

The Lines of Descent of the Lower Pterygotan Insects, with Notes on the Relationships of the other Forms.

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It is a rather interesting fact that those structures which are apparently of no vital importance to the organism, are frequently of the greatest value as indications of relationships between the larger groups (orders, etc.) of insects. This may perhaps be explained by the fact that structures which are of vital importance to the organism would be the ones most directly concerned in the struggle for existence, and would therefore be the ones most acted upon and most profoundly modified by natural selection—or, as a Lamarkian would express it, these structures would be the ones most frequently employed, and would therefore be the ones the most profoundly changed by use.

The nature and arrangement of the thoracic sclerites furnish examples of such structures, which are of little or no vital importance to the organism (since they are practically wanting in some forms), yet are among the most important characters for determining the relationships of the different groups of insects, since they remain as "true to type," or as little modified, as any structures of the body; and in most instances have furnished the clues which were followed out and verified by the study of other structures.

Other structures which have proven to be of considerable value in determining the relationships of the lower insects are: the character of the antennal segments, the nature and location of the compound eyes, the outline of the head, the character of the mouthparts (particularly of the labium), the nature of the terminal abdominal segments and their appendages (the female external genitalia being especially "true to type," or but little modified) and the appendages of the thorax. Conclusions based largely upon an examination of the wings alone, which is apparently necessary in the study of fossil insects, may lead to entirely erroneous results, unless verified by the study of other sets of structures, and this may in some

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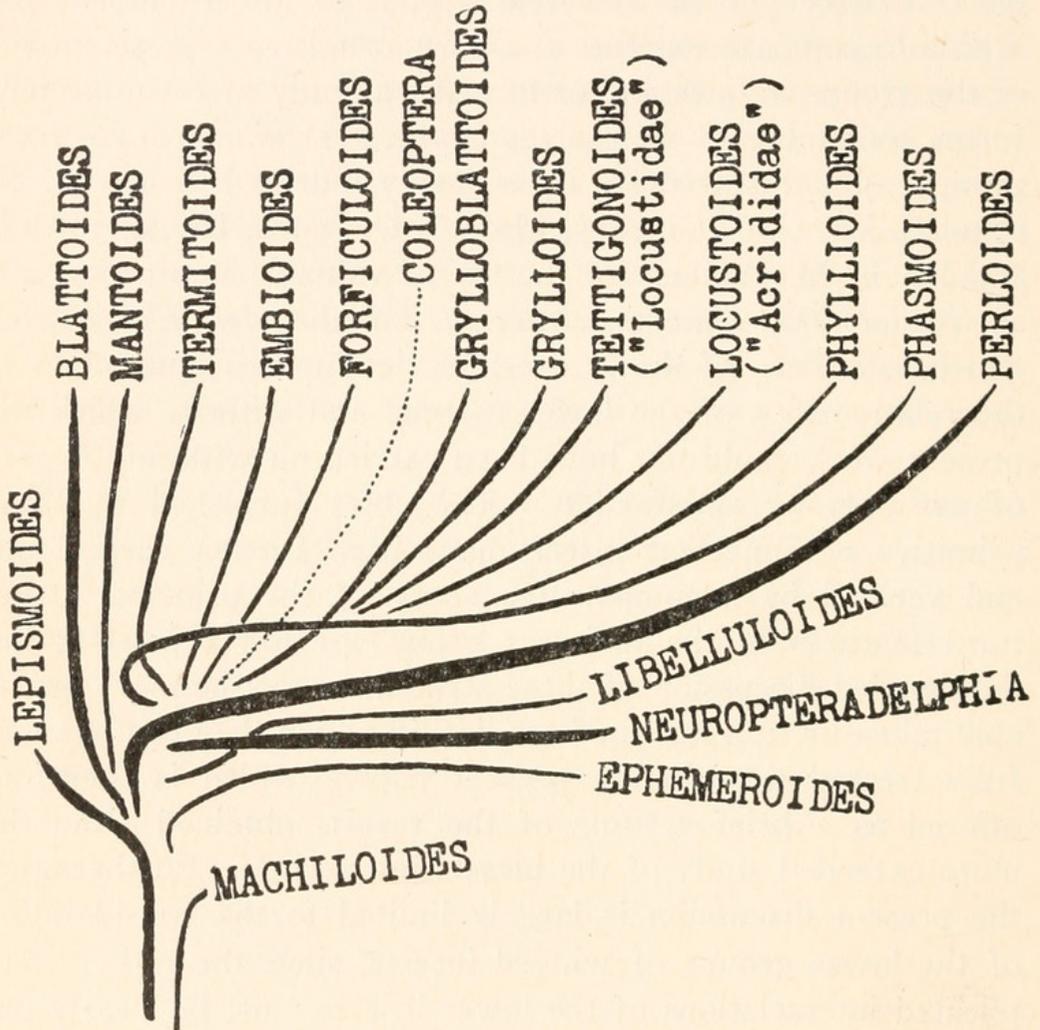
measure account for the marked difference in the lines of descent here given, and those depicted in Handlirsch's "*Fossilien Insekten*."

