

A Contribution to the Study of the Jassoidea (Homoptera)

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INTRODUCTION.

Some ten years ago a study was begun of the jassoid fauna of Australia. Since then group after group has been dealt with in turn, and, at present, it is believed that the principal divisions have been defined, although only a fraction of the actual genera and species have been described.

At an early stage of the investigation it was decided that the series of taxonomic papers should be followed by one in which not only would a key be given to the various families considered previously, but their inter-relationships would be discussed and a comparison made with the faunas of other zoo-geographical regions. The scope of the present paper, which is the final one in the series, is very different from that originally anticipated, because in recent years it has become increasingly clear that the classification adopted in the past is not a natural one. Thus, under the present classification, some families comprise genera in no way closely related to one another, and many genera with well-defined natural affinities are to be found in widely separated groups. Hence it has become necessary to rearrange the position of several genera and to discard certain of the criteria formerly used for the classification of the major groups.

This paper is concerned principally with Australian jassoids, but a few genera from other regions are included, as they assist in an understanding of the complexities involved. The number of families comprised in the Jassoidea must always remain a matter of personal opinion, as a family is an arbitrary unit. In the classification proposed it is realized that the various families are not of equal status.

Moreover there exists a number of groups of genera, representatives of which have either been unobtainable for study (e.g., *Adelungia* Mel. and related genera), or which are unknown to me, that have characteristics that are just as distinct as those considered here of sufficient importance to merit the raising of groups to family rank. Little attention is paid to divisions of lower status.

In order to assign a species to its correct family it is usually insufficient to take into account only one or two of its characters, but the insect must be regarded as a whole, and all its characteristics of structure, coloration, and sculpture examined and balanced. A key is not given, as it was found impossible to construct a concise one, but the figures should render the absence of a key unimportant.

The present writer, who is out of touch with libraries, is fully aware that he is not acquainted with all the literature concerned with jassoid classification, and that this work must be incomplete in certain respects. Nevertheless, it is believed that a study based on the leaf-hoppers of an important, though little-known, faunal zone, will be of assistance in helping to pave the way towards an understanding of some of the problems that have made the classification of this group of Homoptera one of the most complex in the whole insect kingdom.

PRESENT SYSTEMS.

So many varied systems of classification have been proposed for the jassoid complex that little purpose would be served by a general review. Instead the systems of four workers are dealt with, three of which refer to particular geographical units.

The most recent is that of Ribaut (1936), who is concerned with the European fauna, and that of France in particular. Ribaut divides the Cicadoidea into seven families, the Membracidae, Cicadidae, Cercopidae, Scaridae, Ulopidae, Jassidae, and Typhlocybidae. The last four on the list are more closely related to one another than they are to any of the first three, or than are any of the first three to one another, and, whilst it might be accepted that four families are sufficient to include the limited fauna under consideration, if the Scaridae (Ledridae) merit separation, the Jassidae are certainly in need of subdivision. Whilst the character of a pronotum with dorsal protuberances may serve to define *Ledra aurita* L., it is not one of any value when applied to the family as a whole.

DeLong (1923), who described the fauna of a single State in Eastern North America, considers the Jassoidea as a single family, the Cicadellidae, and divides them into four sub-families, the Bythoscopininae, Jassininae, Cicadellinae, and Gyponinae. The sole character made use of to define the Bythoscopininae is that the ocelli are

on the front below the margin of the vertex, and the genera comprised in this family are *Agallia* Curtis, *Idiocerus* Lewis, *Macropsis* Lewis, *Oncopsis* Burm., and *Bythoscopus* Germ. The Jassinae are considered as including those leaf-hoppers that have the ocelli on the margin of the vertex, where such is definite, or on that portion of the head between the vertex and the front, where there is no perceptible limit to either. Three tribes, the Jassini, Aceucephalini, and Typhlocybini are defined, and, whilst the lastnamed is separated on characters supplied by tegminal venation, the position of the ocelli is again made use of to differentiate the remaining two. Whilst only four genera are placed in the Aceucephalini, twenty-five genera are comprised in the Jassini; amongst them are *Jassus* Fabr. and *Euscelis* Brullé. The Cicadellinae, which contain numerous American genera, are defined as having the ocelli on the disc of the vertex and the body cylindrical, not dorso-ventrally flattened, whilst the Gyponinae, although also having the ocelli on the disc of the vertex, have the body dorso-ventrally flattened. Three genera are placed in the Gyponinae: *Gypona* Germ., *Penthimia* Germ., and *Xerophloea* Germ.

Naudé (1926), in a memoir on the jassoid fauna of South Africa, divides the Cicadellidae into six sub-families, the Ulopinæ, Ledrinae, Bythoscopinæ, Cicadellinae, Gyponinae, and Jassinae, and also separates the last-named into Aceucephalini, Jassini, and Typhlocybini.

The Ledrinae are defined in a key as having the hind tibiae four-cornered, usually armed with numerous spines, the eyes elliptical, more or less in line with the margin of the vertex, and the pronotum usually angularly extended laterally, whilst the Ulopinæ have globular eyes standing out from the outline of the head and the pronotum rounded or straight laterally. Other points to be noted are that a genus *Pachynus* Stål, which is related to *Macropsis* occurs in South Africa, and that *Penthimia* and *Rubria* Stål are placed in the Gyponinae.

Baker (1923) presented a classification based on the fauna of the world, although he acknowledged that it did not presume to be a complete system since some of the most important anatomical features of several jassoid genera are neither described nor figured. He divided the Jassoidea into fifteen families, the Tettigonellidae (Cicadellidae), Gyponidae, Penthimiidae, Thaumatoscopidae, Ledoridae, Paropiidae, Stenocotidae, Koebeliidae, Ulopidæ, Signoretidae, Euacanthidae, Pythamidae, Nirvaniidae, Jassidae, and Bythoscopidae. Up to the present the author has accepted Baker's classification, although the Eupterygidae (Typhlocybidæ) have been resognized as a distinct family, and following Haupt (1929), *Jassus* and related genera have been considered as a family, the Jassidae, distinct from the Euscelidae, which comprises the majority of genera usually placed in the Jassidae.

THE COMPARATIVE VALUE OF DIFFERENT MORPHOLOGICAL CHARACTERS.

The Jassoidea are defined by Imms (1925), who gives them family rank, as having 'Ocelli two, rarely absent, variable in position. Antennal flagellum composed of numerous joints. Genae dilated, the frons, lorae, and genae forming one curved surface. Pronotum never prolonged backwards. Posterior coxae transverse, laterally dilated; tibiae angular, the hind pair usually seriatly bristly with a double row of spines; empodia large.' This definition, whilst serving to separate the group from the Membracidae and Cercopidac, is not entirely accurate, since, with many species the frons, lorae, and genae do not form one curved surface, and the hind tibiae may be circular in outline and have more than two rows of spines.

In order to determine the inter-relationships of the various genera and groups of genera, six structural features will be reviewed in turn, and the comparative value of each estimated. The selected characters are the venation of the wing; the venation of the tegmen; the shape and armature of the hind tibia; the structure of the male genitalia; the shape of the prothorax; and the external morphology of the head.

If these six characters in a number of genera are examined in order to decide upon their relative degree of stability, it is found that the venation of the wing is the one least subject to variation, and the next most stable characteristic is the venation of the tegmen. This is because venation is not subject to change following a re-orientation of muscle stresses, and the hind wing being used solely for flight purposes, will vary less than the tegmen, which has a protective as well as a flight function. Following venation, the next most persistent characters are to be found in the basic structure of the head, and of the several factors that have to be taken into account in surveying the morphology of the head, the position of the ocelli is the most unreliable, since it is the most subject to variation. It is convenient to follow a discussion of the head by an examination of the shape of the prothorax, particular attention being paid to the propleurae. Finally come the shape and armature of the hind tibia and the structure of the male genitalia, both of which supply evidence of minor importance since they are more subject to change. Whilst there are other characteristics that could be taken into account, such as the hind tarsi, which Baker (1923) believed to be of value for taxonomic purposes, those chosen are sufficient for the present purpose.

WING VENATION.

Comstock (1918) has pointed out that the Jassoidea resemble the Membracidae in that in the wings of neither group has a transverse basal trachea been developed, and the medial trachea is a member of the costo-radial group. This primitive condition occurs also with the Plecoptera and certain cockroaches.

The nomenclature followed is that of Metcalf (1913, 17), except in respect of the first anal vein for which Tillyard's (1926) interpretation is accepted, this vein being considered as the second cubital vein. Plate IV, fig. 7, represents the wing of *Putoniessa rivularis* (Walk.), of which the venation is typical of that occurring almost universally amongst the Jassoidea, lying well away from the costal margin is a thickened vein, consisting of the apposed sub-costal and radial veins. R_1 is not developed and the radial sector is two-branched, the branches being R_{2+3} and R_{4+5} . The media is distinct basally, and not fused with the radius; distally it has two branches M_{1+2} and M_{3+4} . The remaining veins need no comment, except that the marginal vein is formed by the united tips of the longitudinal veins. Plate IV, fig. 5, represents the wing of *Eury-meloides punctata* Sign., in which the venation is identical with that of *P. rivularis*. Apart from the Eupterygidae a number of divergences from a typical wing occur, such as those shown in Plate IV, figs. 6 and 8. In figure 6, (*Bythoscopus lanio* L.) R_{4+5} and M_{1+2} are united apically. Such a condition occurs in the related genera *Eurinoscopus* Kirk. and *Trocnada* Walk. The wing of *Tartessus fulvus* (Walk.) (fig. 8) is unusual in that the marginal vein extends onto the anal area. This feature also occurs in the related genera *Sarpestus* Spangb., *Tartessoides* Ev. and *Tartessella* Ev.

The wings of the Eupterygidae, which have been figured by Ribaut, are of interest since, with certain genera (*Typhlocyba* Germ. and *Eupteryx* Curt.), a marginal vein is not developed to link the radius and second cubitus, although present, parallel with the hind margin of the wing. It is developed in other genera (*Dikraneura* Hardy). A tendency exists in representatives of this family for the veins to unite apically, so that the radius and media may terminate as a single vein (*Typhlocyba*), as two veins (*Eupteryx*), or as three (*Dikraneura*), but never as four, as is usual in the rest of the Jassoidea.

The notation used on Plate IV is not in accordance with that adopted by Ribaut, as his sub-costal is the radius, his radius the media, and his media the first cubital.

As the venation of the wing is a stable character, it might be supposed that a comparison of a typical jassoid wing with those of related groups would supply evidence of wider affinities.

Plate IV, fig. 3, represents the wing of *Scytinus vivescens* Fairm. (Membracidae), which is essentially identical with the normal jassoid type, the only difference being that the sub-costal vein is incorporated in the costal border and does not lie alongside the radius. The three remaining wings figured on Plate IV all show a wide divergence from the jassoid type, the closest being that of *Acthalion reticulatum* L. (fig. 4). In this wing Sc and R are distinct basally, the former being incorporated in the costal border, the radius terminates as a single vein, and the media is two-branched.

Fig. 2 represents the wing of *Cercopis jactator* F.B.W., in which, although the radius is two-branched, the media is a single vein, and is joined to the fused radial and sub-costal veins well anterior to the base of the wing. Extreme reduction is seen in fig. 1 (*Hindola compacta* Walk., Machaerotinae, Cercopidae), in which both the radius and media are unbranched, although the sub-costa is distinct basally. It is believed that the Machaerotinae are related to the Permian Scytinopteridae, since the tegminal venation of the two groups is similar.

It is thus apparent that but little light is thrown upon the relationships of the various jassoid families from a study of wing venation; this character, however, is of use in certain cases in assisting to link genera into minor groupings, where, although no changes have taken place in the basic venation of the wing, secondary vein fusions or reductions have occurred.

As far as wider relationships are concerned, the membracid type is similar to the jassoid, and that of the Aethalionidae, although distinct, displaying specialization by reduction, is nearer to the Jassoidea and the Membracidae than to either the Cercopinae or Machaerotinae.

VENATION OF THE TEGMEN.

The tegmina of several Homoptera have been found well preserved in Palaeozoic and Mesozoic strata, hence something is known of the venation of the ancestors of recent groups, but since the present-day representatives of this sub-order are mostly confined to a limited range of food-plants, it is not to be expected that they will have any great affinity to forms that may have lived on such plants as *Glossopteris*. The Angiosperms, on which most recent jassoids feed, did not develop until Triassic times, whilst those extinct species which are best known, largely from tegminal impressions, are from rocks of Permian age.

It has been previously mentioned that the Permian Scytinopteridae show affinities to present-day Machaerotinae. Tillyard (1926), however, considered that *Permojassus australis* Till., which he placed in the Scytinopteridae, might well, on tegminal venation alone, be placed in the Jassidae, its principal difference from recent forms being

that the media is three-branched and the costal space extensive. However, any idea of jassoid relationship is disposed of by the hind-wing, which has also been found.

Three Triassic tegmina have been ascribed to the Jassidae (Tillyard, 1920), *Eurymelidium australe* Till., *Mesojassus ipsviciensis* Till., and *Triassojassus proavitus* Till. As pointed out by Tillyard, the venation of *E. australe* somewhat resembles that of *Eurymela* Le P. and S.; the sub-costa is not apparent as a separate vein, the radius is unbranched, and the media has two branches, but a considerable development of cross veins occurs such as is not found in modern eurymelids, except in the costal region. In the development of the radius and the media, *Mesojassus* also resembles *Eurymela*, whilst *Triassojassus*, though having a media with three apical branches, has a radius similar to that of many present-day groups other than the Eurymelidae, its three branches apparently being R_1 , R_{2+3} , and R_{4+5} .

Handlirsch (1908) figures a number of Jurassic tegmina, of which two, *Acocephalites breddini* Meunier and *Jassites punctatus* Brodie, resemble the majority of present-day groups in having a radius with two principal branches R_{2+3} and R_{4+5} , R_1 also being distinct in the latter, and with an unbranched media. Two other tegmina figured might well have belonged to primitive jassoids. These are *Homopteralum signoreti* Westwood and *Pseudodelphax pulcher* Brodie, in both of which R and M are two-branched.

Martynov (1926) has created two species, *Karrajassus crassinervis* and *Archijassus minimus* on Jurassic tegmina from Turkestan, which he placed in this family. The tegmen of the former shows relationships with *Triassojassus*, whilst *Archijassus* is only represented by a fragment.

On the scanty evidence available it would seem that true jassoids first appeared in Triassic times and are descendants of a Permian group, of which so far no representatives have come to light.

