture runs another V-shaped suture (dt) in *Liburnia pallescens* and *Delphacodes propinqua* taking its origin near the pseudoscutoscutellar suture and posteriorly apposing or almost touching the pseudoscutoscuteller suture and then diverging before joining with its mate from the opposite side. In *Purohita cervina* it takes its origin from the posterior side of the tergopleural suture. From the region where the suture (dt) apposes or nearly apposes the pseudoscutoscutellar suture, the area of alinotum is raised as a ridge, this elevated area passes below the elevated area running along the suture (ct). At the posterolateral corners, one on either side, there is a small suture (et) directed anteriorly whose extension varies with the species. In *Liburnia pallescens* it curves to join the suture (dt); in *Delphacodes propinqua* it reaches only a little more than half of the area from its origin to the suture (dt); In *Purohita cervina* it diverges to join with the tergopleural suture. The postnotum is reduced and is fused to the posterior margin of alinotum. It carries internally the unpaired phragma (Fig. 8) whose sclerotisation is interesting. There is a distal membranous area surrounded by a thikly

sclerotised proximal area. At the lateral sides of the proximal area there are still thickly sclerotised conical areas. In *Liburnia pallescens* and *Purohita cervina* there is not much difference in the thickness of sclerotisation between the proximal and distal areas, whereas in *Delphacodes propinqua* the difference is quite conspicuous. The third phragmata are of uniform size in both the sexes of *Purohita cervina*, while in the males of tribe Delphacini their lateral thickly sclerotised areas extend internally as projections tapering distally.

The pleural suture is visible as extending from the wing process but stopping short of the coxal cavity. It divides the pleuron into a large episternum and a narrow epimeron. Lower to the pleural suture runs another suture (ft) parallel to it for considerable distance and then distally curves back to join the intersegmental line between the meso and metathorax (Fig. 3). From the posterior margin of the suture ((ft) extends another suture (gt) to the leg base which is bifurcated. At the anterolateral margin of episternum is located the basalare, but there is no subalare in the epimeron. The hind coxa is firmly united to the pleuron and as there is no movement the trochantin is also not developed. The pleural suture and the pleural ridge deserve special attention as they have undergone great modifications. The pleural ridge is in contact with the pleural suture at its base but is separated from the suture as it runs posteriorly. Towards the middle it is supported by an apodeme (ap1) and another one (ap2) at the distal region where the pleural suture terminates. As already mentioned the pleural suture stops before joining the coxal cavity but the ridge continues and is fused with the coxa ; thus the division of the pleuron into the episternum and the epimeron is complete. From the middle of the pleural ridge arises a branch (br) which runs posteriorly and bifurcates into two before joining the coxal base. Externally towards the posterior side, the branch (br) is marked by a suture (gt). All these ridges form a firm skeletal frame work to support the pleuron so as to withstand the stresses and strains of the powerful leaping action of the hind legs.

The metasternum (Fig. 2) is comparatively well developed. The sternacostal suture is indistinct and the sternacosta is extending as a long, thin ridge, marked externally the entire length by a suture (ht). Hence it is difficult to demarcate the exact boundary between the basisternum and the sternellum. The sternal apophysis is not developed and there is no furca formation in the metathorax. Anteriorly the sternum has a transverse submarginal suture, the presternal suture, which cuts off a narrow presternum.

The legs :

The coxo-trochanteral, the trochantero-femoral and the femoro-tibial joints are dicondylic, the remaining articulations are monocondylic. All the dicondylic articulations are horizontal except the trochantero-femoral which is vertical ; the monocondylic articulations are dorsal. The fore and middle legs are similar in structure and equal in length, but the length of the individual regions are dissimilar. The hind leg is large and its various components have undergone modifications partly to fit in the role of leaping taken by it.