It is an almost hopeless task to attempt to determine the lines of descent in the different groups of insects, unless one is able to compare together the most primitive representatives of the groups in question, or to make a study of the annectent forms combining in themselves characters common to several groups. On this account, I am deeply indebted to Mr. A. N. Caudell, Mr. C. C. Gowdey, Maj. A. D. Imms, Dr. K. Jordan, and Dr. E. M. Walker for the use of valuable specimens such as *Grylloblatta*, *Timema*, *Arixenia*, *Labidurodes*, *Embia*, etc., which have been of the greatest service in furnishing clues to the relationships of the lower insects, and without which the present work could not have been carried on with any degree of certainty or satisfaction. The clues furnished by these primitive or annectent insects have been further carried out and verified by a comparative study of the principal structural features in the different groups of lower insects; but the detailed discussion of these structures may be more profitably taken up in a series of articles, in which they can be more fully treated than in the present paper—which is therefore offered as a brief resumé of the results obtained from the more extended study of the insects in question. Furthermore, the present discussion is largely limited to the consideration of the lower groups of winged insects, since the rather complicated interrelations of the lower insects must be clearly understood, before one can proceed to the study of the higher forms.

The accompanying diagram is offered merely as an expedient to aid in visualizing the points brought out in the following discussion, rather than as an attempt to portray the actual relations of the various groups, since it is practically impossible to depict correctly the true relative positions of the different lines of descent, in a diagram drawn in one plane. It requires a figure of *three dimensions* to portray the fact that several groups approach each other from different angles, and if an attempt were made to represent this in a diagram

drawn in one plane, there would result such an intricate crossing of lines as to render it practically incomprehensible and therefore useless.

Since the termination "-oidea" has always been restricted to



groups of the rank of a *super-family* (e. g. Muscoidea, Ichneumonoidea, etc.), Handlirsch and his followers have done violence to established usage in employing the termination "-oidea" to designate groups to which they would attribute the rank of an *order*. On the other hand, the method of designating the different groups by some familiar term (which immediately calls to mind the typical or well known representatives of the group as a whole) is self-explanatory in a diagram, and therefore has much to recommend it. On this account, I have used the termination "-oides" (rather than the

pre-empted termination “-oidea”) in connection with the name of a well known or typical family merely as a convenient expedient to designate the different groups shown in the diagram. With the exception of the Grylloids and Tettigonoids (which form the Orthoptera, in the restricted sense), I would regard all of these groups as of the rank of an order, and have therefore referred to them in the text, by terms ending in “-ptera” (e. g. Dermaptera, Plecoptera, etc.) in accordance with general entomological usage.

As is shown in the diagram, the Phyllioid forms, or Phylliidae, are closely related to the Phasmoid group, or Phasmidae, yet occupy a position somewhat intermediate between the Phasmidae and the true Locustidae—which are usually incorrectly called “Acrididae.” Although the Phyllidae are closely related to the Phasmidae, they are as distinct from them as the Neuroptera are from the Mecoptera, and should therefore be classed in a distinct order, the *Phyllioptera*, as was mentioned in a previous publication (Entomological News, Vol. 26, p. 347). It may be remarked, however, that the distinctive characters there given, apply chiefly to the females, since the males of the Phylliidae (e. g. those of *Phyllium scythe*) have long antennae, and well developed hind wings.