Carpenter (1933) gives a reconstruction of a hypothetical forewing of the common ancestor of Permian Homoptera. This figure is reproduced on Plate V, fig. 1, for comparison with the present author's reconstruction of the forewing of a hypothetical ancestor of recent jassoids. The principal difference between the two figures is concerned with the radius, as, although in both cases it is shown to have three branches, in fig. 1, R is two-branched and Rs single, and in fig. 2 R is single and Rs two-branched. The identification of the components of the radius in fossil impressions is made possible by the fact that R is convex and Rs concave.

According to Metcalf, the sub-costal trachea is anomalous, and may be very long, as in *Jassus*, or about half the length of the main stem, as in *Platymetopius* Burm. In only one genus, *Sarpestus* (Plate VI, fig. 8), has the sub-costal vein been noted as distinct

from the costal margin, and in some species in the related genus *Tartessus* Stal it is apparent in a reduced form. The radius retains its primitive condition in a number of genera, as shown on Plate VI, in all figures but 4, 6, and 10, with which R_1 is absent, the two branches representing R_{2+3} and R_{4+5} . With other genera, for example *Kyphoctis* Kirk. (Plate V, fig. 8), several costal veinlets may be present, and it is possible that one of these may represent R_1 . In *Aethalion reticulatum* (Plate V, fig. 4), and with the Eurymelidae (Plate V, figs. 3, 5, 7, 9) R_{2+3} and R_{4+5} occur as a single vein, but R_1 may be distinct, as shown on Plate V, fig. 3, which represents the nymphal tegminal pad of *Eurymelops rubrovittata* A and S.

Metcalf, referring to the tracheation, states that the media is typically two-branched and that M_{1+2} must have come to lie parallel with R_{4+5} and become gradually reduced to its usual present condition of, at the most, only a cross vein connecting the media with R_{4+5} . In the fully developed tegmen the media occurs as a single vein, except with the *Eurymelidae*, in which it forks into two principal branches. In certain genera in this family the lower branch may re-divide into M_3 and M_4 (e.g., *Cornutipo* Ev., Plate V, fig. 7), whilst with others all four branches may be distinct, as is shown in the figure of the tegmen of *Pogonoscopus lenis* (Jac.) given by China (1926). The first cubitus is almost invariably two-branched, but, as shown in Plate V, fig. 8 (*Kyphoctis*) and fig. 4 (*Aethalion*), secondary veinlets may be developed at its apex. The second cubitus lies along or close to the claval suture and connects with the margin of the tegmen. The only departure from the normal that occurs in the anal area is that a Y-vein may be formed. This probably originates in a cross-vein first connecting the two anal veins, followed by the second anal vein terminating at the cross-vein instead of extending to the anal border. Such a Y-vein is found in all the Australian Stenocotidae and in a number of genera in other families. It is also present in all the Fulgoroidea, and occurred in the Mesozoic Ipsviciidae.

Plate V, fig. 6, represents the tegmen of *Paradorydium menalus* Kirk., in which the radius appears to be a single vein, and the media seems to have two branches. Actually the reverse position occurs, the elongation of the tegmen having drawn out the cross-vein that represents all that is left of M_{1+2} .

Plate V, fig. 10, represents the tegmen of *Idiocerus seckeri* Ev., which is similar to all other Australian species that have been placed in this genus, but differs from European representatives, which have normal complete venation as far as the radius is concerned.

On major differences in the venation of the tegmen the Jassoidea can be separated into three distinct groups, the Aethalionidae, in which both the radius and the media are unbranched; the Eurymelidae, in which R_{2+3} and R_{4+5} are represented by a single vein,

and the media always has two principal, and may have three or four subsidiary, branches; and the rest of the Jassoidea, in which the radius has at least two branches, and the media is either unbranched or has one branch reduced to a cross-vein. Apart from the presence or absence of R_1 , the development of cross veins, the extent of the appendix and the partial fusion of adjacent veins, the venation of the tegmina of the third group of the Jassoidea, is remarkably uniform. Such differences as do occur are only of use when considered in conjunction with other characters for separating minor groups.

THE HEAD.

It is quite certain that the most reliable criteria for the determination of the inter-relationships between various jassoid groups are to be obtained from a study of head structure. This has, to a certain extent, been recognized in the past, since the usual divisions of the Jassoidea into families and sub-families have been based upon a cephalic character, the position of the ocelli. The choice of this character is an unfortunate one as it is unreliable, hence genera which are clearly related on other grounds may have species in which the ocelli are ventral, marginal, or dorsal. On the other hand, genera that have no other common characteristic have been placed in the same family merely because of the similar position of the ocelli.

The forerunners of present-day leaf-hoppers probably had opisthognathous heads with two distinct median sclerites, the clypeus, and the frons. The hind margin of the frons lay well away from the hind margin of the head, and the paired ocelli were situated close to the posterior corners of the frons. The dilator muscles of the sucking-pump were attached to the posterior half of the clypeus, which was wider than the anterior half. The sutures that bounded these sclerites, and which have been discussed in an earlier paper (Evans, 1938), were the clypeal suture, that extended from the point where the two divisions of the clypeus met, and terminated close to the antennae; the frontal suture that lay between each antenna and the ocellus, and the Y-shaped epicranial suture that lay along the posterior margin of the frons. Separating the clypeus from the frons was the transverse epistomal suture, and dividing the vertex, which must have been entirely ventral in position, was the coronal suture. A sub-genal suture was also present. Changes from such a type have taken place in several directions, the first, and almost universal change being the fusion of the frons and the clypeus and the disappearance of the epistomal suture. This was brought about by the gradual backward migration of the dilator muscles of the sucking-pump. Accompanying the disappearance of the epistomal suture the development of a transverse suture took place, separating the clypeus into two parts, an ante- and post-clypeus. This suture connects the apices of the clypeal sutures.

In certain groups, not only has the epistomal suture been obliterated, but no trace remains of an epicranial suture. This backward development of the fronto-clypeus has been accompanied by a shifting of the ocelli, which thus came to lie at the margin of the head. In other groups the head is now in two or even three planes, and, in some, the posterior third or less of the fronto-clypeus has become dorsal in position, forming with the vertex the crown of the head.

The ocelli have moved onto the crown of the head in three distinct ways. In some cases they have retained their position close to the junction of the frontal and epicranial sutures and the fixing of the head has changed their aspect (*Penthimiinae*). In others, although the epicranial suture remains ventral, they have migrated to a marginal, and finally a dorsal, position by way of the anterior apex of the head (*Ulopidae*, *Stenocotidae*), whilst in others, in which the head has become greatly produced and flattened and no traces remain of the epicranial sutures, the ocelli have moved from their position at the apices of the frontal sutures to the edge of the head close in front of the eyes, and from thence on to the crown (*Ledridae*).

The shifting of the ocelli in the last two instances cannot have been brought about by changes in muscle stresses, but must be a direct response to light stimuli. Kennedy (1928) has pointed out that the majority of primitive living insects occupy environments of low intensity of light and heat, and that Mesozoic climates may have had a general lower level of intensity, so that changes in the position of the ocelli from a ventral to a dorsal aspect may have been a reaction to a change of environmental conditions.

Such changes from a hypothetical primitive head as have been described have taken place independently in several distinct groups. To illustrate this, attention is drawn to the illustrations on Plates VII, VIII, and IX; only numbers will be referred to, names for the time being ignored. On Plate VII, fig. 7, is shown the head most nearly approaching the supposed archetype, since a trace of an epistomal suture remains. In the nymph of this particular species, the suture is complete. Figs. 5 and 6, on Plate VIII, display the same feature, whilst Figs. 6, 8, 9, 10, and 11 (Plate VII) represent the next step, in which, although the epistomal suture is obliterated, the ocelli and the greater part of the vertex remain ventral in position. Figs. 1 and 3 on Plate VIII are of special interest, in that, although the epistomal suture is lost, traces remain of the subgenal suture.

How the ocelli may become dorsal, though remaining close to the epicranial suture, is shown on Plate VII, figs. 2 and 4, which illustrate species in related genera. Plate IX, fig. 13, is another instance. Steps in the movement of the ocelli from the underside to the top of the head, occurring both laterally and apically, are shown on Plate VIII, fig. 5, Plate IX, figs. 3, 4, 5, 11, and 12. Not only may

all trace of the epistomal, coronal, and epicranial sutures be obliterated, but the frontal sutures may also disappear (Plate VIII, figs. 3, 4, and 7). Further discussion of the lines of development of leaf-hopper heads will be given in later sections. In order to make full use of head-shape and structure as a basis for phylogeny, a long series of forms must be studied before arriving at an estimate of the stability or otherwise of the various characters.

THE PROTHORAX.

A study of the prothorax is helpful, as it supplies valuable supporting evidence for use with other characters. On Plate IX the prothoraces of a number of species are figured in lateral aspect, and the principal point to be noted, and to which attention will be drawn later, is the width of the segment at the point of junction of the pronotum and propleurae. The episternum is seldom visible, being reduced and hidden by the head, but the epimeron (shaded in all figures) is seen to be wide dorsally in most of the figures, and narrow in only a few, and in only one case (fig. 10) is its dorsal ending hidden. The pronotum likewise may be wide laterally or very narrow.

HIND TIBIA.

Whilst the venation of the wings and tegmina are of greatest value in determining the limits of the principal jassoid groups, and the head supplies the most reliable characters for the separation of lesser groups, the hind tibiae are of subsidiary value. In the possession of elongated hind tibiae, armed with three or four rows of spines, the Jassoidea differ markedly from the Cercopidae, which have short, apically thickened hind tibiae armed with one or two stout spurs, and differ, though to a less marked extent, from the Membracidae, which have short hind tibiae, semi-circular in outline, that are covered with hairs, and may also have one or two rows of very small spines.

A number of types of tibial armature are illustrated on Plate X. The various figures will be referred to in connexion with the different families. It is supposed that the ancestors of present-day jassoids had hind tibiae that bore a row of long hair-like spines on one edge, two rows of evenly spaced spines arising direct from the tibia itself, and a row of spines mounted on prominent bases, that may have either decreased in size from the apex to the base, or have been of equal size. Such types are shown in figs. 1, 3, 4, 9, and 12. Changes have occurred in the elongation of the tibia, accompanied by a wider separation of the spines (figs. 8 and 11), the reduction in size and even disappearance of most of the spines and the increased development of one or a few spurs (figs. 5, 14, and 15), and in the reduction in size of the spurs and the addition of minute spines set between their bases (figs. 7 and 13). Of the four figures so far

not mentioned, figs. 2 and 16 represent slight deviations from the supposed primitive type, whilst fig. 10 is the hind tibia of *Aethalion reticulatum*, which has more membracid than jassoid affinities, and fig. 6 represents the hind tibia of *Lasioscopus acmarops* (Jac.), which, being a myrmecophile, has certain adaptive characters.

MALE GENITALIA.

For a long time the male genitalia have been a favourite character for use in specific determinations, and there is no doubt that their structure is of value for this purpose. The mere fact that they are usually the first part of an insect's body to show any morphological changes following species differentiation, would suggest that they are peculiarly unstable, and therefore likely to be of little use for the determination of the relationships of major groups. With certain reservations, this is held to be the case, yet Singh-Pruthi (1925), in his valuable work on the male genitalia of Hemiptera finds sufficient characters in these organs alone to suggest certain basic jassoid relationships.

The male genitalia of the Jassoidea are situated on the ninth, tenth, and eleventh abdominal segments. The ninth segment is very wide in the tergal region and narrow in the sternal region, and bears a pair of appendages, the sub-genital plates, or, as Snodgrass (1935) terms them, the harpagones. The aedeagus projects from the segmental membrane, which is a backward continuation of the body wall that separates the ninth from the tenth sternite, and may have a large basal apodeme for muscle attachment. It is usually attached to a phallobase, the basal plates of Singh-Pruthi, to which are connected accessory clasping organs, the parameres. With many genera the ninth segment extends posteriorly past the segmental membrane as a pair of protective flaps, the pygophores. In addition to the processes mentioned above, a pair of styles may be developed, either on the sub-genital plates or on the pygophores. The tenth segment is much reduced, and beyond it again is a still smaller sclerite, and the anal style. Following Singh-Pruthi, the sclerite between the tenth segment and the anal style is regarded as the greatly reduced eleventh segment.

On Plate XI are figured the male genitalia of twelve species of leaf-hoppers. Figs. 1 and 2, which represent the genitalia of *Bakeriella procurrans* (Jac.) and *Eurymela fenestrata* Le P. and S. respectively, differ from all the others in lacking any development of a pygophore, but the most noteworthy difference is that the phallobase or basal plates of these species, both of which belong to the Eurymelidae, have no connexion with the aedeagus. Wide apodemal processes serve instead for the attachment of the muscles that control the aedeagus, which is directed ventrally; this is universal

throughout the family. Whilst the sub-genital plates of *E. fenestrata* are wide, and bear strong styles that arise from their ventral margins, those of *B. procurrens* are narrow and do not carry styles. The lack of styles is a character common to all species in the sub-family Ipoinae, but they are universally present with the Pogonoscopinæ and Eurymelinae, but in one genus in the last mentioned family (*Eurymelita* Ev.) they arise from the dorsal and not the ventral margin of the sub-genital plates.

The genitalia of *Idiocerus kirkaldyi* Ev. (Plate XI, fig. 6) are of interest, because the basal plates, which are fused into a Y-shaped structure, are produced as a thecal sheath that invest the aedeagus, except at the distal end, resulting in the wide separation of the aedeagus from the basal plates proper. This suggests an approach to a condition such as is found in the Eurymelidae. Each side of the base of the exposed portion of the aedeagus is covered by the ends of narrow pleural plates that belong to the tenth segment. A somewhat similar structure is seen in fig. 4 (*Macropsis tasmaniensis* Ev.), but with this species a style is developed, and a process attached to the basal support of the aedeagus.

With *Eurinoscopus viridis* Ev. (Plate XI, fig. 3), although, as with *I. kirkaldyi*, the aedeagus base is at some distance from the parameres, the intervening space, in this instance, is bridged by the basal plates themselves. Fig. 5 (*Austroagallia torrida* Ev.) differs from the other genitalia illustrated in that the ninth segment is wide ventrally, but this is of no significance as species in related genera, figured by Lawson (1920), have the usual narrow ventral development of this segment.

Singh-Pruthi considers that the genitalia of the various groups can be *roughly* reduced to three sub-types, typically found in the Bythoscopinæ, Jassinæ, and Tettigoniellinæ, also that the Jassine type is the central from which the other two can be derived. The genitalia of five other sub-families recognized by this author are considered by him to show a medley of relationships, as, for instance, the Megophthalminæ (Paropiidae) essentially resemble the Bythoscopinæ, but have sub-genital and basal plates of the Jassine type, and the Ledrinae possess characters of both the Tettigoniellinæ and Bythoscopinæ!

