

CONTRIBUTION TO A MONOGRAPH OF THE INSECTS OF
THE ORDER THYSANOPTERA INHABITING NORTH
AMERICA.

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INTRODUCTION.

Very little attention has been given to the Thysanoptera of North America. So far as I can learn, descriptions or names of only twenty-three species have thus far (June, 1902) been published, besides three which have been recognized as previously described from Europe. Of the twenty-six species thus known in this country, four at least are certainly unrecognizable (*Limothrips tritici* Packard, *Phlaothrips mali* Fitch, *P. caryæ* Fitch, *Thrips phylloxeræ* Riley). Of the remaining twenty-two, six have been found identical with previously described species and therefore become synonyms—the large number is not surprising as many of the early descriptions are entirely too brief to insure positive identification. Therefore only sixteen species have hitherto been known to occur in this country. We may say that almost no systematic work has been done on the order in the United States, and, with the exception of a study of the "Thripidae of Iowa," by Miss Alice M. Beach, most of the descriptions are scattered through different publications. I have endeavored to collect and present here such important facts as have already been published relating to members of this order, together with the observations which I have been able to make. An attempt has been made to place the work upon a systematic basis, and in order to make the descriptions uniform, and thus comparative, all the existing types that it has been possible for me to see have been examined and redescribed. In all, thirty-seven species are thus treated in the systematic part of this paper. Other descriptions which it has not been possible for me to place are given together by themselves in the hope that some one more fortunate or skillful than myself may have material by which to identify them.

There are given herein descriptions of eighteen species which I believe to be new, all but two of them having been collected at Amherst, Massachusetts, and within a radius of 2 miles of the Massachusetts Agricultural College, but even this field has not yet been thoroughly collected. The abundance of new species obtained within such narrow limits shows us how very little has been done upon this order and therefore it will not be surprising, when more attention shall be given to these tiny insects by collectors, if this small order, which has been considered as insignificant in numbers as well as in the size of its individuals, should prove to be quite extensive in the number of its species. Of the new species described in this paper, a complete set of types has been deposited in the Massachusetts Agricultural College; a set of cotypes, so far as they exist, has been deposited in the United States National Museum; a third set of cotypes I have retained for my own use, and the remainder I have also deposited in the Massachusetts Agricultural College. The number of specimens from which the species has been described follows each description. Eleven of the thirteen previously described American species have been redescribed as have also a number which I believe have been previously described in Europe. Descriptions of early stages have been given where known and the authority therefor noted in each instance. It will be noticed that in all cases the description of the female precedes that of the male, or the latter may be wanting entirely. Among the Thysanoptera the females are much more abundant than the males and also more characteristic when both are known. For these reasons all of the descriptions are based mainly upon the female. It would be impossible to give a bibliography of the species of this country without including many references to European works. Therefore the bibliography is intended to include the literature of this order for the world rather than for North America alone. Each reference has been numbered so that it could be referred to by number when desired without repeating the whole title. Such references have been made by inserting the bibliographical number inclosed by a parenthesis where authority for a statement is referred to, thus, (1).

I desire here to acknowledge that I am under many obligations to those who have assisted in making this paper more complete by kindly loaning type specimens, without the examination of which the identification of several species could not have been certain. I should state that these types were not loaned to me directly, but to Prof. C. H. Fernald, who kindly took upon himself the responsibility for them, but as I have been the one to profit by them it gives me pleasure to express my thanks to Prof. J. H. Comstock, through whose kindness I was able to see the type of *Limothrips poaphagus*; to Prof. Herbert Osborn for the privilege of examining at my leisure his type of *Thrips*

striata; to Prof. C. P. Gillette for the loan of his supposed *Thrips striatus*; to Prof. H. E. Somers for sending the types of Miss Beach and Professor Osborn, with their kind permission, to Dr. Henry Uzel for the positive identification of *Thrips tabaci* with his *Thrips communis*, and finally to Dr. L. O. Howard and Mr. Theodore Pergande for giving me access to the material in the United States National Museum collection.

This paper forms the major portion of a thesis for the degree of doctor of philosophy at the Massachusetts Agricultural College, where it has been prepared under the supervision of Prof. Charles H. Fernald and Dr. Henry T. Fernald, who have charge of the work in the department of entomology. To both, for the many ways in which they have guided and encouraged me in the work of the past three years, I give my heartiest thanks.