The true Locustidae (usually termed “Acrididae”) occupy a position intermediate between the Phylliid-Phasmid group, and the Gryllid-Tettigonid group, as indicated in the diagram. Phasmoid forms, such as *Timema*, have retained many characters suggestive of the ancestral condition of the Locustid group, thus suggesting that the Locustid line of development may lead toward the Phasmid line of descent, while that of the Gryllid-Tettigonid group, although closely paralleling the Locustid line of development, may lead toward the Grylloblattid line of development; but this point may be better taken up under the discussion of the relationships of the Gryllidae and Tettigonidae. The reasons for considering the Locustoid forms as representing a distinct order, the *Diphtheroptera*, have already been given (Ent. News, Vol. 26, p. 348) and need not be further considered here.

As is indicated in the diagram, the line of descent of the Tettigonidae (which are usually incorrectly termed "Locustidae") closely parallels that of the Gryllidae, the more primitive members of the two groups being very closely related, although the more highly modified members of the two lines, are quite widely divergent. The Grylloid and Tettigonoid forms comprise the order *Orthoptera* (in the restricted sense) which occupies a position somewhat intermediate between the Phasmid and the Grylloblattid lines of descent and is also related to the Perlids. A study of the extremely interesting insect *Grylloblatta campodeiformis* Walk., led me to believe that the Gryllids and Tettigonids approach more closely to the Grylloblattid line of descent, while the true Locustids ("Acrididae") approach rather more closely to the Phasmid line of descent; but an examination of an extremely primitive Grylloid insect from Thayetmyo, Burmah (which bears a slight resemblance to an Ephemeropterid!) would indicate that the Gryllids also approach the Phasmid line of descent, and such primitive Tettigonoid forms as *Phasmodes* (the *Prophytoptera*—Ent. News, Vol. 26, p. 348), are remarkably Phasmid-like, so that it is doubtless more correct to consider the Grylloid-Tettigonoid group as arising from forms intermediate between the Phasmoid insects and the Grylloblattoid insects (which also approach the Phasmid line of descent).

Certain Phasmoid insects, such as *Timema*, have retained many characters suggestive of the Perlid group, and many other facts indicate that the Phasmid line ultimately leads back to that of the Perloid insects. The Phasmid line of descent also converges toward that of the Grylloblattids, and at the same time approaches the Mantoid group in some respects, although the Mantoid insects have followed a somewhat different course of development. In order to show in the diagram, that the Phasmoid line not only leads back to the Perloid line, but also approaches the Mantid line, and is likewise connected with the Grylloblattoid line by intermediate forms, it was necessary to swing the Phasmoid line around from its position near the Mantoid line, and over the other

lines of descent, in order to bring it into a position in which it could be shown in the diagram that the Locustids, Gryllids, etc., sprang from forms intermediate between the Phasmid group and the Grylloblattid group. In thus swinging the Phasmid line around over the other lines of descent, it became impossible to show that the Phasmid line also converges with that of the Grylloblattids, etc., upon the Perlid line of descent, so that it should be understood that the Phasmid and Grylloblattid lines are much more intimately related than is shown in the diagram. The Phasmid group (called the *Cheleoptera*, Ent. News, Vol. 26, p. 348) forms a distinct order of insects, second in importance only to the Perlid group, from the standpoint of phylogeny, since it is paralleled by, or is approached by, so many other lines of descent; and in some regards it is fully as important as the Perlid line itself, although I am inclined to consider that the Perlids, as a whole, are more primitive than the Phasmids.

As was mentioned above, the Grylloblattid line of development parallels, or converges toward that of the Phasmids, and both lead back to the Perlid group. This, however, does not mean that living Grylloblattids were descended from living Perlids, but is merely a way of expressing the fact that the Perlids have departed as little as any group, from the ancestral condition characteristic of the common ancestors of the Grylloblattids, Perlids, etc. As is shown in the diagram, the Grylloblattoid, Forficuloid and Embioid lines all converge toward the Perlid line. It could not be shown in the diagram, however, that the Grylloblattids are quite closely related to the Termites, and at the same time that their closest affinities are with the Forficuloid and Embioid (with the Phasmoid) lines among the more primitive forms, although it is indicated that the Gryllids, Tettigonids, etc., occupy a position intermediate between the Grylloblattoid and the Phasmoid lines of descent. The Grylloblattoid line is much more closely paralleled by the Embiid and Termitid lines of descent than is indicated in the diagram, since a comparison of a wingless female *Embia major* with the wingless female *Grylloblatta* suggests a very

close relationship between the two; but for that matter the lines of descent of the Perlid, Phasmid, Grylloblattid, Forficulid, Embiid and Termitid groups all converge as we trace them further back, so that it is extremely difficult to tell which are the most closely related. The Grylloblattid group forms a distinct order termed the *Notoptera* (Ent. News, Vol. 26, p. 347), which are among the most interesting and important of the annectent forms surviving to the present day.*