It is apparent that, whereas the male genitalia are of great value for specific differentiation; for determining the limits of a genus; and the degree of relationship between allied genera, with certain exceptions, they are of little help in deciding the affinities of major groups, except as subsidiary characters taken in conjunction with others of more dependable nature. As an example of the unreliability of deductions based on genitalia alone, attention is drawn to

Plate XI, figs. 1, 3, and 4, which represent the genitalia of three species of leaf-hoppers, all of which were formerly placed in the Bythoscopidae, and which might be supposed to be related on grounds other than the position of the ocelli, since all have long, narrow subgenital plates. The genitalia of *B. procurrens* (fig. 1) have already been shown to differ radically from all those figured, with the exception of *E. fenestrata* (fig. 2), even though superficial examination would not suggest affinity between these two species. Fig. 6 (*I. kirkaldyi*), also formerly placed in the Bythoscopidae, has only superficial resemblance to fig. 3, whilst fig. 5 (*Austroagallia torrida*), though previously classed in the Bythoscopidae, has no resemblance at all to either fig. 3 or 4.

PROPOSED CLASSIFICATION.

In a previous paper (Evans, 1936) the statement was made that it was unfortunate that the Palaearctic jassoid fauna was the first to be studied thoroughly, since the classification of other faunas has of necessity been based on this, and that it was believed that, when the Australian fauna was better known, new light would be shed on the whole jassoid complex.

In the system now presented the Jassoidea are divided into twenty-one families, a number of which are of doubtful status. In establishing this system of classification, due regard has been paid not only to morphological details, but also to general appearance, sculpturing, and coloration. In no case has a single characteristic, such as the position of the ocelli, been allowed to assume undue importance.

After considerable thought it was decided to give each of the major divisions the rank of Family, as by so doing the arrangement of the lesser groups is facilitated. It is certain that the Aethalionidae and Eurymelidae are worthy of separation almost as complete as that of the Membracidae, but for convenience they are classed as ordinary jassoid families. Certain of the more recent families, such as the Euscelidae and Eupterygidae, which are represented by numerous genera and species, are not as distinct as others, such as the Paropiidae and Austroagalloididae, which are only represented by a few survivors from an earlier geological age. Families, such as the Euacanthidae are retained only provisionally because the author is familiar with but a few representatives, and hence is not in a position to determine their true status. The accounts of the various families are not intended as definitions, as such would be impossible without a full knowledge of the fauna of the world, and only brief mention is made of well-known established families for which no changes are proposed.

Aethalionidae

(Plate IV, fig. 4; Plate V, fig. 4; Plate VII, fig. 9; Plate X, fig. 10)

This family is confined to South America. Only one species, *Aethalion reticulatum* L., is known to me. Baker (1915) suggested that relationships might exist between this family and the Eurymelidae, but there is no resemblance between the two groups in a single character of any significance.

They have already been shown to differ from the rest of the Jassoidea in the venation of both the wing and the tegmen, and in the armature and shape of the hind tibia. The adult head displays several primitive characteristics, such as the ventral position of the ocelli and the persistence of the coronal and epicranial sutures. In the nymphs there is no suture separating the ante-clypeus from the fronto-clypeus, but an ill-defined epistomal suture occurs, traces of which may be seen in the adult head. Other features that serve to separate the Aethalionidae from the rest of the Jassoidea are the proximal fusion of the sub-genital plates and the large pronotum. Mr. China has informed me that species in this family are ant-attended, thus resembling the Membracidae in habits as well as in certain structural details.

Eurymelidae

(Plate IV, fig. 5; Plate V, figs. 3, 5, 7, 9; Plate VII, fig. 8; Plate X, figs. 4, 5; Plate XI, figs. 1, 2)

The Eurymelidae, which are the dominant family of leaf-hoppers in Australia, have two outstanding characters that separate them from the rest of the Jassoidea. The media of the tegmen has two, three, or four branches, and the aedeagus is completely separated from the basal plates. Apart from these features their appearance is distinct, and they can be recognized by their flattened face and more or less diamond-shaped fronto-clypeus, which is completely surrounded by well-defined sutures. The ocelli are always close to the junction of the frontal and epicranial sutures, well away from the posterior border of the head, and show no tendency to migrate to a marginal position. There are three distinct sub-families, the Ipoinae, Pogonoscopinae, and Eurymelinae. It is believed that the Ipoinae are the most primitive and that the Pogonoscopinae are a specialized off-shoot from the base of the Eurymeline stem.

The Ipoinae, of which thirteen genera, containing twenty-nine species, have so far been described (many more await description), feed principally on eucalyptus trees, but two species have been recorded from *Casuarina* sp., one from *Eremocitrus glauca*, and others occur on mistletoe (*Loranthus*) growing on various hosts. They range from small forms with narrow sub-genital plates to large species with wide sub-genital plates. Two species are of special

interest; one of these, *Bakeriola procurrans*, which is confined to Western Australia, has hind tibiae with a complete armature of spines, whilst most eurymelids have a reduced armature, accompanied by spur development. The sub-genital plates are simple, being long and narrow without accessory styles; the tegmina are not tectiform, and the head facially is as wide as long. None of these characteristics are typical of the family, and suggest that *B. procurrans* is a generalized species, and may represent a type from which other forms have arisen. The other species of interest is *Cornutipoides tricornis* Ev., also from Western Australia (figured in Evans, 1934), which has a prominent horn on the head formed entirely of the fronto-clypeus, and a pair of lateral horns arising from the vertex on each side. It differs from other described members of the family in having narrow maxillary plates and prominent globular eyes, and, as with the related *Cornutipo scalpellum* Ev., the media in the tegmen has three branches. It is assumed that, whilst the venational character is primitive, the others mentioned are due to extreme specialization.

The Eurymelinae, of which twenty-five species, contained in seven genera, have been described, range from forms very similar to the less specialized Ipoinae to large, brightly coloured species that have reduced tibial armature and large sub-genital plates.

The Pogonoscopinae, which are largely confined to Western Australia, and of which six species, contained in three genera, have been recorded, are all myrmecophilous and feed on the roots of eucalyptus trees.

Until raised to family rank by the present author in 1934, the Eurymelidae were included in the Bythoscopidae solely on account of the facial position of the ocelli. Singh-Pruthi suggested that, in the reduction of the basal plates and in the flap-like sub-genital plates, the group approached the Cercopidae, but a consideration of other characters lends no support to this view. Although now widespread in Australia and extending to New Guinea and New Caledonia, it is probable that this family developed in Western Australia in Cretaceous times, when that part of the present continent was separated from Eastern Australia by a wide sea (Tillyard, 1924). Their close association with trees of the genus *Eucalyptus* lends support to this view, since there is evidence to show that these trees date back to Cretaceous times (Seward, 1931). Though descended from an ancient stock, the wide variation in coloration and minor structural features that occurs in many genera, suggests that species differentiation is still in progress. Like the Membracidae and Aethalionidae, all the Eurymelidae are ant-attended, and in common with these groups the nymphs lack jumping powers, such as are common to all the rest of the Jassoidea.

Bythoscopidae

(Plate IV, fig. 6; Plate VI, fig. 6; Plate VII, figs. 1-4; Plate VIII, 7, 8; Plate X, fig. 1; Plate XI, fig. 3)

In an earlier paper (Evans, 1936), it was pointed out that the Bythoscopidae appear to comprise a heterogeneous collection of genera bound together by a single character of doubtful phylogenetic significance, the ventral position of the ocelli, and, in the paper referred to, the following Australian genera were placed in this family: *Eurinoscopus* Kirk., *Trocnada* Walk., *Chinaella* Ev., *Idiocerus* Lewis, *Podioscopus* Kirk., *Austroagallia* Ev., *Austroagalloides* Ev., *Oncopsis* Burm., *Macropsis* Lewis, and *Stenoscopus* Ev..

With the exception of *Eurinoscopus*, *Trocnada*, and *Chinaella* it is now proposed to remove the above genera from the family and to add the following genera: *Penthimia* Germ., *Vulturinus* Kirk., *Neoculturinus* Ev., *Thaumatoscopus* Kirk., *Hecalus* Stål, *Renteriella* Sign., and a genus not represented in Australia, *Gypona* Germ.. Only one point has received consideration in making these changes; whether or not the species in the various genera give evidence of phylogenetic affinities to *Bythoscopus* Germ.. It is realised that certain genera not represented in Australia should also be removed and others added, but those mentioned are sufficient for the present purpose. The reasons for discarding seven genera will be discussed in connexion with the families to which they have been relegated, but the first step is to explain why seven genera, none of which have previously been considered as having affinities to *Bythoscopus*, are placed in this family, and why three Australian genera have been retained in it.

Bythoscopus and Eurinoscopus

There has never been any doubt concerning the close relationships of these two genera, which differ solely in that the tegmen of *Eurinoscopus* is somewhat narrower than that of *Bythoscopus* and lacks the numerous costal cells present in the latter. Also species in the Australian genus are smaller and narrower than *B. lanio* L..

Eurinoscopus

As this genus, together with *Bythoscopus*, represents a basic type, the principal features are described. The head is much wider than long, has wide maxillary plates, a fronto-clypeus separated from the vertex by a perceptible though faint semi-circular suture, and prominent antennal ledges that extend from the eyes to the fronto-clypeus. The head (Plate IX, fig. 1) is neither evenly convex nor flat, and that part anterior to the antennal ledges lies at an angle to the rest. The tegmina overlap apically, and the area enclosed by the two branches of the first cubitus is not pigmented as is the rest

of the tegmen, but forms a supplementary appendix. The wing (Plate IV, fig. 6) has the apices of R_{4+5} and M_{1+2} fused into a single vein, and the hind tibiae (Plate X, fig. 1) are flattened and slightly curved and bear an armature of regular spines, and when the insect is at rest the hind femora, which bear apical spines, lie against the wide propleurae.

Eurinoscopus and Chinaella

Chinaella (figured in Evans, 1936) differs from *Eurinoscopus* in the more declivous head and pronotum and the greater overlap of the tegmina apically.

Eurinoscopus and Trocnada

Trocnada resembles *Eurinoscopus* in all essential cephalic characters, but differs from it in that posterior to the antennal ledges the head is on a plane with the declivous pronotum and at right-angles to the anterior half of the head. Species in the two genera are similar in the venation of the tegmen, the possession of a supplementary appendix, the venation of the wing, the shape and armature of the hind tibiae, and in the structure of the male genitalia.

Eurinoscopus, Trocnada, and Penthimia

The close resemblance between the heads of insects in these three genera may be seen by a glance at Plates VII and IX. On Plate VII, figs. 1 and 2 and 3 and 4 represent the heads of *Penthimia americana* Fh. and *Trocnada gigantea* Ev. respectively, and on Plate IX, fig. 1, represents the head of *Eurinoscopus viridis* in profile, and fig. 2, *Penthimia americana* in the same aspect. The figures make discussion unnecessary, and all that need be mentioned is that in essential points of structure there is no difference between the three heads. Species in all three genera have the prothorax similar in shape, and the position of the hind femora and the shape and armature of the hind tibiae are identical. The tegmen of *Penthimia* approaches that of *Bythoscopus* more than *Eurinoscopus*, and the wing venation is of the normal jassoid type.

Eurinoscopus, Penthimia, Neovulturnus, Vulturnus and Thaumatoscopus

All the above genera, except the first, have been previously placed in the Penthimiidæ (Evans, 1937, c), and their inter-relationships discussed. In the paper referred to, figures were given to show progressive change in head-shape from a species resembling *Eurinoscopus* (*Neovulturnus lapsus* Ev.) to one resembling *Penthimia* (*Neovulturnus maculosus* Ev.), and from such a type to a species with a produced foliaceous head (*Thaumatoscopus dunkensis* Ev.).

Neovulturnus, *Vulturnus*, and *Thaumatoscopus* resemble *Eurinoscopus* in having overlapping tegmina with supplementary appendices, wide propleurae, and hind femora that rest against the propleurae, and hind tibiae similar in shape and armature.

Eurinoscopus and Reuteriella

The head of *R. flavescens* (Plate VIII, fig. 7; Plate IX, fig. 3) differs from those of species in the genus *Eurinoscopus* in being considerably produced and flattened, and in lacking frontal and epicranial sutures, but resembles it in the shape of the maxillary plates and in having distinct antennal ledges that extend as far as the eyes. The pronotum is wide laterally and on a plane with the crown of the head, and the propleurae widely separate the eyes from the base of the tegmina. The latter are long and narrow, and have a supplementary appendix, and the wings have R_{4+5} fused apically with M_{1+2} . *Reuteriella* also resembles *Eurinoscopus* in characters supplied by the hind legs.

Reuteriella and Gypona

Gypona (Plate VIII, fig. 8 and Plate IX, fig. 5) differs from *Reuteriella* in having the ocelli on the crown of the head and not marginal, and in having a less produced head. However, in *Reuteriella*, the ocelli, though usually marginal, may be on the crown close to the margin, but not touching it. In both genera the coronal suture is distinct on the crown, but in neither does it extend to the apex, suggesting that the crown consists in part of the fronto-clypeus, so that the division of the head into dorsal and ventral surfaces may have started as in *Trocna* and *Penthimia* and have been followed by a flattening process, as in *Thaumatoscopus*. The prothorax of *Reuteriella* is similar in shape to that of *Gypona*; the tegmina of both are long and narrow, but those of *Gypona*, although they overlap apically, lack a supplementary appendix, and in the wing of *Gypona*, although R_{4+5} is distinct from M_{1+2} , there is no cross-vein between them, and the veins touch at the point usually occupied by a cross-vein. The hind legs of *Gypona* are similar in shape and armature to those of *Reuteriella*, but the hind tibiae may have a few minute spines set between each of the largest spines.

Hecalus

Hecalus (Plate IX, fig. 4) must also be placed in the Bythoscopidae, although the head differs from those already described in lacking prominent antennal ridges, and in having a swollen fronto-clypeus.

The ocelli are on the margin of the head just in front of the eyes close to the apices of the frontal sutures. Epicranial sutures are absent, but the coronal suture is distinct and from its shortness it is evident that the greater part of the crown is of fronto-clypeal origin. The tegmina are short, do not overlap, and may be brachypteros in one sex. The wings have normal venation. Thus, although in certain characters this genus displays no obvious relationship with *Bythoscopus* and other genera in the *Bythoscopidae*, it resembles them in the basic structure of the head, in the shape of the prothorax, and in the shape and armature of the hind tibiae.

It is not suggested that the genera placed in this family are all very closely related to one another, but it is maintained that they all have greater affinity to *Bythoscopus* than have such genera as *Agallia* and *Macropsis*, and than they themselves have to other genera, such as *Euscelis* and *Thaumotettix*. The family may be divided into three sub-families, the *Bythoscopinae*, *Penthimiinae*, and *Gyponinae*, the *Penthimiinae* being subdivided into the *Penthiminii* and *Thaumatoscopini*, and the *Gyponinae* into the *Gyponini* and *Hecalini*.