The coxa of the fore leg (Figs. 2, 3, and 10, Co) is elongated with a medially narrow region ; the distal region is stouter than the proximal part. The proximal submargin of coxa (Fig. 11) is encircled by a faint basicostal suture which marks off the basicoxite from the coxa. The basicostal suture internally bears the basicosta, which strengthens the base of the coxa. The proximal margin of coxa is oblique with a distinct marginal rim. Proximally the marginal rim of coxa possesses a small concavity (Plc) at the dorsolateral side to which is articulated the pleural articular process. Anterior to this at the coxal rim there is another small concavity

(Tna) for the articulation of trochantin. Thus coxa has pleural as well as trochantinal articulations. Further, the coxal base is attached to the coxal socket by a thin membrane surrounding it— the coxal corium. The coxa is decorated with small scattered spines in *Purohita cervina* ; but these are absent *in Liburnia pallescens* and *Delphacodes propinqua*. Distally, the coxa has a pair of articular surfaces to hinge with the trochanter by a dicondylic articulation. A thin conjunctival membrane joins the distal rim of coxa with the proximal rim of the segment following.

The trochanter (Fig. 10, Tr) is the smallest segment of the leg and is highly sclerotised. Its lumen is reduced by thick inflection of its wall near the middle. It externally bears small, scattered spines. The dorsal surface of the trochanter is short and concave while the ventral surface is longer and convex. From the trochanteral base arises a pair of thin apodemes, one from the dorsal and the other from the ventral side. They extend into the coxa, tapers distally and are articulated to the trochanteral base by membranes. They serve for the attachment of the trochanteral muscles. The distal rim of the trochanter is oblique. Its articulation with the femur is so fixed that the femur moves along with the trochanter and the conjunctival membrane between them is reduced.

The femur (Fig. 10, Fe) is almost equal in length to that of tibia in *Liburnia pallescens* and *Delphacodes propinqua*, while it is shorter than the tibia in *Purohita cervina*. Its proximal end is slightly stouter and it gradually narrows posteriorly. It is comparatively thinner in *Purohita cervina* than in the other two species. The femur has four or five longitudinal rows of spines of varying sizes. In *Liburnia pallescens* there are four rows of spines ; dorsal, ventral, anterior and posterior. The anterior and posterior rows are large and of equal size, the dorsal row small and the ventral row is composed of minute spines. In the other two species, *viz.*, *Delphacodes propinqua* and *Purohita cervina*, it has five longitudinal rows of spines ; one dorsal, two ventrolateral, one anterior and the other posterior. In the former, the anterior, the posterior and the ventrolateral rows are comparatively well developed, the dorsal row being composed of small spines. In the latter, the anterolateral row is the largest, the posterolateral row larger, the dorsal row large, the anterior and posterior rows are small and basally apart. There are no apodemes attached to the femur as it has got no independent movement.

The tibia (Fig. 10, Ht) is generally the longest segment in araeopids. It is slightly bent proximally ; it is broad distally in *Liburnia pallescens* and *Delphacodes propinqua*, while it is *vice versa* in *Purohita cervina*. It has five longitudinal rows of spines displayed in the same fashion as that of the preceding segment of *Delphacodes propinqua* and *Purohita cervina*. Its row of largest spines is much smaller than the row of the largest spines of the femur. Of these, the ventrolateral rows are larger than the remaining three in the tribe Delphacini. In *Purohita cervina* the dorsal and ventrolateral rows are large and of the same size. The anterior and posterior rows are small and the spines are located well apart basally. At the hind region of tibia the spines are scattered. A pair of thin, long distally tapering apodemes are articulated to the tibial base similar to that of the trochanteral base extending into the femur to which are articulated the tibial muscles. Distally, the tibia has a concavity within which is articulated the tarsus.

The tarsus (Fig. 10, Ta) is considerably shorter than the tibia and is subdivided into three tarsomeres. Of the three, the basal two are equal in length while the distal one is longer and approximately equal to the combined length of the basal two. The tarsus is clothed with large, scattered spines. The first tarsomere distally bears a crescent-shaped concavity within which fits the second tarsomere. The second one is hinged to the third by a similar articulation.

Similar to that of the tibial basal rim, the tarsus base has a pair of distally tapering apodemes for the attachment of tarsal muscles.