As shown in the accompanying diagram the *Coleoptera* are rather closely related to the Forficulids, and also to the Embiids and Grylloblattids, but ultimately lead back to the Perlid line of descent. Indeed, the *Coleoptera* are a much more ancient group than is usually thought to be the case, and although some of the representatives of the group are quite highly specialized, others show undoubted affinities with the lower insects as shown in the diagram. The *Apocoleoptera* (Platyp-sylloides) or Platyp-syllidae form a distinct order, arising as an offshoot from the main line of descent of the *Coleoptera*, and in some respects they resemble the parasitic Forficuloid group Hemimeridae. Whether this is due to a convergence in form as the result of similar modes of life, or is due to the fact that the *Coleopteron* and Forficuloid lines of descent closely parallel each other, is not clear.

The Forficulid line of descent parallels that of the Embiids and Grylloblattids rather closely, as is shown by a comparison of the rather primitive Forficulid *Labidurodes*, with specimens of *Grylloblatta* and *Embia major* Imms. Furthermore, such primitive Forficulids as *Arixenia*, show undoubted Perloid affinities, and the Embiid, Forficulid, Grylloblattid and Perlid lines of descent are to be considered as paralleling each other extremely closely. Together with the other groups just mentioned, the Forficulids converge toward the Termitid and Phasmid lines of development (the Phasmid *Timema* having retained certain characters suggestive of those found in the

* The color of these insects is likewise extremely primitive, yellow to brown-yellow being apparently the original color of the ancestral Pterygota, while the paler shades (white or tinge of gray) are more characteristic of the Apterygotan forms.

Forficulid *Labidurodes*). I have not seen specimens of "*Hadotermes japonicus*" described by Hagen 1868 (Proc. Bost. Soc. XI, p. 399), but Sharp (Insects, Part I) states that this insect described by Hagen as a Termite, is really a Forficulid, so that this Forficulid must be very similar to the Termites, if Hagen was deceived by it. The *Hemimerus*-like forms represent an off-shoot from the Forficuloid line. The Hemimeroides are not represented in the diagram, but their affinities are undoubtedly strongly Forficulid, though they may perhaps represent a distinct order called *Dermodermaptera* by Verhoeff. The term Dermaptera, applied to the Forficulids, may possibly be restricted to another group of Orthopteroid insects, on the grounds of priority; if this be necessary, the later term *Euplexoptera* might be applied to the Forficulid group.

The Embiidae as a whole, are extremely closely related to the Perlids, perhaps more nearly than to any other group of insects. The wingless females of *Embia major* Imms are exceptionally favorable for comparison with the wingless females of *Grylloblatta* and *Timema*, and their unusually large size and well pigmented sclerites makes the study of their structural details a comparatively simple matter, although the more primitive genus *Clothoda* would doubtless be of greater importance from the standpoint of the determination of the genealogy of the group. A study of *Embia* has convinced me that the Grylloblattoid, Embioid, Forficuloid, Termitoid and Phasmoid lines of descent all converge upon the Perloid line. Furthermore, the Embiids combine characters common to the Termites and Forficulids (with the Grylloblattids), so that they may be considered as occupying a position somewhat intermediate between the Forficulids and Termites, as shown in the diagram, although their closest affinities are with the Perlid group. I formerly (Ent. News, Vol. 26, p. 346, etc.) applied Packard's term, Platyptera (used in the restricted sense) to the Embiid order, but I find that the designation Platyptera was applied to the Diptera by Meigen, 1803, and to the Pisces by Cuvier 1837, long before Packard applied it to the Orthopteroid insects, so that it is necessary to change the term

Platyptera to *Euplatyptera*, in referring to the Embiid group.