Euscelidae

(Plate VIII, fig. 10)

The Jassinae have presented in the past a bewildering collection of genera of doubtful affinities, linked together by the fact that all have the ocelli on the margin of the head. As understood here, this family includes only such genera as *Thaumotettix* Zett., *Chlorotettix* Van D., and *Selenocephalus* Germ, which are all related to *Euscelis* Brullé.

The Euscelidae are poorly represented in Australia, and no attempt is made to remove all the genera which have been placed in the Jassinae in the past, and which do not belong to the Euscelidae, although a number are changed to other families, and for certain groups of genera, new families are erected.

There is little doubt that the Euscelidae are not far removed from the *Bythoscopidae*, but are of more recent development. With the head, the frontal sutures diverge outwards, the eyes and the ocelli lie at their apices on the margin of the head or just above or below it. A distinct epicranial suture is never developed, but the coronal suture is almost invariably present, and the crown of the head consists in part of the fronto-clypeus and in part of the vertex. The propleurae may be wide or narrow, and usually separate the eyes from the bases of the tegmina, and the hind tibiae are

heavily armed, but lack prominent spurs. No *Acucephalini* have been recorded from Australia. Lawson (1920), in defining this tribe, states that the ocelli are on the margin of the vertex or just above it, but much farther from the eyes than with the *Jassini*. Of the two species of this tribe available to me for study, *Acucephalus nervosus* (Schrank) and *Acucephalus fasciatus* L., the former is noteworthy in that the fronto-clypeus is confined entirely to the ventral surface of the head, and the flattened produced crown consists only of the vertex. Both species lack a marginal vein in the wing between R_{1+2} and Cu.

In so far as is known none of the *Euscelidae* are arboreal, but feed on low-growing plants, principally grasses.

Agalliidae.

(Plate VII, fig. 11; Plate XI, fig. 5)

This family, which comprises *Agallia* Curt., *Aceratagallia* Kirk., *Austroagallia* Ev., and related genera, contains a number of small insignificant species with certain distinctive cephalic characters, which serve to separate them from the rest of the *Jassoidea*.

The clypeal suture forms a continuous line with the antennal ledges on each side of the head, and the epicranial sutures, which are usually perceptible, though never well-marked, proceed from above the antennal ledges and are joined by the coronal suture. There is no trace of frontal sutures, and hence the ocelli, which in most leaf-hoppers lie at the apices of the frontal sutures, are isolated. In the *Idioceridae*, which somewhat resemble the *Agalliidae* in superficial characters, frontal sutures are distinct, and epicranial sutures, when perceptible, occur as a transverse suture that joins the apices of the frontal sutures. The pronotum narrows laterally, the bases of the tegmina lying close behind the eyes; both tegmina and wings have normal complete venation, and the hind tibiae, which have numerous spines, lack prominent spurs.

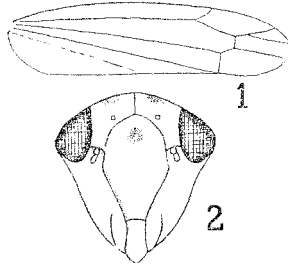
All known species feed on grasses and other low-growing plants, none being arboreal.

Eupterygidae

(Plate VIII, fig. 12)

The *Eupterygidae* are usually considered as a distinct family or as a tribe of the *Jassinae*. The majority of species have a head such as shown on Plate VIII, fig. 12 (*Typhlocyba ulmi*), which resembles *Euscelis*, in that the frontal sutures diverge towards the eyes, and there is no trace of an epicranial suture, but others have

the frontal, epicranial, and coronal sutures distinct, which suggests that this family may have arisen from the same main stem as the *Bythoscopidae* independently of the *Euscelidae*. No named specimens with this character being available, recourse has been made to describing a new species of the genus *Empoasca* Walsh.



1. Tegmen of *Empoasca bancrofti*.
2. Head of *Empoasca bancrofti*.

Empoasca bancrofti, n. sp.

Length, 4 mm. *Head*, bright yellow with three large round black spots; eyes, black. *Pronotum*, yellowish-grey, medially black. *Scutellum*, yellow, lateral angles black. *Tegmen*, greyish-yellow. The rest of the body yellow. *Male Genitalia*, with the sub-genital plates broad basally and narrow apically and with short twisted parameres.

Type ♂, from Eidsvold, Queensland (coll. T. Bancroft), in the collection of the C.S.I.R. Division of Entomology at Canberra.

Idioceridae

(Plate V, fig. 10; Plate VII, fig. 12; Plate IX, fig. 8; Plate X, fig. 2; Plate XI, fig. 6)

This family is erected to contain leaf-hoppers in the genus *Idiocerus* Lewis and *Pedioscopus* Kirk., and in such other genera as are related to *Idiocerus*, but lack Australian representatives.

No attempt is made to define the limits of this family, but it will be shown that not only do species in the above genera give no evidence of close affinity with *Bythoscopus*, but also are they distinct from all other jassoid families. It is possible that Australian species that have been placed in the genus *Idiocerus* are not congeneric with the genotype, *I. adustus* H., but they are closely allied to it.

The head is flat or convex, but always in one plane, the crown, which consists solely of the vertex, never being sharply separated from the face. The antennal ledges are not prominent, and the

antennae of the males may have disc-like swellings near the tip. The frontal sutures are distinct and the ocelli lie at their apices, and coronal and epicranial sutures, which are seldom clearly defined, lie as shown on Plate VII, fig. 12. The propleurae are narrow, and the bases of the tegmina lie close behind the eyes. The tegmina, which are long and narrow and usually hyaline, have wide appendices, and the venation may be reduced. Those species representative of the Palaearctic fauna figured by Melichar (1890), have R^2+3 and R_{4+5} present as distinct veins, but all described Australian species have these veins partially fused (Plate V, fig. 10), whilst, with *Pedioscopus*, although the radius is reduced, the media is distinct from it basally.

The venation of the wing is of the usual type, and the slender hind tibiae have a few prominent spurs that decrease in size from the apex to the base. The male genitalia, which are of an unusual type, have already been discussed. So far as is known all species in this family are arboreal.

Austroagalloidea

(Plate VI, fig. 4; Plate VII, fig. 5; Plate IX, fig. 10)

In 1936 (Evans, 1936) a new genus *Austroagalloides* Ev. was defined to contain a number of leaf-hoppers that had ventral ocelli, superficially resembled species in the genus *Idiocerus*, and which were thought to be related to *Agallia*. Further analysis of their structure has led to the decision that insects in this genus are sufficiently distinct to merit separation as a family, and it is probable that the present genus, which contains seven described species, should be divided into two or three genera.

The head (Plate VII, fig. 5) in most species lies in three distinct planes, and consists of a wide crown which is entirely made up of the vertex, and which is separated from the rest of the head by a transverse ridge, followed at right-angles by a more or less rectangular area bounded by the eyes laterally and the antennal ledges anteriorly. The only sutures present in this area are the frontal sutures that terminate close to the ocelli. The anterior portion of the head is more or less parallel to the crown. The figure of the head should be compared with those immediately above it on Plate VII, both of the upper figures being representatives of the Bythoscopidae, and the following differences noted. The eyes of *Austroagalloides nigra* Ev. are considerably larger and no sutures are developed above the apices of the frontal sutures, and, whilst the ocelli of both *Penthimia americana* and *Trocnada gigantea* lie on

the crown of the head close to the junction of the epicranial and frontal sutures, the crown of *A. nigra*, which is not shown in the figure, consists, as has already been mentioned, of the vertex only.

The pronotum (Plate IX, fig. 10) narrows laterally, and the bases of the tegmina lie close behind the eyes. The tegmina are long, narrow, and steeply tectiform, and have a very narrow appendix or none at all, and with the wings R_2+3 is incorporated in the costal margin and not distinct. The hind tibiae have an armature of weak spines, either evenly spaced or reduced in numbers, and of the types figured resemble most closely Plate X, fig. 16. When the insect is at rest the proximal ends do not lie as far forward as the propleurae.

The family is confined to Australia, and all species feed on eucalyptus trees. Its representatives are especially abundant at altitudes over 3000 feet, although they also occur in areas subject to high temperatures and low rainfall.

Thymbridae

(Plate IV, fig. 7; Plate VII, fig. 10; Plate IX, fig. 7; Plate X, figs. 8 and 12)

The following genera, all of which are confined to Australia, New Guinea, and the neighbouring islands, are placed in this family, which was formerly considered (Evans, 1937, b) as a tribe of the Euscelidae: *Thymbris* Kirk., *Alseis* Kirk., *Epipsychidion* Kirk., *Putoniessa* Kirk., *Macroceps* Sign., *Rhotidoïdes* Ev., *Hackeriana* Ev., *Rhotidus* Stål.

In the more primitive genera, e.g., *Macroceps* (Plate VII, fig. 10), the head is much wider than it is long and the fronto-clypeus is small and entirely ventral. Posterior to the epicranial suture, but anterior to the ocelli, is a transverse ridge that extends right across the head to the eyes on each side. In genera, such as *Putoniessa* and *Rhotidoïdes*, with the backward extension of the fronto-clypeus, the ridge lies along the ventral apical border of the head, and the ocelli have moved from a ventral to a marginal position. In *Thymbris* the ridge is still perceptible, but the ocelli are on the crown, whilst in *Rhotidus* and *Hackeriana*, in which the head is produced and the ocelli on the crown, in the case of the former, well away from the apex; no trace remains of a transverse ridge or of the epicranial suture. Both the tegmina and the wings have normal venation; the pronotum is narrow laterally, and the hind tibiae are armed with prominent spurs that decrease in size from the apex to the base.

All known species are arboreal, and the majority are confined to eucalyptus trees.

Macropsidae

(Plate VI, fig. 7; Plate VII, fig. 6; Plate IX, fig. 6; Plate X, fig. 3; Plate XI, fig. 4)

It is difficult to understand why this well-distributed group of leaf-hoppers has been associated so long with *Bythoscopus*, since, apart from ventral ocelli, and the shape of the parameres and sub-genital plates, both characters of little phylogenetic significance, there are no features common to the two groups. Of the three genera present in Australia, two, *Macropsis* Lewis and *Oncopsis* Burm., are of world-wide distribution, whilst *Stenoscopus* Ev. is confined to Western Australia.

The head, as far as Australian species are concerned, lies almost entirely in one plane, and a crown, if present, is very narrow. The ante-clypeus and lorae are frequently somewhat swollen, the maxillary plates narrow, the clypeal sutures directed outwards towards the eyes, and the antennal scrobes form a continuous line with them.

Frontal, epicranial, and coronal sutures may be faintly indicated, as shown on Plate VII, fig. 6 (*Oncopsis pullus* Ev.), or not apparent, and a pair of compact sausage-shaped markings indicate the attachments of the muscles of the sucking-pump. The fronto-clypeus is usually small, the vertex is large, and the whole head is generally punctate or rugose. The pronotum, which may be declivous or raised into a hump, narrows laterally (Plate IX, fig. 6), and the bases of the tegmina lie close behind the eyes. The tegmina have normal venation, and frequently several angular cells are developed; they are tectiform, have narrow appendices, and do not overlap apically. The wing venation is distinct, as R_{2+3} and R_{4+5} are fused for their entire length. The hind tibiae are not flattened nor curved, and have a row of evenly-spaced short, strong spines (Plate X, fig. 3).

Of the three genera, fifteen species of *Macropsis*, seven species of *Oncopsis*, and one species belonging to the genus *Stenoscopus*, have been described from Australia. These represent but a fraction of the large numbers that await description, and it is probable that an intensive study of the family would lead to the erection of several new genera. As far as is known, all members of this family inhabit trees and shrubs.

Tartessidae

(Plate IV, fig. 8; Plate VI, fig. 8; Plate VII, fig. 7; Plate X, fig. 7; Plate XI, fig. 11)

This family is erected to hold a very distinct group of genera, three of which occur in Australia (*Tartessus* Stål, *Tartessella* Ev., and *Tartessoides* Ev.). Previously these genera had been included in the Euscelidae (Evans, 1937, b).

The head is of particular interest, because in the nymphs of some species of *Tartessus*, the frons is a distinct sclerite, and even in the adult head traces may remain of the epistomal suture (Plate VII, fig. 7). The ocelli lie at the corner of the frons, close to the junction of the frontal and epicranial sutures, and may be either ventral, marginal, or dorsal, and the crown may consist entirely of the vertex or of the vertex and a narrow frontal margin. The tegmina have several cells, and a wide appendix that extends to the costal margin, and in *Sarpestus specularis* Spangb., a New Guinea species, traces remain of the sub-costal vein. In this genus the media is fused for the greater part of its length with the radius. The wing is unique amongst the Jassoidea, in having a marginal or ambient vein that continues on to the anal area. The hind tibiae have three rows of long, strong spines and one row of fine hair-like spines, and between each of the spines of one row, all of which are set on swollen bases, occur a few minute spines. This development of minute interpolated spines is of little significance as it has occurred independently in several groups.

All species in this family are arboreal, and the Australian representatives, although not confined to eucalyptus trees, are principally associated with them.

Jassidae

(Plate VII, fig. 14)

This family is only known to me from two species belonging to the genus *Jassus* Fabr. The head of one of these, which is illustrated on Plate VII, fig. 14, is long and narrow, and the frontal sutures lie close to the eyes on each side. The ocelli are marginal, and the coronal suture joins the transverse epicranial suture at the apical margin of the head, thus the wide crown consists entirely of the vertex. The tegmina superficially resemble those of *Tartessus*, as the wide appendix continues as far as the costal border. The male genitalia are of interest, since the aedeagus is very long and the basal plates short.

Species in this family resemble the Tartessidae, as the epicranial suture lies along the ventral posterior margin of the head, and is transverse, but in the lengthening and narrowing of the face they differ widely from all other genera that have arisen from the Bythoscopoid stem. Only a single genus, *Tharra* Kirk., belonging to this family has been recorded from Australia.

Cicadellidae

(Plate VI, fig. 9; Plate VIII, fig. 9; Plate IX, fig. 13;
Plate X, fig. 13)

This well-differentiated family needs little comment, its most outstanding characteristic being that not only does the hind-most portion of the fronto-clypeus form part of the crown, but the attachment impressions of the muscles of the sucking-pump extend on to the crown. The frontal sutures are also on the crown of the head and are always distinct, and traces may remain of a transverse epicranial and a longitudinal coronal suture. The ante-clypeus and the post-clypeus are usually swollen, the pronotum is wide laterally, and the tegmina long and narrow. The hind tibiae have an armature of strong spines, but lack spurs, and may have minute spines between each of the most prominent spines.