The pretarsus (Figs. 10, 12 and 13) arises from the end of the tarsus. To accommodate the pretarsus, the last tarsomere has undergone certain modifications. The pretarsus consits of a pair of lateral claws (Cla) and a median lobe, the arolium (Ar.) The claws are hinged to a dorsomedian process at the distal end of the last tarsomere, the unguifer (Uf). The claws are hollow, curved, distally tapering structures. Beneath the bases of claws there are small plates called auxiliae (Ax). The arolium is a small, sclerotised sac. On its ventral surface the pretarsus bears a median basal plate, the unguitractor (Ut), which is partly invaginated into the distal end of last tarsomere. To its proximal end is joined a long apodeme with which is attached the muscles of claws.

The middle legs are similar in structure to the fore legs as already mentioned. The fore coxa is longer than the middle coxa, while the fore tibia is shorter than the middle tibia.

The hind legs (Fig, 14) are remarkable for their large size in comparison to the two anterior pair of legs. The coxa (Figs. 2, 3, 9 and 14) of the hind leg is highly modified, it is short and broader than long. Posteriorly it is articulated with the trochanter by means of two small, projecting areas. This type of hinge permits a wider area of movement to the trochanter than the type of articulation found in the fore leg. The coxa is hollow and at the outer margin there is a large spine (Sh). It is firmly joined to the metapleuron and consequently the trochantin has disappeared. There is a basicostal suture, a basicosta and a basicoxite similar to that of the fore leg. In addition to this, the coxa is strengthened by a complicated system of ridges which prevent it from collapsing. In *Purohita cervina* it has small spines scattered all around, but it is without spines in the remaining two species.

The trochanter (Figs. 9 and 14, Tr) is a small ring-shaped segment. Its proximal and distal margins are highly sclerotised so much so that its internal extensions reduce the internal space. At the proximoventral region, the rim is specially thickened and from this arises a thinly sclerotised structure gradually increasing in thickness as it (Cap) projects through the hollow coxa in the metathorax. The inner end of this apodeme is circular and rimmed by three narrow sclerites (sr) which can be easily separated out in specimens boiled in potassium hydroxide solution. Muscles from the thorax are inserted to it. The trochanter is firmly united with the femur and moves along with it. The hind legs work together during jumping so as to enable the insects to take longer leaps. Like the trochanters of fore and middle legs, the hind trochanter is sparsely clothed with small spines.

The femur (Fig. 14, Fe) is shorter than the tibia and forms a distinct head proximally. The trochantero-femoral joint is so fixed that it allows only restricted movements and the trochanter moves along with the femur. The distribution of spines on the femur is similar to that of the fore leg.

Tibia (Fig. 14) is long, slender and distally broad in all the species. It has a large basal, a middle and five distal spines. The distal spines gradually decrease in size from one end to the other and occur in clusters of four and one. Posterior to these spines, the tibia bears a spur whose shape is of utmost significance in systematics. In *Liburnia pallescens* and *Delphacodes propinqua* it is foliaceous and its hind margin carries a number of teeth; fourteen to twenty in the former and sixteen to twenty five in the latter. In *Purohita cervina* the spur is cultrate and without teeth. Towards the posterior border, the spur is provided with minute

spines which are comparatively larger in *Purohita cervina*. The tibia has five rows of spines similar to that of fore tibia but smaller in size.

The first tarsomere (Fig. 14) bears at the hind margin two clusters of large spines in *Liburnia pallescens* and *Delphacodes propinqua*, one cluster with five spines gradually decreasing in size from one end to the other and the other cluster with two spines. In *Purohita cervina* it has only one cluster of six spines of unequal size. The second tarsomere bears at the hind margin one cluster of three spines of unequal size and another independent spine. There is difference in the comparative length of the tarsomeres with that of the fore leg, the basal one being longer than the other two. All over the surface, the tarsomeres bear long scattered spines. The pretarsus is similar in structure to that of the anterior pair of legs.

It is remarkable to observe that the following modifications, undergone by the hind legs, are in direct relation with the jumping mechanism :

1. The coxa of the hind leg is hollow, immovably attached to the metapleuron and strengthened by a number of ridges within it.

2. The trochanter is articulated proximally with two small conical projections of the coxa, giving maximum freedom of movement, thus compensating for the fusion of coxa with metapleuron.

3. The apodeme arising from the trochanter is enlarged chiefly to provide adequate base for the insertion of the muscles from the thorax.