As was mentioned above, the Termites occupy a position somewhat intermediate between the Grylloblattid-Embiid-Perlid group and the Blattidae, and in many respects, they approach very closely to, or parallel the Blattoid line, in their phylogenetic development. I have been unable to study such primitive Termites as *Mastotermes*, but I feel certain that these will show marked affinities with the Grylloblattid-Embiid-Perlid group, since those Termites which I have been able to examine all indicate a close relationship to this group, and I think that the Termitid line leads back to the Perlid rather than to the Blattid line of development, as is indicated in the diagram. As will be discussed later on, the Blattid and Perlid lines ultimately approach each other quite closely, so that the resemblances of the Termites to the Blattids may possibly be explained as the retention in both lines, of characters inherited from the common ancestral group from which sprang the ancestors of the Blattids, Termites and Perlids. The affinities of the Termites to the Blattid group may, on the other hand, be much closer than is indicated in the diagram; but this point can be definitely determined only upon the examination of the most primitive representatives of the Termitid group, which are not at present accessible to me. Since this group forms a distinct order, the term *Isoptera* should be applied to it. Although I have been unable to obtain specimens of the rare order *Zoraptera*, described by Silvestri, I would judge from the figures of these insects, that they form an off-shoot from the main Termite stem, and have departed but little from the rest of the Termitoid group.

Since the Perlid line of development is approached or is paralleled by so many other lines of descent, it forms one of the most important of the lower groups of winged insects, the only other lower group which rivals it in this particular being the Phasmid group. The Perlids as a whole are as primitive as any winged insects, and, with the Blattids, must be regarded as the nearest living representatives of the ancestral winged insects, since the group as a whole is as little modified as any known winged forms. The nearest relatives of the Perlids

are the Embiid (and Forficulid) but the Phasmid, Grylloblattid and Termitid lines all appear to converge toward the line of descent of the Perlid group, such forms as *Timema*, *Grylloblatta*, etc., being very similar in many respects to the more primitive members of the Perlid group. Such Orthoptera-like Perlids as *Eusthenia* would doubtless be of great interest from the point of view of the study of the rather close relationship of the Perlids to the Orthopteroid forms; but, unfortunately, I have been unable to procure specimens of this interesting genus for study. The Perlid group constitutes the order *Plecoptera*, and, as will be discussed further on, the Perlid and Blattid lines of descent converge as we follow them further back, and ultimately approach the line of descent of the Lepismids. Indeed, such immature Plecoptera as nymphs of *Peltoptera* are surprisingly *Lepisma*-like, indicating a rather close relationship between the two groups, although we are dependent upon *immature* forms to furnish the "connecting links" between the ancestors of the Perlids and the ancestors of the Lepismids, while in the Blattid group, even the *adult* forms have departed but little from the condition characteristic of the ancestral Lepismids; so that the Blattids are probably somewhat closer to the Lepismids than the Perlids are.

The Mantoid line of descent parallels that of the Blattoid group quite closely, and also approaches the Perloid line near the point at which the Blattoid line draws near to that of the Perlids, as is shown in the diagram. Certain Mantoid forms, such as *Mantoida luteola* exhibit affinities with the Neuropteroid forms; but this is to be expected, since the Mantids and Neuroptera both approach the Perlid line of descent, and would therefore have many characters in common. On the whole, however, I would place the Mantoid line somewhat closer to the Blattoid line, than to the Perloid line of descent, as is indicated in the diagram. The Mantoid forms constitute a distinct order, which may be termed the *Eudictyoptera*, since both Mantids and Blattids were formerly grouped together in the order Dictyoptera. The reasons for regarding the Mantids as a distinct order will be given elsewhere.

As may be seen from the diagram, the Blattoid line of de-

scent is the most direct of the developmental lines leading from the ancestors of the Lepismids to those of the winged forms, and even in the adult stages, the Blattids have preserved many characters common to the ancestors of the Lepismids and Blattids of today. The Blattid line of development is very closely paralleled by that of the Mantids, and ultimately the lines of descent of the Blattids and Perlids converge, if we trace them back far enough. Indeed, it would appear that those features wherein the most ancient Blattoid forms differ most from their modern representatives, are those in which they approach the closest to the Perlid forms, so that the two lines of descent in all probability sprang from ancestors similar enough to be grouped in a single family, although their modern representatives have followed rather widely divergent lines of development. The Blattid line of development is rather closely approached by that of the Termites; but the Termite line of descent appears to lead back to that of the Perlids rather than to the Blattid group. The Blattids are enough different from their nearest relatives to be grouped in a distinct order, and were therefore designated as the *Palaeoptera* in a previous paper (Ent. News, Vol. 26, p. 349).