This family, members of which feed principally on grasses, is poorly represented in Australia, only one genus, *Cicadella* Latreille, having been recorded.

Euacanthidae

(Plate VII, fig. 16; Plate IX, fig. 14)

Euacanthus Le P. and S. does not occur in Australia, but three Australian species have been placed in a genus *Euacanthella* Ev., which is believed to be related to *Euacanthus*.

The family contains species that are similar in general appearance to members of the Cicadellidae, but which differ in that, although the hind portion of the fronto-clypeus extends on to the crown, the frontal sutures are ventral, the ocelli, though dorsal, are close to the margin of the head, and a transverse dorsal ridge marks the position of the epicranial suture. It is possible that the area between this ridge and the apex of the head represents the remains of the frons. The pronotum is wide laterally in *Euacanthus*, though narrow in *Euacanthella*, and in both genera the ante- and post-clypeus are swollen. The tegmina are short and rounded apically and lack a cross-vein (M_{1+2}) joining the media to the radius. The hind tibiae are armed with evenly-spaced spines of equal size mounted on slightly protuberant bases and with minute spines set between them. All species known to me are grass-feeders.

Pythamidae

(Plate VII, fig. 13)

This family is only known to me by one species, *Mainda praeculta* Dist., the head of which is figured, although two Australian genera, *Fortior* Kirk. and *Dryadomorpha* Kirk., have been described. For

particulars of the characteristics of this family, reference should be made to Baker, 1923. This author has pointed out that the Pythamidae have affinities to the Euacanthidae and Signoretidae rather than to the Cicadellidae.

Signoretidae

(Plate VI, fig. 10; Plate VII, fig. 15; Plate IX, fig. 15;
Plate X, fig. 16)

No representatives of this Oriental family occur in Australia. A number of illustrations are given of *Preta gratiosa* Mel., and it will be seen that, although in cephalic characters this species would appear to be close to *Euacanthus*, the tegminal venation and armature of the hind tibiae are of a distinctive nature.

Nirvaniidae

(Plate VIII, fig. 11)

Four species contained in four genera have been described from Australia, but these insects are rare, and for a discussion of this family reference should be made to the work of Baker, mentioned above. The head of *Nirvana pallida* Mel. is figured; with this species the frontal sutures are short, and it is probable that the produced crown consists solely of the vertex.

Stenocotidae

(Plate V, fig. 8; Plate VIII, figs. 5, 6; Plate X, figs. 9, 11;
Plate XI, figs. 8, 9)

The Stenocotidae, with the exception of a single genus, are confined to Australia. The face of the head is usually flattened and as wide as long, and the fronto-clypeus in certain species is separated into a frons and post-clypeus, the arched epistomal suture persisting in a reduced form (Plate VIII, fig. 5). The ocelli, which lie at the apices of the frontal sutures, may be ventral or dorsal or lie in marginal depressions. The tegmina in all Australian representatives have the anal veins fused apically, and the hind tibiae have distinct spurs, decreasing in size from the apex to the base. Sexual dimorphism occurs in some genera.

Baker (1923), in a discussion of the position of the genus *Koebelia* Baker, which occurs in Western North America, suggested that it lay between *Stenocotis* Stål and *Ulopa* Fall., but was sufficiently distinct from either to merit the erection of a family, the Koebeliidae, to contain it. This genus is now transferred to the Stenocotidae, because of the close similarity of head structure between *Kyphoctis tessellata* Kirk. and *Koebelia californica* Baker (Plate VIII, figs. 5 and 6). The resemblance is not confined to these two species, as the frons of *Stenocotis* is also similar in shape to that of *Koebelia*. A Y-vein is not developed with *Koebelia*, and the hind tibiae (Plate X, fig. 9), though lacking spur development, is of a

primitive type, from which that of *Stenocotis* might well have been derived. The male genitalia of *K. californica* and *Smicrotis* sp. are shown on Plate XI, figs. 8 and 9, and it will be noticed that both species have an aedeagus with a very long basal prolongation.

All the Australian Stenocotidae are arboreal and confined to eucalyptus trees. The habits of *K. californica* are unknown to me.

Ulopidae

(Plate VI, fig. 3; Plate VIII, fig. 1)

The Ulopidae are a family of small leaf-hoppers, members of which, according to Baker (1923), 'possess a character that is unique among jassoid insects, namely strongly rounded genae, the sharp outer edge of which curves mesad to the front above the lorae, leaving the latter with the outer border apparently free in facial view.'

On Plate VIII, fig. 1, is shown the head of the European *Ulopa reticulata* Fabr., with which the maxillary plates have been moved slightly out of position, and it will be seen that the distinctive characteristic of this family is nothing more than the persistence of the sub-genal suture, which, as shown in fig. 3 on the same plate (*Anacephaleus ulopae* Ev.), may also occur with the Ledridae, although exceptional in this family.

The Ulopidae are too well known to need further discussion, but it may be mentioned that the wide crown consists entirely of the vertex, and that ocelli, if present, lie well away from the frontal and epicranial sutures, having migrated to the crown independently of the backward development of the fronto-clypeus. One genus, *Austrotolopa* Ev., has so far been described from Australia. It is believed that all species in this family feed on grasses.

Paropiidae

(Plate VIII, fig. 2)

The Paropiidae are another well-known family of small leaf-hoppers, and are related to the Ulopidae. As may be seen from the figure of the head of *Megophthalmus scanicus* Fall., the frontal and epicranial sutures are replaced by wide carinae, and the marginal depressions that contain the ocelli and the crown are formed from the vertex. A single genus, *Kahavalu* Kirk., has been recorded from Australia.

Ledridae

(Plate VI, fig. 5; Plate VIII, figs. 3, 4; Plate IX, figs. 11, 12;
Plate X, figs. 14, 15; Plate XI, fig. 7)

The Ledridae comprise a heterogeneous collection of genera that might well be divided into three families, but which for the moment are grouped in three sub-families. The Ledrinae in which the Palaearctic genus *Ledra* F. occurs, contains six described Australian genera, *Ledropsis* White, *Ledramorpha* Stål, *Jukuruka* Dist., *Porcorhinus* Dist., *Rubria* Stål, and *Platyledra* Ev.

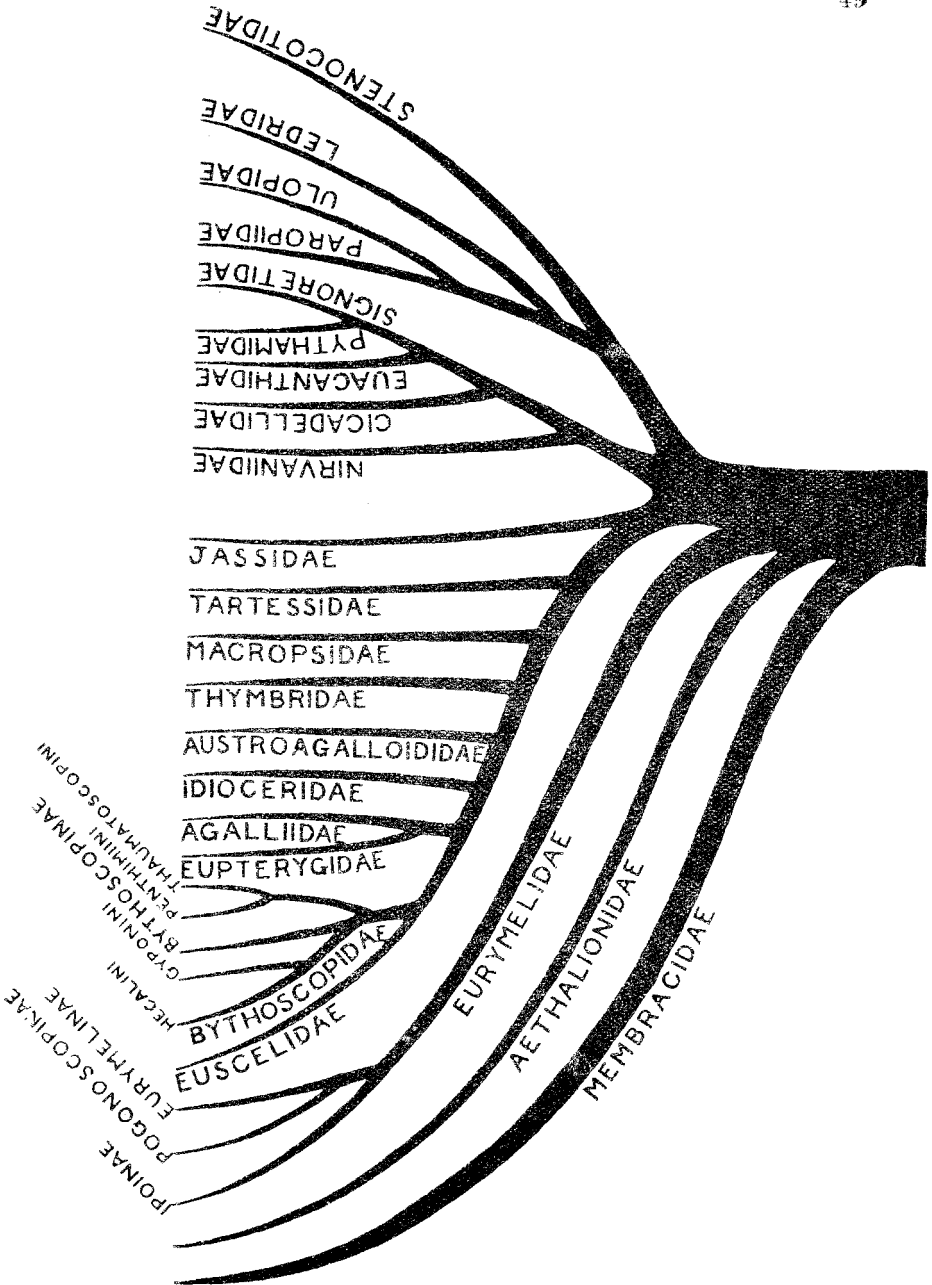
Insects in this sub-family have the head considerably flattened, widely produced, and concave ventrally. The ante-clypeus is narrow, often pear-shaped, and the post-clypeus includes nearly all that part of the head, both the face and the crown, that lies between the antennae and the ocelli. Although the coronal suture may appear to extend to the apex of the crown, a study of nymphal heads shows that it terminates close to the ocelli, and the obsolete frontal sutures, which are perceptible in *Ledropsis crocina* Dist., terminate at the ocelli. Thus the ocelli have migrated to their present dorsal position by way of the side of the head and not over the apical margin. The posterior median swollen ventral portion of the post-clypeus, although differentiated from the flattened lateral portions, is not separated from them by sutures; no well-marked antennal ledges are developed, and the eyes are prominent. The pronotum is collar-like, and may be raised into flap-like processes; the tegmina may have simple or reticulate venation, and the hind tibiae are considerably flattened and may lack spines or spurs, but usually one or a few spurs remain. In spite of the fact that species in the genus *Dorycephalus* Kirsch have marginal ocelli and hind tibiae with numerous spines, it is thought that they represent a primitive ledrid type, and are herewith transferred to the Ledrinae. The head and pronotum of *Dorycephalus platyrhynchus* Osb. is figured on Plate IX, fig. 12, and should be compared with that of *Rubria carnosa* Stål (fig. 11).

Two genera described recently (Evans, 1937, a), *Ledrella* Ev. and *Ledrapora* Ev., are placed in a new sub-family the Ledrellinae. Species in this group resemble those in the Ledrinae in the venation of the tegmina, in having prominent eyes and in the ocelli being on the crown, which in the case of *Ledrapora* is narrowly produced and consists almost entirely of part of the fronto-clypeus. The hind tibiae are flattened and similar in armature and shape to that figured on Plate X, fig. 3. They differ in the possession of distinct antennal ledges and a wide ante-clypeus; the head is not spatulate, and the pronotum, though wide laterally, is not collar-like.

The third sub-family, the Cephalinae, has been defined previously (Evans, 1937, a). Insects in this group differ from those in the other two in their smaller size, in having deep antennal pits, in having the ventral posterior surface of the fronto-clypeus evenly concave or convex, not raised centrally, and in having hind tibiae which are not flattened, but short and feebly spinose. They resemble them in that the frontal and epicranial sutures are obsolete, the produced crown consists largely of the fronto-clypeus, the ocelli are on the disc of the crown, and the pronotum is collar-like.

PHYLOGENETIC TREE

A phylogenetic tree is reproduced on p. 49 to indicate the possible inter-relationships of the various jassoid families. With only the Eurymelidae and Bythoscopidae are lesser divisions shown, and with the latter family only a few of the many that probably exist.



HABITS AND FOOD-PLANTS

Little is known about the habits of leaf-hoppers, but the Eury-melidae differ from all other jassoid families, with the possible exception of the Aethalionidae, in that they are ant-attended and the nymphs lack jumping powers. In only a few groups, such as the Eupterygidae, do both arboreal and grass-feeding species occur, and it is seldom that one species will feed indiscriminately on both types of plant, though it does happen, as recorded by DeLong (1923) in the case of *Gypona octolineata* (Say), which occurs on a variety of weeds, grasses, shrubs and trees. Very few specific food-plants of Australian leaf-hoppers have been recorded, but it is known that the majority feed on eucalyptus trees. Only one species (*Eurymelanus elegans* Ev.) has been taken on *Acacia* spp., which, after the eucalypts, are the dominant Australian trees, and on which several species of membracids feed. None has been taken on any of the Proteaceae.

Whilst the Eurymelinae, Pogonoscopinae, and most of the Ipoinae, all the Thymbridae, Austroagalloididae, Stenocotidae, Australian Idioceridae, and most of the Tartessidae feed on eucalypts, none of the Macropsidae have been taken on these trees, but have been found on a variety of low-growing shrubs.

All the Australian Euacanthidae, Euscelidae, Ulopidae, Cicadellidae, Cephalaelinae, and Agalliidae, so far as is known, feed on grasses, weeds, and plants of a similar habit. In general it is found that most leaf-hoppers with ventral ocelli are arboreal, whilst those with dorsal and marginal ocelli feed on grasses and other low-growing plants.

SIZE, COLORATION AND SCULPTURE

The size, coloration, and sculpture of leaf-hoppers are of assistance in determining relationships. It would seem that, with certain exceptions, the most primitive groups of present-day leaf-hoppers are small, and the general tendency has been towards an increase rather than a decrease in size. In the Eurymelidae, which includes the largest leaf-hoppers, the more generalized species, such as *Bakeriola procurrans*, are smaller than the more specialized, such as *Ipo pellucida* F. and *Eurymelops bicolor* (Burm.). Similar examples could be given for the Stenocotidae. All the Ulopidae are small, likewise the Cephalaelinae and the large size of several Ledrids conforms with the idea that they may be highly specialized types descended from an extinct primitive stem. On the phylogenetic tree the Agalliidae and Eupterygidae are shown as arising from the same side-branch; this is because the factor of size as well as structure has been taken into account.