HISTORY OF THYSANOPTERA.

These insects were first described by DeGeer in 1744, under the name *Physapus* (2). Linnaeus ignored this name and placed the four species known to him in a genus which he called *Thrips*, locating it in the order Hemiptera, immediately after his genus *Coccus* (5). In 1806, C. Dumeril raised the group to the rank of a family, which he called *Vesitarses* or *Physapodes* but retained it in the order Hemiptera (44). C. F. Fallen (47), in 1814, changed the name of the family to "Thripsites," but did not change its ordinal position, and this name was retained by Newman (61) as the name of a "natural order," which, however, had only family value. In 1825, Latreille (50) used for them the names *Thripsides* and *Physapi*. A. H. Haliday, in 1836, published an extensive study of the British insects belonging to this group and concluded that they should be given the rank of an order, for which he proposed the name *Thysanoptera* (63). Probably about two years later, Burmeister (69) also gave them ordinal rank, with the name *Physapoda*, since which time most writers have adopted one or the other of these ordinal names. Those who adopt *Physapoda* appear to base their preference largely upon the priority of Dumeril's use of the name *Physapodes*, *Physopoda* (*Physapoda*) being a re-formation of the term. It does not, however, seem to the writer that this position can be sustained, as at that time there was no genus *Physopus*, DeGeer's name having no standing, as it was given before the tenth edition of *Systema Naturæ*.^a

It seems therefore that Haliday was the first to give the group the rank of an order and to apply thereto a properly formed ordinal name: *Thysanoptera*, from *δίσσωτος*, a tassel, and *πτερόν*, a wing. This basing of the name upon characters of the wings is in accord with general usage in the various orders of insects. I believe that *Thysan-*

^a See Canons V and XIII, A. O. U. Code, 1892.

optera can claim priority and correctness of formation and should therefore be adopted.

While the scientific name of the group has been subjected to so many changes, the most frequently used common name has persisted unchanged since the time of Linnaeus. It is nothing more or less than the name which he gave to the genus *Thrips*, and is now applied in the same form to any individual of the order. It is therefore incorrect to drop the "s" when referring to an individual, as is frequently done. *Thrips* is a Latin name derived from the Greek *Θριψ*, meaning a wood-louse, and is in the singular number and masculine gender, as will be also all generic names of which it forms the termination.

Various other common names based upon two of the most striking characters of the group have also been used to a limited extent: Bladder feet (*Blasenfusse* or *Vesitarses*), referring to the peculiar structure of the extremity of the leg, is appropriate and much used by German writers. Fringe-wings, from *Thysanoptera*, has also been used, but much more rarely.

SYSTEMATIC POSITION OF THYSANOPTERA.

The systematic position of this group has undergone unusual change since its establishment by Linnaeus. Working as he did upon the most striking superficial characters, Linnaeus recognized in *Thrips* certain affinities with the Hemiptera-Homoptera, in which order he placed them. About 1828 through the anatomical studies of Straus-Durchein and Latreille, sufficient evidence was obtained to lead Latreille to separate them from the Hemiptera and place them among the Orthoptera. By other writers they have been regarded as Pseudoneuroptera, but at the present time the general opinion is that they form an order by themselves.

So far as the writer can learn, the best work dealing with this question has been done by Jordan (309). His studies were made principally upon *Heliothrips dracena* Heeger, representing the Terebrantia and *Phlaothrips brunnea* Jordan, representing the Tubulifera, but many other species were also considered and his conclusions are based upon anatomical (both external and internal) and biological considerations. The following is a free translation of a portion of Jordan's conclusion.

In regard to the place of Physapoda, we must classify them according to their immersed germ band and their larval form in the line of the Orthoptera, Homoptera, Hemiptera, wherein they should be placed according to their anatomy and biology.