The foregoing statements may be briefly summed up as follows: The Phylliidae are closely related to the Phasmidae and also to the true Locustidae (usually termed "Acrididae"). The true Locustidae ("Acrididae"), Tettigonidae ("Locustidae"), and Gryllidae arose from forms intermediate between the Grylloblattid and Phasmid lines of descent. The Phasmid, Grylloblattid, Forficulid, Embiid and Termitid lines of descent all converge upon that of the Perlidae, although the Forficulid and Embiid groups are somewhat nearer to the Perlidae than are the other groups. The Perlids, as a whole, are the most primitive of the groups thus far mentioned, but are not more primitive than the Blattidae. The Mantid line of development closely parallels that of the Blattid group, and approaches the Perlid line of development near the point at which the Blattid and Perlid lines of descent converge. The ancestors of the forms giving rise to the Blattid and Perlid lines of develop-

ment were doubtless similar enough to be grouped in a single family, or sub-family, whose ancestors in turn, if traced further back, would be similar enough to the ancestors of the Lepismid group, to be classed in a single family with them. In the same way, if we continue to trace the lines of descent still further back, the ancestral groups would be successively more and more inclusive (i. e. the ultimate ancestral types become more and more alike, the further back we go) until we at length reach the ancestral stem-family containing the similar forms which were eventually to give rise to the various Apterygotan and Pterygotan lines of descent with all their subdivisions and ramifications.

In a recent issue of the *Zeitschrift f. wiss. Insektenbiologie* (Bd. XI, 1915, Heft 9-10, pp. 269-273) I expressed the opinion that there were several lines of descent leading from the ancestors of the Apterygota to those of the Pterygota*, and I further suggested that the similarities in structure between the Protura (or "Myrientomata") and the Plecoptera, or between the Dicellura and the Dermaptera would indicate that there have been lines of descent leading from the ancestors of the Protura to those of the Plecoptera, and from the ancestors of the Dicellura to those of the Dermaptera. The study of new material (such as nymphs of *Peltoperla*, specimens of Lepismids from the Galapagos Islands, etc.) not available at that time, however, has led me to interpret these facts in another way. While I still believe that there are numerous lines of descent leading from the ancestral *groups* which gave rise to the ancestral Apterygota to those *groups* which gave rise to

*This paper, which was submitted for publication more than two years ago, recently appeared in the "Zeitschrift" despite my request to withdraw it. Furthermore, since the proof sheets were never sent me for correction, the article is full of obvious typographical errors, such as the total absence of capital letters in the title, misspelled words in the text (e. g. "sence" for sense), and even the omission of certain words which have totally altered the meaning of certain of the statements (e. g. on page 271 the statement "the Apterygota are no more to be regarded as degenerate Pterygota, than Amphioxus is to be regarded as a *vertebrate*" should read—than Amphioxus is to be regarded as a *degenerate vertebrate* (!)).

the ancestral Pterygota, I do not think that there was as direct a line from the ancestors of the Dicellura to those of the Dermaptera, or from the ancestors of the Protura to those of the Plecoptera, as my former statements would lead one to infer, and I would prefer to explain the similarities between the Dicellura and Dermaptera, or between the Protura and Plecoptera, as follows:

The Forficulid and other lines of development of the Orthoptera-like groups converge either toward the Perlid, or the Blattid line of development; and both the Perlid and Blattid lines ultimately lead back to, or closely parallel, the Lepismid line of descent. Ultimately we reach the more remote ancestral group containing the common ancestors of the Lepismid, Blattid and Perlid lines of descent. If we trace the lines of development of this ancestral group still further back, we find that the more remote ancestors of the forms giving rise to the Lepismid line of descent, in turn possessed many characters common to the remote ancestors of the Japygid, Proturan, and other Apterygotan groups; and the common ancestors of all these were doubtless so similar that they might be classed in a single family or even sub-family. From this common ancestral stem-family there arose the various lines of descent leading to the different Apterygotan and Pterygotan groups of insects; and since all these lines have a common origin, it is merely to be expected that the Forficulids, for example, might retain certain features which have also been retained by the Japygids, or that the Plecoptera might have retained certain features which have also been retained by the Protura, etc. The resemblances between the Japygids and Forficulids, or those between the Plecoptera and Protura, might therefore possibly be regarded as due to the retention in each, of certain features derived from their ancient common ancestral stem group, rather than due to the fact that they indicate that there are distinct lines of descent leading from the immediate ancestors of the Japygids to those of the Forficulids, or from the immediate ancestors of the Protura to those of the Plecoptera, etc. At any rate, the ancestors of the Forficulids and Plecoptera were too closely related to be descended from