Leaf-hoppers are ornamented with a wide variety of colour patterns. In the Ledridae, Ulopidae, Paropidae, and Stenocotidae, no

bright colours are developed, various shades of brown being predominant. In the Ippinae and Pogonoscopinae yellow, black, and brown markings only occur, whilst the Eurymelinae, though largely black, may have vivid orange, red, and yellow coloration, but green, the principal pigment in many families, is never present.

The body-sclerites of most leaf-hoppers are smooth, yet many have transverse striations on the pronotum and raised carinae may be developed on the head and prothorax. All the Macropsidae have the head and pronotum punctate or rugose, as to a lesser extent is the case in the Austrogalloidea. This characteristic alone serves to differentiate these families from the Bythoscopidae.

GENERIC AND SPECIFIC DIFFERENTIATION

Any attempt to arrange the components of a group of insects of such ancient lineage as the Jassoidea into a system based on natural relationships, must always be complicated by two factors. First, the picture is incomplete, like a jig-saw puzzle of which most of the pieces are missing. Secondly, confusion is liable to occur because of parallel evolutionary trends. Considered as a whole, the Jassoidea are a remarkably homogeneous group, doubtless because they occupy the same environment during both their immature and adult life, and the types of environment available are limited, hence but few adaptive characters have been developed. They may be tree or shrub-inhabiting insects or live in pastures and similar environments; a few are myrmecophiles. Most of the arboreal forms are confined to a single species or genus of plants, and a few (certain Eupterygidae) have alternate seasonal food-plants, and migrate from deciduous to evergreen trees.

Five types of evolutionary development can be recognized. In one type new species and later genera have resulted from isolation, either geographical or as the result of the adoption and retention of a new food-plant. Such changes as accompany isolation usually lack direction, and may in the case of new food-plants be due to a physico-chemical reaction resulting from the nature of the cell-sap ingested. Another group of evolutionary changes is caused by a gradual re-orientation of muscle fibres that causes a change of shape of certain body sclerites. Changes of an orthogenetic nature that confer no benefit on the organism, and do not appear to be in response to any stimulus, also occur, and finally those of an adaptive nature and those due to mutations.

It is not proposed to discuss the classification on an evolutionary basis of all the families, but only to give examples selected from a few, and to show how, in many instances, it is difficult to decide upon the limits not only of genera, but also of species.

In the Eurymelidae genera are plentiful and species few, and the genera, which are clear-cut, may be of mutational origin. Certain species in this family (e.g., *Eurymela fenestrata*) have numerous

constant colour varieties, whilst in other species (e.g., *Eurymeloides punctata* Sign.) variable colour varieties occur. It is possible that some of these colour varieties may occupy different areas, or the same area, and may not inter-breed, and hence may represent incipient or true species. Possible incipient species also occur in such genera as *Rhotidoidea*, where minor colour variation is often accompanied by slight structural differences largely affecting the extent of the crown. In the genus *Cicadella*, several Australian species occur with which changes in colour pattern are invariably accompanied by minor morphological changes. The above examples are concerned with specific differentiation; in other groups specific differences are well-established, but generic ones indefinite.

In the Bythoscopidae, *Neovulturmus lapsus* differs in head structure from *Thaumatoscopus dunkensis* to such an extent that the two species might well be placed in different families, yet a complete series of intergrades occurs between them. Similar series are found in the Cephalinae between *Anacephaleus* Ev. and *Cephalelus* Perch, and in the Eupelicinae between *Dorydium* Burm. and *Paradorydium* Kirk. Such series of changes would appear to be along orthogenetic lines.

In the above instances species development has resulted from a progressive development in a definite direction, in each case concerned with the shape of the head. In many genera, such as *Oncopsis* and *Macropsis*, although species are distinct in colour pattern and morphological differences, no trends in any particular direction have been noted. In the Bythoscopidae it is believed that evolution has proceeded in several directions from a basic type resembling *Eurinoscopus*, whilst the present-day Ledrids, which give little evidence of evolutionary direction, are probably the remnants of an ancient group of which no primitive types survive.

ORIGINS OF AUSTRALIAN FAUNA

In this section the problem of leaf-hopper distribution is only discussed from the Australian point of view. Of the twenty-one families given in the new classification, representatives of all but two, the Aethalionidae, which are confined to South America, and the Signoretidae, which are an Oriental family, occur in Australia.

Tillyard (1924) has given a table showing the known sources of the present Australian and New Zealand faunas, in which are ten divisions extending from Upper Permian to Late Tertiary times. Only four divisions need be considered here, of which the representative faunal elements are the Middle Austro-Malayan of Upper Cretaceous and Early Tertiary times, the Last Antarctic of Middle Tertiary times, the Autochthonous xerophytic element of Tertiary times, and the Late Austro-Malayan of Late Tertiary times.

It is suggested that the Bythoscopidae and Tartessidae are part of the Middle Austro-Malayan element, that the Euscelidae, Eupterygidae, Agalliidae, Macropsidae, and Idioceridae form part of the last Antarctic element that reached Australia in Mid-Tertiary times, and that the Jassidae, Euacanthidae, Pythamidae, Cicadellidae, and Nirvaniidae, none of which are well represented in Australia, and all of which are largely though not entirely confined to north-east Australia, form part of the Late Austro-Malayan element.

The Thymbridae and Austroagalloididae form part of the indigenous xerophytic fauna as do also the Stenocotidae, but the last named family, together with the Ulopidae, Ledridae, and Paropiidae, all of which are to-day represented by the survivors of an ancient well-distributed fauna, may have originated in Cretaceous or even earlier times. The Eurymelidae possibly belong to the Western Australian element of Cretaceous times.

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Note.

After the completion of this paper a small collection of leafhoppers was received from Dr. A. Zachvatkin. Amongst them was a specimen of *Macroceps ahneri* Mel. This species is not congeneric with the genotype, *Macroceps fasciatus* Sign., but, together with *Achrus nigronervosus* Lind., *Symphypyga leopardina* Hpt., and *S. albigutta* V.K., and doubtless other species, would appear to represent a distinct group, differing from any considered in the foregoing pages. All these insects have a fronto-clypeus that is considerably swollen, small antennal scrobes, a vertical vertex, and hence no development of a crown, rounded frontal and epicranial sutures, and no coronal suture. The tegmina may have reticulate venation, and the hind tibiae have two rows of closely-set slender spines and one row of widely-spaced spines, mounted on distinct but not prominent bases.

Several species of *Melicharella* Sem. were included in the collection. In spite of superficial differences in a number of morphological features, it is certain that this genus, and also *Symphypyga obsoleta* Hpt., are related to *Austroagalloides* and belong to the same family. .

Unfortunately specimens of *Adelungia*, sent by Dr. Zachvatkin, were damaged in transit.

In addition to the above, a specimen of *Eupellia cuspidata* F. has been received from Mr. China. This species does not belong to the Euseculidae, and a consideration of its structure, sculpture, and coloration has led to the decision to place it in a sub-family of the Ledridae, the Eupellinae.

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EXPLANATION OF PLATES.

PLATE IV

- Fig. 1.*—Wing of *Hindola compacta* (Cercopidae, Machaerotinae).
Fig. 2.—Wing of *Cercopis jactator* (Cercopidae, Cercopinae).
Fig. 3.—Wing of *Sextius virescens* (Membracidae).
Fig. 4.—Wing of *Aethalion reticulatum* (Aethalionidae).
Fig. 5.—Wing of *Eurymeloides punctata* (Eurymelidae).
Fig. 6.—Wing of *Bythoscopus lanio* (Bythoscopidae).
Fig. 7.—Wing of *Putoniessa rivularis* (Thymbridae).
Fig. 8.—Wing of *Tartessus fulvus* (Tartessidae).

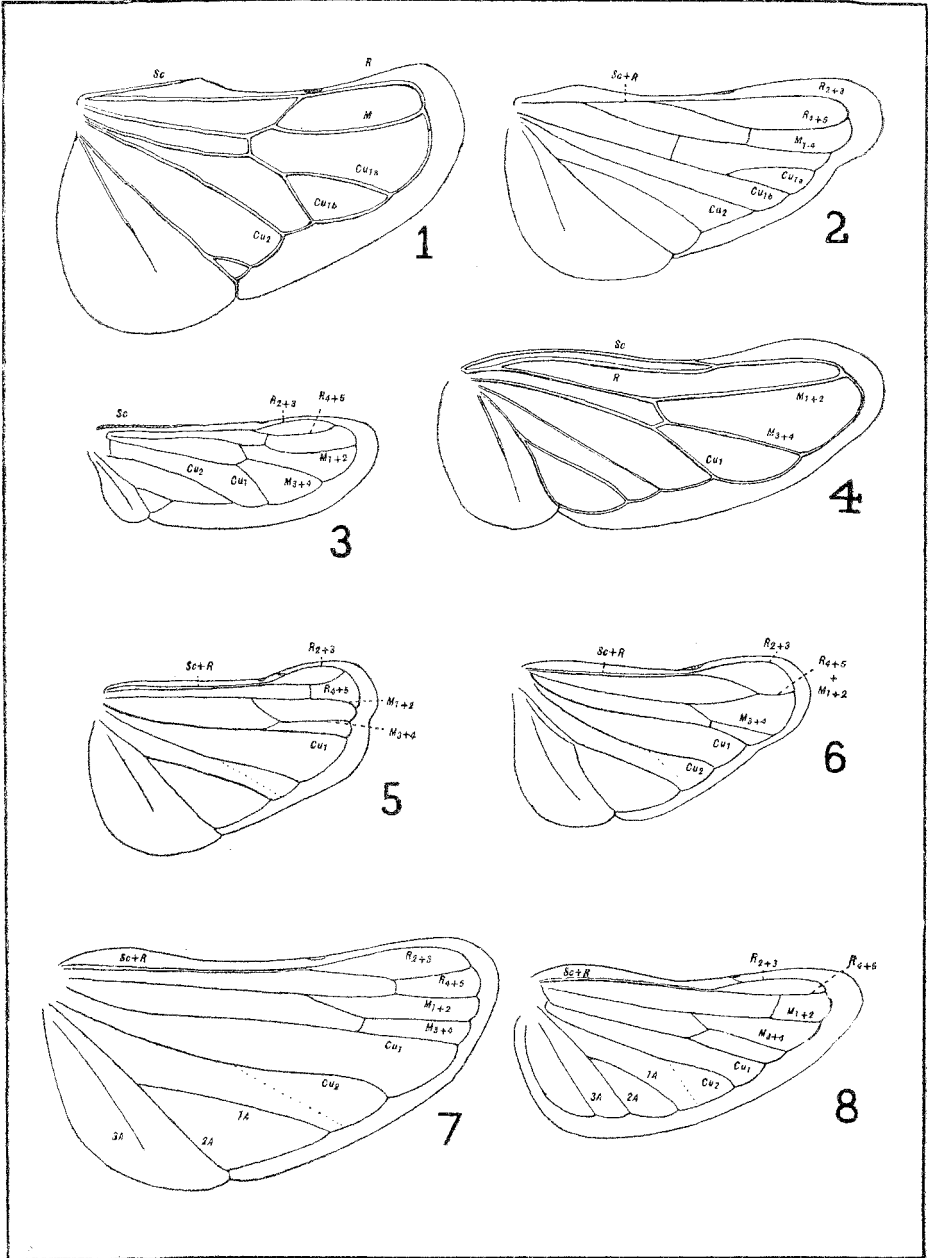


PLATE V

- Fig. 1.*—Hypothetical tegmen of common ancestor of Permian Homoptera. (After Carpenter, 1933.)
- Fig. 2.*—Hypothetical tegmen of common ancestor of recent Jassoidea.
- Fig. 3.*—Tegminal pad of pre-imaginal instar of *Eurymelops rubrovittata*.
- Fig. 4.*—Tegmen of *Aethalion reticulatum* (Aethalionidae).
- Fig. 5.*—Tegmen of *Eurymelita terminalis* (Eurymelidae).
- Fig. 6.*—Tegmen of *Paradorydium menalus* (Euscelidae).
- Fig. 7.*—Tegmen of *Cornutipo scalpellum* (Eurymelidae).
- Fig. 8.*—Tegmen of *Kyphoctis tessellata* (Stenocotidae).
- Fig. 9.*—Tegmen of *Bakeriola procurrentis* (Eurymelidae).
- Fig. 10.*—Tegmen of *Idiocerus seckeri* (Idioceridae).