The wings :

Wings show polymorphism in araeopids and are found to occur in three different forms, *viz.*, brachypterous, koelopterous and macropterous. In *Delphacodes propinqua* the wings are dimorphic—macropterous as well as koelopterous ; in the other two species only macropterous forms have so far been collected. Tegmina or fore wings are of slighty harder consistency, longer and narrower than the hind wings. The former are variously coloured in different species, the latter are invariably transparent.

Metcalf interpreted the wing-venation of certain families of Fulgoroidea, using the Comstock-Needham system of vein nomenclature. A decade later Muir (1923) briefly discussed the venation of Fulgoroidea, and recently Fennah (1944) has studied it in details. The wing-venation is comparatively well developed in Araeopidae. Unlike that of certain families of Fulgoroidea, such as the members of the families Flatidae, Ricaniidae etc., there is no precostal region in araeopids. In tegmen (Fig. 15). the costa (C) is a well developed, unbranched vein running along the anterior margin. Subcosta forms a common stalk basally with the costa and distally branches into two—(Sc 1) and (Sc 2). Radius coalesces with the subcosta (Sc+R) for nearly half of its length, diverges from it and after some distance bifurcates into the radial one (R 1) and the radial sector (Rs). Media (M) arises independently from the base and soon after its origin, it coalesces with the combined subcosta and radius (Sc+R) for a short distance. Distally it has three branches—(M 1), (M 2) and (M 3) ; according to Metcalf (1913) in Fulgoroidea the third branch (M 3) joins with another (M 4) during the course of the development of media. Cubitus is forked into two, namely, (Cu 1) and (Cu 2), soon after its origin ; the former branch distally bifurcates to give the (Cu 1a) and (Cu 1b). The anal vein is two branched, (IA) and (IIA) ; they distally fuse to give a 'Y' vein, a charateristic feature of the superfamily Fulgoroidea (Imms, 1957). The first anal (IA) represents the postcubitus of Snodgrass (1935) because of its

independent origin without fusing either with the base of the cubitus or with the third axillary. As the revised nomenclature of Snodgrass (1935) in respect of the cubito-anal region, has not met with general acceptance the authors have preferred to retain the old name, the cubitus two (Cu 2). All the veins of tegmen, except cubitus two are characterised by the presence of macrotrichiae throughout their length. In *Purohita cervina* most of the macrotrichiae are found on either side apposing the veins and not always on the veins.

The hind wing (Fig. 16) is conspicuous for the absence of macrotrichiae and the enlarged anal area. The costa is similarly disposed as the tegmen. The subcosta is unbranched and runs very close to the costa. The radius is represented by a single vein. The media is reduced and is also represented by a single vein. Basally the subcosta, the radius and the media all unite together and run for a short distance apposing the costa anteriorly. Proximal to this the media diverges to join with its basal sclerite, the combined subcosta and radius unite with its own sclerite; the costa continues independently. The branching of cubital vein is similar to that of the tegmen but in the hind wing the (Cu 1a) coalesces with the media for almost its entire length being separated only near the distal margin. The first anal is unbranched, the second anal is three branched (IIA 1, IIA 2 and IIA 3) to support the enlarged anal area.

The articular membrane of the wings is thickened and corrugated at its posterior margin to form the axillary cord. The pteralia of the tegmen (Fig. 15) are the following :

Tegula (Tg). It is a well developed sclerotised plate overlapping the base of the tegmen and movably articulated with the base of the costal vein. It is provided with scattered, small hair on the surface.

Humeral plate (Hp). It is a small, sclerotised conical plate projecting anteriorly and situated at the base of the costal vein. It is roofed over by the enlarged tegula.

First and second axillaries (Fa). The first and second axillaries are fused together to form a small sclerite situated between the costa and the median plate. It is slightly curved and is in connection with the fused subcostal and radial veins distally.

Median plates (Mps). They consist of a pair of unequal, apposing small sclerites, the larger sclerite lying proximal to the smaller. These are situated between the fused first and second axillary and the third axillary. The media is in connection with the distal sclerite.

Third axillary (IIIAx). It is a small triangular sclerite situated at the posterior margin of the tegmen in between the median plates and the axillary cord. Medially it touches the proximal median plate.