two distinct groups of insects, and such annectent forms as the nymphs of *Peltoperla* serve to bring the Plecopteron line of descent very close to that of the Lepismids; so that I am inclined to believe that all of these lines of descent of the Orthopteroid insects ultimately approach very close to that of the *Lepisma*-like forms, as is shown in the diagram. It should be borne in mind, however, that since no group of living insects is descended from any other group of living insects, close resemblances are largely an expression of close parallelism in the lines of descent.

Before leaving the discussion of the lower winged insects, it is necessary to briefly touch upon the relationship of the Libellulid, Ephemeroïd and Neuropteron groups to each other and to the Orthopteroid groups of insects, since the Libellulids, and Ephemeroïds in particular, are very primitive, although somewhat aberrant types of insects. By the term "Orthopteroid" is meant all of those Pterygotan forms whose lines of development approach that of the Blattids or Perlids (e. g. the Perlids, Phasmids, Phylliids, Locustids, Tettigonids, Gryllids, Grylloblattids, Forficulids, Embiids, Termites, Mantids and Blattids).

The Libellulid group or *Panzygoptera* (i. e. Zygoptera and Anisoptera) is apparently related to both the Ephemeroïds and the Neuroptera (i. e. the line designated as the Neuroptera-*delphia*) and also approaches closely to the Perlid-Embiid line of descent, as is indicated in the diagram. The Libellulids may perhaps be regarded as occupying a position intermediate between the Neuropteroid insects, such as the Ascalaphidae, etc., and the Perlid-Embiid group, but possibly ultimately approach the Ephemeroïd line of descent.

The Ephemeroïd line of descent is a rather puzzling one to trace. It approaches the Neuropteron group, and also approaches the Libellulid ("Odonatan") line of descent, but ultimately appears to draw near to the Perlid line, as shown in the diagram, although it does not parallel this line as closely as one might be led to expect from the rather close relationship between the Ephemeroïds and the Neuropteron group. The Ephemeroïds are in certain respects among the most

primitive of winged insects, although in other respects they are decidedly specialized. They are to be regarded as a markedly aberrant group related to the Neuropteroid insects, as well as to the Libelluloid and Perlid lines of development. They appear to approach as closely to the Lepismoid forms as to any of the Apteriygotan insects, and the immature stages of *Heptagenia* and *Hexagenia* are strikingly Crustacea-like in certain respects (such as the mouthparts, etc.) as will be discussed in another paper. The Ephemeroïd forms constitute the order Plecoptera of Packard.

The Neuropteradelphia form a section of the class Insecta, containing the Neuroptera and those insects which have descended from forms not unlike the ancestors of the Neuroptera. As was mentioned above, the Neuropteroid forms are related to the Ephemeroïd group as well as to the Libelluloid group, and also approach the Plecopteron (Perlid) line of descent. The Neuropteron line of descent not only approaches that of the Plecoptera but also approaches the line of the Blattids and Mantids from another angle, which cannot be shown in the diagram, since it would be necessary to draw the Neuropteron line in a plane perpendicular to that of the diagram, in order to bring out this double relationship. The relationship of the Neuropteron group to the Plecopteron (Perlid) group is somewhat closer than that of the Neuropteron group to the Blattid-Mantid group; and the resemblance between the Neuroptera and the Blattid-Mantid group may possibly be due to the fact that both are related to the Plecopteron group—in other words the Neuroptera may be related to the Mantids through the mediation of the Plecoptera. A comparison of certain Mantid forms (such as *Mantoida luteola*) with certain Neuroptera, however, has led me to think that the Mantids, Perlids and Neuroptera may form the three apices of a triangle, each apex of which is connected with the other two by mutual bonds of relationship, so that the relationship between the Neuroptera and the Mantids is possibly more direct than through the mediation of the Plecopteron group, to which both are related.

(To be continued)



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