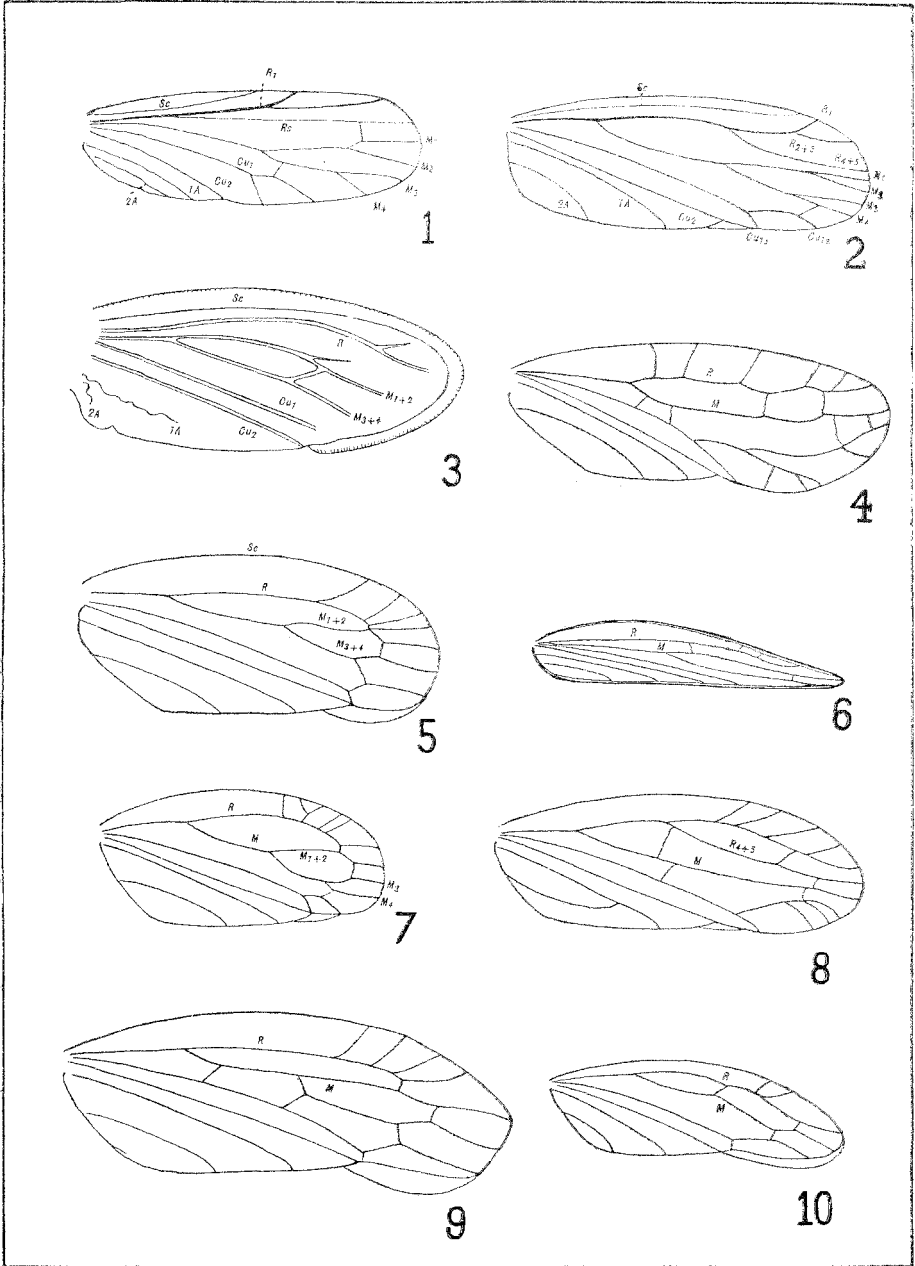


PLATE VI

- Fig. 1.*—Tegmen of *Rubria sanguinea* (Ledridae).
Fig. 2.—Tegmen of *Macroceps tonnoiri* (Thymbridae).
Fig. 3.—Tegmen of *Austrolapa kingensis* (Ulopidae).
Fig. 4.—Tegmen of *Austroagalloides karoondae* (Austroagalloidiidae).
Fig. 5.—Tegmen of *Anacephaleus carribensis* (Ledridae).
Fig. 6.—Tegmen of *Trocnada gigantea* (Bythoscopidae).
Fig. 7.—Tegmen of *Stenoscopus drummondi* (Macropsidae).
Fig. 8.—Tegmen of *Sarpestus specularis* (Tartessidae).
Fig. 9.—Tegmen of *Cicadella pasiphae* (Cicadellidae).
Fig. 10.—Tegmen of *Signoretia aureola* (Signoretidae).

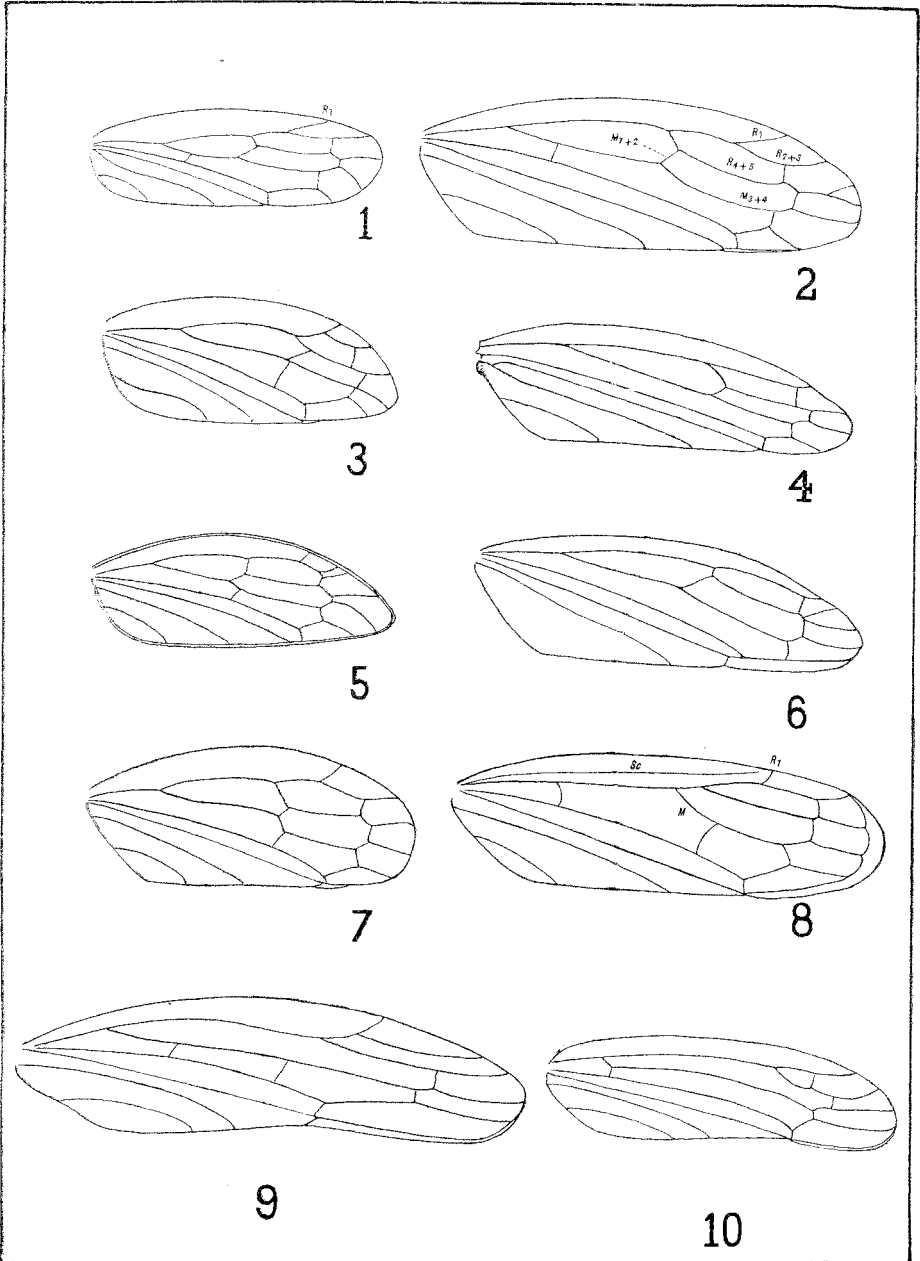


PLATE VII

Figs. 1 and 2.—Head of *Penthimia americana* (Bythoscopidae).

Figs. 3 and 4.—Head of *Trocnada gigantea* (Bythoscopidae).

Fig. 5.—Head of *Austroagalloides nigra* (Austroagalloididae).

Fig. 6.—Head of *Oncopsis pullus* (Macropsidae).

Fig. 7.—Head of *Tartessus blundellensis* (Tartessidae).

Fig. 8.—Head of *Opio multistrigia* (Eurymelidae).

Fig. 9.—Head of *Aethalion reticulatum* (Aethalionidae).

Fig. 10.—Head of *Macroceps fasciatus* (Thymbridae).

Fig. 11.—Head of *Austroagallia torrida* (Agalliidae).

Fig. 12.—Head of *Idiocerus leurensis* (Idioceridae).

Fig. 13.—Head of *Mainda praeculta* (Pythamidae).

Fig. 14.—Head of *Jassus indicus* (Jassidae).

Fig. 15.—Head of *Preta gratiosa* (Signoretidae).

Fig. 16.—Head of *Euacanthus interruptus* (Euacanthidae).

cs., coronal suture; es., epicranial suture; fs., frontal suture; v., vertex; eps., epistomal suture; fc., fronto-clypeus; ac., ante-clypeus; cls., clypeal suture.

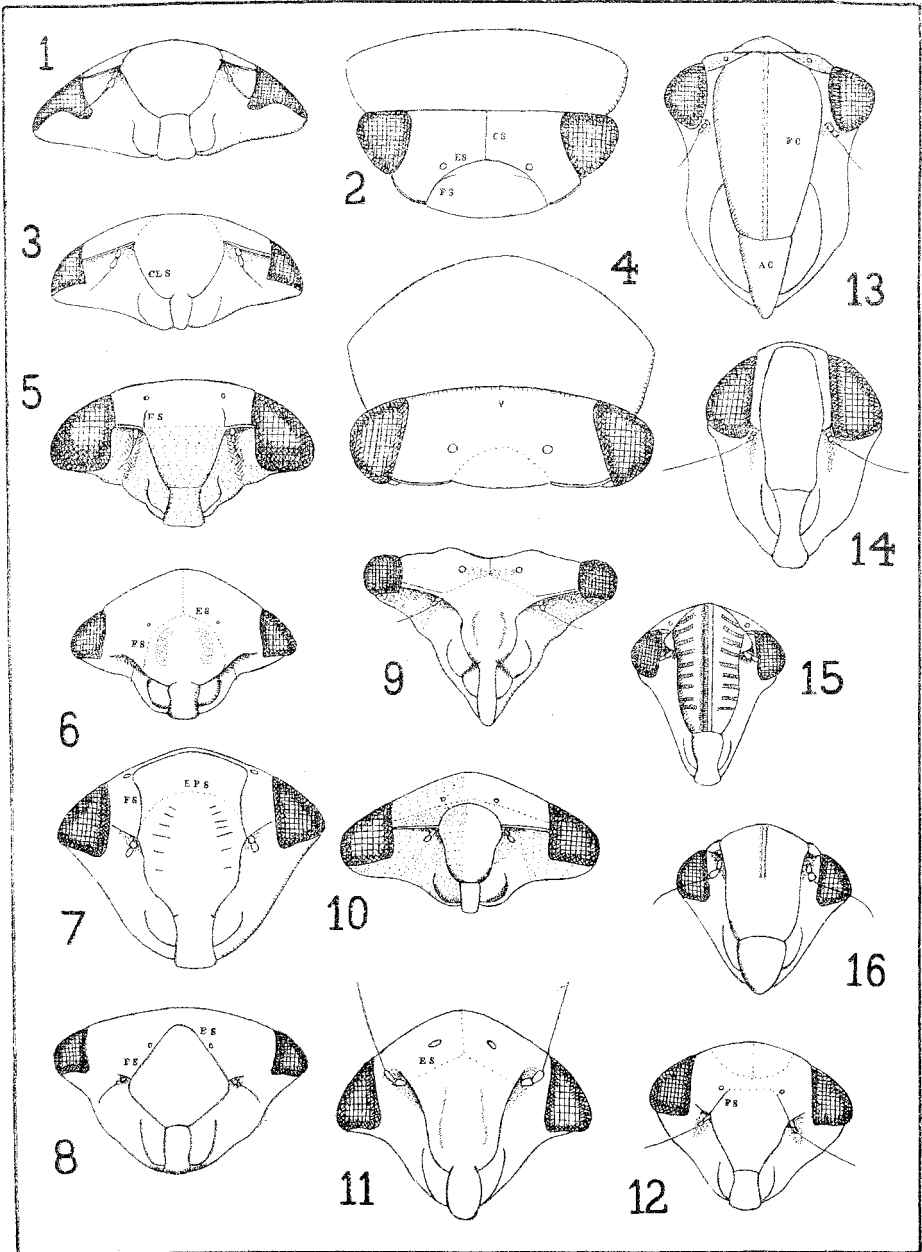


PLATE VIII

- Fig. 1.*—Head of *Ulopa reticulata* (Ulopidae).
Fig. 2.—Head of *Megophthalmus scanicus* (Paropiidae).
Fig. 3.—Head of *Anacephaleus ulopae* (Ledridae).
Fig. 4.—Head of *Ledropsis crocina* (Ledridae).
Fig. 5.—Head of *Kyphoctis tessellata* (Stenocotidae).
Fig. 6.—Head of *Koebelia californica* (Stenocotidae).
Fig. 7.—Head of *Reuteriella flavescens* (Bythoscopidae).
Fig. 8.—Head of *Gypona angulata* (Bythoscopidae).
Fig. 9.—Head of *Cicadella circulata* (Cicadellidae).
Fig. 10.—Head of *Deltocephalus obliquus* (Eusceiidae).
Fig. 11.—Head of *Nirvana pallida* (Nirvaniidae).
Fig. 12.—Head of *Typhlocyba ulmi* (Eupterygidae).
- sgs., sub-genal suture; f., frons; pc., post-clypeus; fs., frontal suture; es., epicranial suture.