The relative position of the sclerites in the articular membrane of the hind wing (Fig. 16) is similar to that of the fore wing, though they differ in shape and size. The humeral plate and the tegula are reduced. The median plate (Mp) is represented by a single large plate. The third axillary (IIIAx) has proportionately increased in size along with the increased importance assumed by the second anal vein in the hind wing.

Discussion :

Araeopids exhibit great morphological diversity in the thorax and particularly marked in the metathorax. Their pro and mesothorax very much resemble

those of other fulgoroids except in the presence of a number of secondary sutures in the latter. The development of the secondary sutures in the thorax of these insects, which lack corresponding ridges, is interesting as it follows a similar course in both the tribes under observation, namely, Delphacini and Tropidocephalini, suggesting similar lines of evolution.

In *Liburnia pallescens* and *Delphacodes propinqua* the first and third phragmata show sexual dimorphism. In males, the first phragma is comparatively well developed and the third phragma much larger than the corresponding phragma of females. So the males are adapted for better flying in the subfamily Delphacini. In *Purohita cervina* the phragmata are uniformly developed in both the sexes.

In araeopids, the jumping mechanism is developed in connection with the hind legs, although the metathorax lacks furca. In order to compensate this loss, the metathorax has developed a complicated system of ridges to form an internal skeletal frame work at the lateral sides, to withstand the extra stresses and strains shouldered by it.

In araeopids the apodeme (Fig. 9, Cap) arising from the ventral side of the trochanter and projecting into the metathorax in connection with the jumping mechanism, has extraordinary importance. Qadri and Aziz (1950) report an analogous case in *Pyrilla perpusilla* in which they attribute its origin to the coxa. In araeopids this apodeme is homologous to the apodeme arising from the trochanteral base for the muscular attachment of the trochanter in the fore and middle legs. The development of the jumping mechanism has its own impact on the hind leg as a whole as it has grown enormously in all directions than the fore and middle legs. The hind coxa is also, consequently, immovably articulated to the pleuron, and has developed two distal conical projections for the attachment of the trochanter thus allowing maximum freedom of movement to the latter so much so that it can swing on the former.

The function of the spur has been a matter of speculation in araeopids. Some early workers believed that it assists in some way or other to take longer leaps, but other homopterans without spur also leap equally well, if not better, and so the spur does not appear to have any direct bearing with the jumping mechanism. The authors suspected that these insects must be making use of their spurs for some such purpose as cleaning because of their structure and position, but their observation in the field and experiments in captivity have failed on *Liburnia pallescens* and *Delphacodes propinqua* to exhibit any such action on the part of the insects under study.

Summary :

The present paper deals with the morphology of the thorax of three species of Araeopidae belonging to two tribes viz., tribe Delphacini—*Liburnia pallescens* and *Delphacodes propinqua* and tribe Tropidocephalini—*Purohita cervina*. The following features are noteworthy.

(1) In araeopids the pro and mesothorax are similar to other fulgoroids except for a number of secondary sutures for the latter. The metathorax exhibits great morphological diversity from other allied forms and develops a number of secondary sutures. It lacks furca and has a complicated skeletal frame work at the lateral sides. In the tribe Delphacini, the first and second phragmata exhibit sexual dimorphism, whereas in Tropidocephalini they are uniformly developed in both the sexes.

(2) The hind leg is much larger than the fore and middle legs and bears the spur, the characteristic feature of the family. The spur is foliaceous with a num-

ber of teeth at the posterior margin in *Liburnia pallescens* and *Delphacodes propinqua*, whereas it is cultrate and without teeth in *Purohita cervina*. The hind legs develop a jumping mechanism.

(3) In tegmen, the costa in single, subcosta two branched, radius is represented by radial one and radial sector, media three branched, cubitus two branched, of which the cubitus one in its turn is bifurcated distally, and the anal vein is two branched which join distally to form the characteristic 'Y' vein of Fulgoroidea. In the hind wing, costa is similar to the fore wing, subcosta, radius and media unbranched, cubitus and first anal similar to the fore wing, and the second anal three branched. The first and second axillaries are fused together in both the wings, the median plates are two in the tegmen and one in the hind wing, the third axillary is much larger in the hind wing.

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