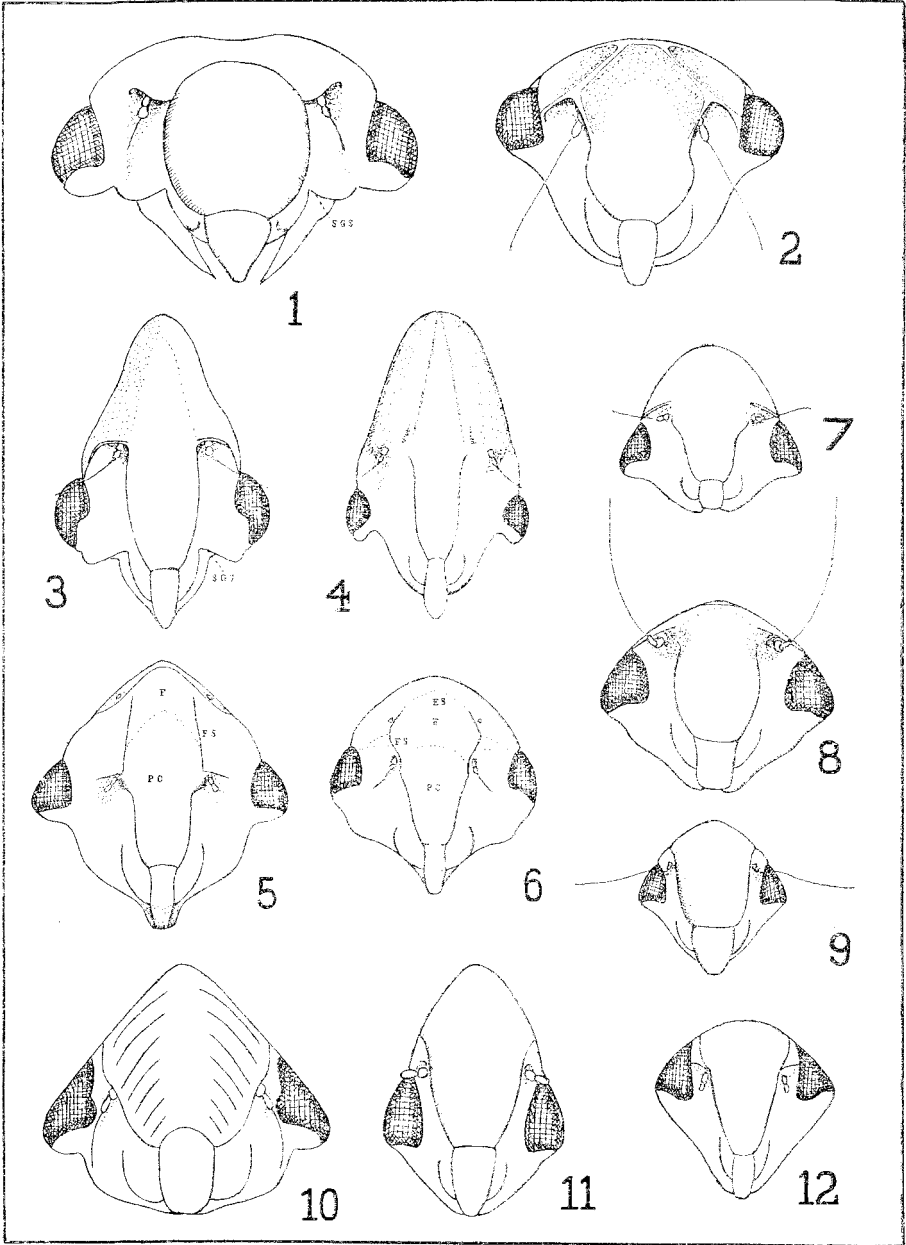


PLATE IX

- Fig. 1.*—Head and Prothorax of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 2.—Head and Prothorax of *Penthimia americana* (Bythoscopidae).
Fig. 3.—Head and Prothorax of *Renteriella flavescens* (Bythoscopidae).
Fig. 4.—Head and Prothorax of *Hecalus lineatus* (Bythoscopidae).
Fig. 5.—Head and Prothorax of *Gypona angulata* (Bythoscopidae).
Fig. 6.—Head and Prothorax of *Oncopsis pullus* (Macropsidae).
Fig. 7.—Head and Prothorax of *Rhotidoides norfolkensis* (Thymbridae).
Fig. 8.—Head and Prothorax of *Idiocerus leurensis* (Idioceridae).
Fig. 9.—Head and Prothorax of *Chlorotettix unicolor* (Euscelidae).
Fig. 10.—Head and Prothorax of *Austroagalloides nigra* (Austroagalloididae).
Fig. 11.—Head and Prothorax of *Rubria carnosa* (Ledridae).
Fig. 12.—Head and Prothorax of *Dorycephalus platyrhynchus* (Ledridae).
Fig. 13.—Head and Prothorax of *Oncometopia saturalis* (Cicadellidae).
Fig. 14.—Head and Prothorax of *Euacanthus acuminatus* (Euacanthidae).
Fig. 15.—Head and Prothorax of *Preta gratiosa* (Signoretidae).

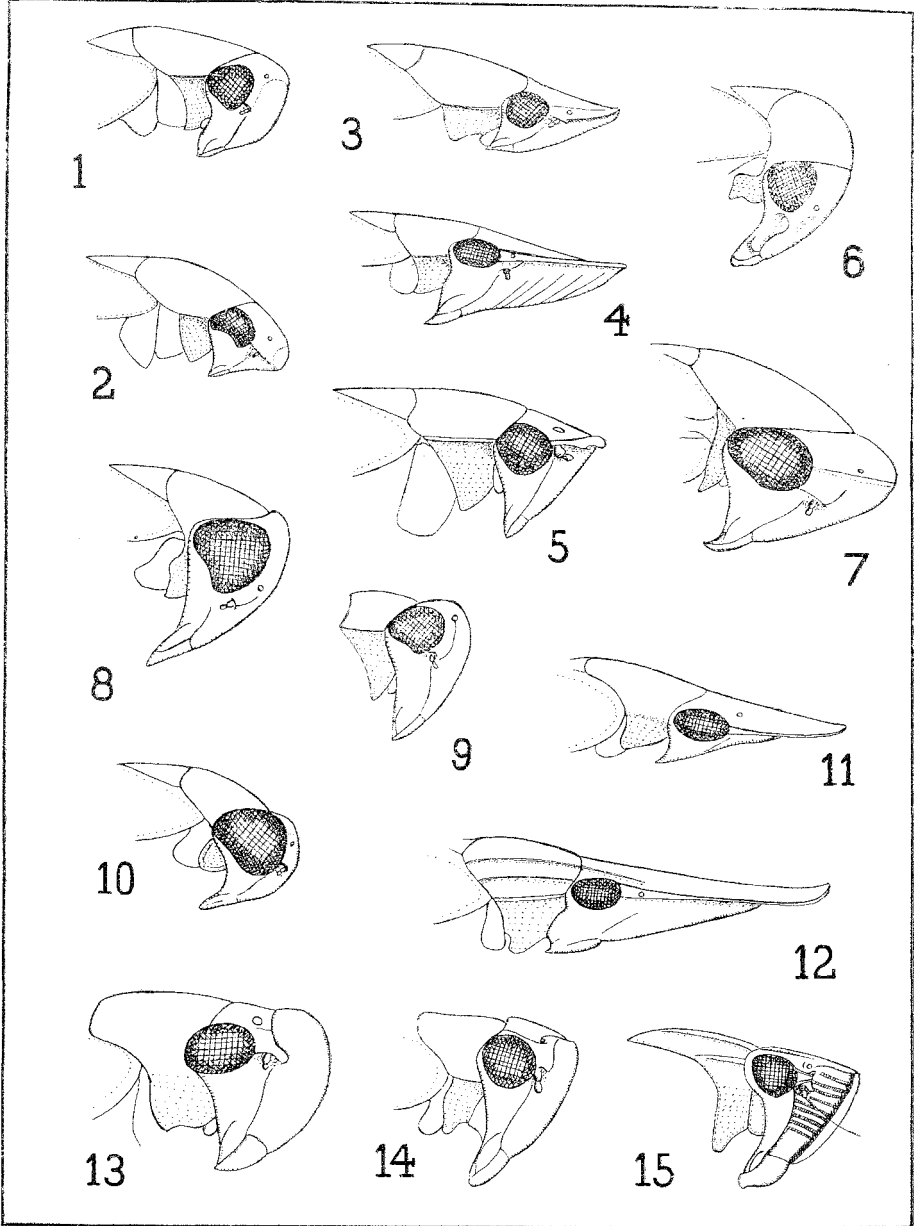


PLATE X

- Fig. 1.*—Hind Tibia of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 2.—Hind Tibia of *Idiocerus kirkaldyi* (Idioceridae).
Fig. 3.—Hind Tibia of *Macropsis victoriensis* (Macropsidae).
Fig. 4.—Hind Tibia of *Bakeriola procurrens* (Eurymelidae).
Fig. 5.—Hind Tibia of *Eurymelops bicolor* (Eurymelidae).
Fig. 6.—Hind Tibia of *Lasioscopus acmaeops* (Eurymelidae).
Fig. 7.—Hind Tibia of *Tartessus fulvus* (Tartessidae).
Fig. 8.—Hind Tibia of *Rhotidus leurensis* (Thymbridae).
Fig. 9.—Hind Tibia of *Koebelia californica* (Stenocotidae).
Fig. 10.—Hind Tibia of *Aethalion reticulatum* (Aethalionidae).
Fig. 11.—Hind Tibia of *Stenocotis depressa* (Stenocotidae).
Fig. 12.—Hind Tibia of *Macroceps tamarensis* (Thymbridae).
Fig. 13.—Hind Tibia of *Cicadella richmondensis* (Cicadellidae).
Fig. 14.—Hind Tibia of *Rubria sanguinea* (Ledridae).
Fig. 15.—Hind Tibia of *Ledropsis crocina* (Ledridae).
Fig. 16.—Hind Tibia of *Preta gratiosa* (Signoretidae).

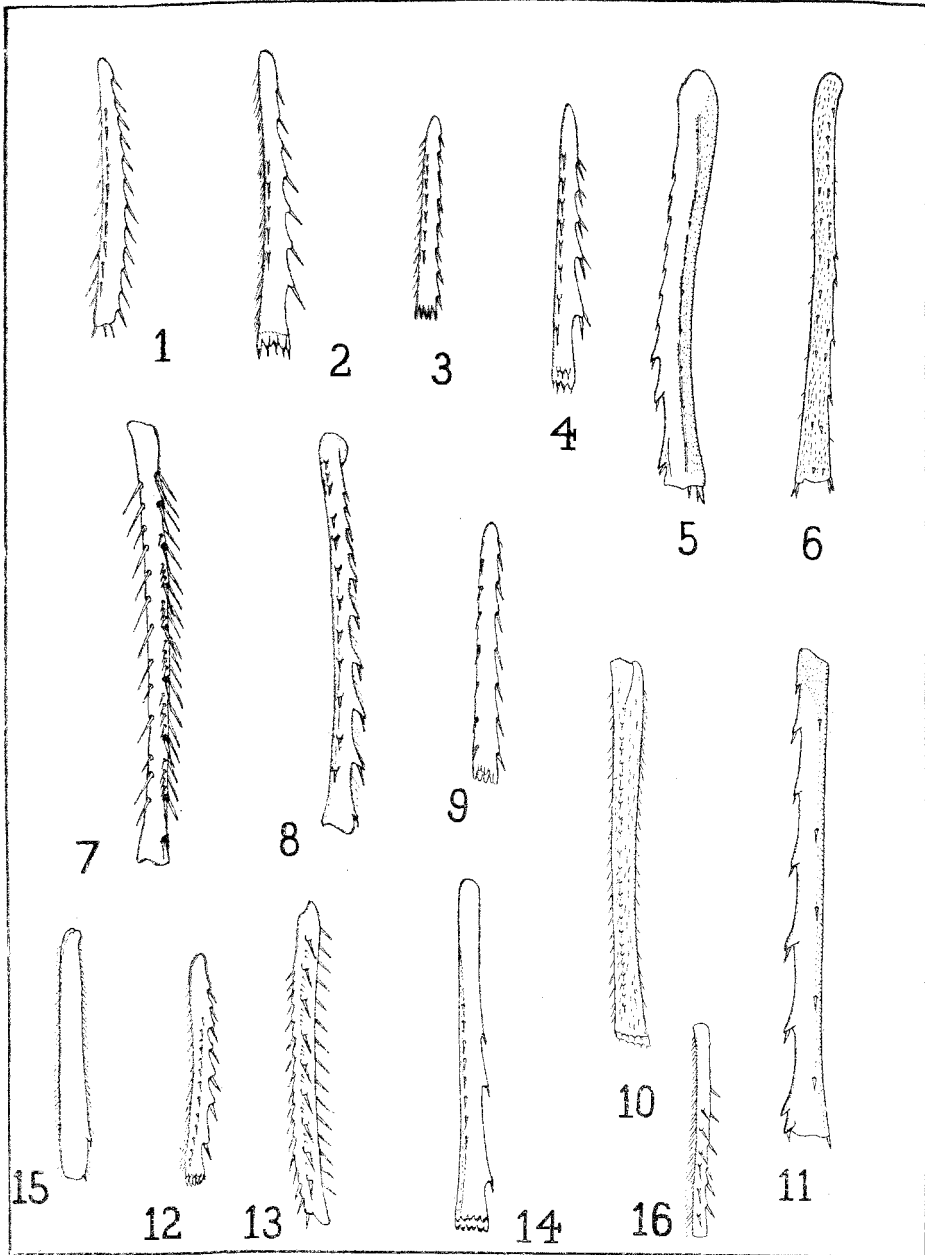
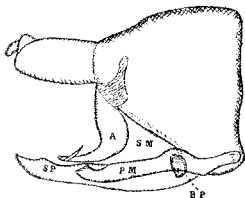


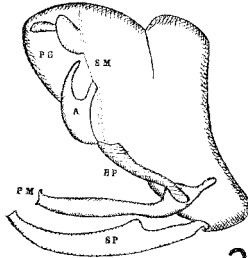
PLATE XI

- Fig. 1.*—Male Genitalia of *Bakeriola procurrans* (Eurymelidae).
Fig. 2.—Male Genitalia of *Eurymela fenestrata* (Eurymelidae).
Fig. 3.—Male Genitalia of *Eurinoscopus viridis* (Bythoscopidae).
Fig. 4.—Male Genitalia of *Macropsis tasmaniensis* (Macropsidae).
Fig. 5.—Male Genitalia of *Austroagallia torrida* (Agalliidae).
Fig. 6.—Male Genitalia of *Idiocerus kirkaldyi* (Idioceridae).
Fig. 7.—Male Genitalia of *Ledropsis crocina* (Ledridae).
Fig. 8.—Male Genitalia of *Koebelia californica* (Stenocotidae).
Fig. 9.—Male Genitalia of *Smicrotis* sp. (Stenocotidae).
Fig. 10.—Male Genitalia of *Hackeriana glauca* (Thymbridae).
Fig. 11.—Male Genitalia of *Tartessus idyia* (Tartessidae).
Fig. 12.—Male Genitalia of *Euscelis stactogalus* (Euscelidae).

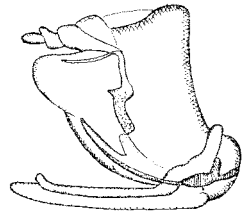
a., aedeagus; sm. segmental membrane; bp., basal plate; sp., sub-genital plate; pm., paramere; pg., pygophore.



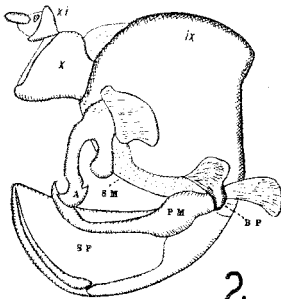
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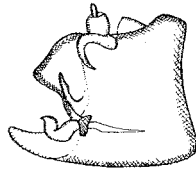
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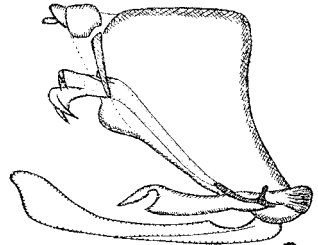
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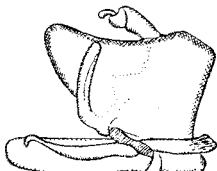
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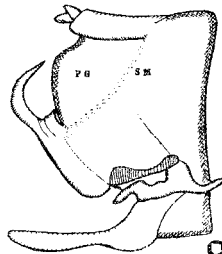
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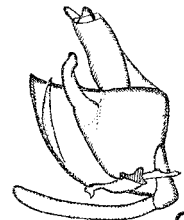
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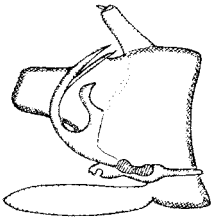
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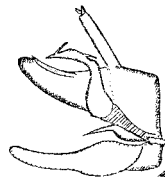
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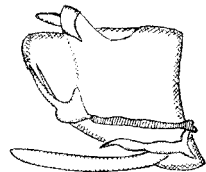
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