In habits the Physapoda, especially the larvæ, resemble small Cicadellinae. The hypognathism of *Thrips* is found in such marked degree that the mouth cone comes to lie under the prothorax as in the case of Homoptera, especially Phytophthira. The number and position of the ocelli resembles the Orthoptera s. l. more than the Homoptera, while the position of the antennæ is similar to that of the Orthoptera

and Aphidæ. In the structure of the mouthparts, the Physapoda are not as far removed from the Orthoptera as are the Rhynchota; the Physapod proboscis is of a type between the biting mouthparts of Orthoptera and the sucking mouth of the Rhynchota, by which it is not meant that the Homoptera have developed from our Physapoda. The biting mouth organs of the Orthoptera are here concealed by the transformation of the mandibles into piercing bristles and the growing together of the labrum with the maxillæ and labium, while the piercing bristles form a short tube to the sucking proboscis. In this respect the Physapoda should be considered as Rhynchota together with the Homoptera and Heteroptera.

Thrips have the free prothorax in common with the Orthoptera s. l. and the Rhynchota. The development of the meso- and metathorax shows that at least the metasternum and mesosternum are nearly equal to those in the Orthoptera, while the absence of the metaphragma, which is always present in the Orthoptera, and the disappearance of the long metathoracic muscles which are not reduced there, bring Thrips into close connection with the Homoptera. The first ventral ring is maintained through the absence of the first ventral plate and the entrance of the dorsal plate into the thoracic covering in the Physapoda just as in many Orthoptera s. l., but a quite similar condition is also shown in the first abdominal segment of the Homopterous Psyllidæ, a sign that Orthopteroid characters may be retained even in genuine Rhynchota.

A reduction of the system of venation of the wing takes place in the Phytophthira as in the Physapoda, but not in the same degree in the Orthoptera s. l. The Physapod wing is a Phytophthiran wing in which the large spread is greatly reduced, as in the Pterophoridae, by the development of long fringes.

In regard to the concentrated nervous system, Thrips come very close to Rhynchota and are far removed from the Orthoptera, but in this connection it is worth noting that the aberrant Mallophaga, provided with biting mouth parts, also possess a concentrated nervous system. Aside from these doubtful cases, all other Orthoptera have a developed chain of ventral ganglia. The tracheal system of Thrips has the small number of three or four pairs of stigmata. We find the stigmata reduced usually in the breathing organs of holometabolous insects. Among the Rhynchota we find it as in the Coccidæ; all other Rhynchota and the Orthoptera are holopneustic. The alimentary canal of Physapoda is characterized by the possession of four malpighian vessels which occur in like manner in all Rhynchota with the exception of the Aphidæ which have none, and the Coccidæ which have two urinary organs. The Orthoptera have a large number of urinary tubes, with the exception of the Termitidæ and Psocidæ with six and the Mallophaga with four. The long, slender œsophagus of Terebrantia which reaches even into the abdomen is found also in the Psyllidæ, the large loop of the midgut of Terebrantia is characteristic of many Homoptera, but in these the enlargement of the loop of the gut running back, takes place at the beginning of the midgut.

The male sexual apparatus, with its simple, often pear-shaped testes, resembles the Mallophaga about as much as the Phytophthira; the female organs, from the rosette arrangement of the ovarian tubes, resembles the tubes in the Rhynchota; the want of connective strands of the eggs with the germ area places the ovaries especially beside those of the Cicadellinæ. The genital armature of the Terebrantia is found in the Orthoptera and Phytophthira.

In anatomical respects, therefore, the Physapoda come nearer the Homoptera than the Orthoptera s. l. There is also a series of biological facts which strengthen still further the connection of these insects with the Homoptera. First, I would recall that the Physapoda with their nymph and pronymph stages, in which they take no nourishment, exhibit a very similar transformation to that which is known to take place in Coccid males. The parthenogenesis of Thrips is not Orthopteroid, but a method of reproduction which is peculiar chiefly to the Phytophthira. The frequent

occurrence of apterous species without rudiments of wings, the condition that one sex is so frequently winged while the other is wingless, that among the normally winged species there appear individuals with reduced wings, that the latter phenomenon occurs especially toward autumn; all these are occurrences which take place to a considerable degree in the Phytophthira.

The manner of nourishment of Thrips, their life in larval colonies, the rapid and successive development of each generation, the sucking of plant roots by the larvæ, the periodical swarming of multitudes of the winged species give to Thrips throughout an Aphid-like character.

Therefore we can not doubt that we must separate the Physapoda from the Orthoptera s. l., but we must still determine whether we may incorporate them into the Rhynchota. If we maintain the division of the insects into eight orders (Thysanura, Orthoptera s. l., Rhynechota, Neuroptera, Lepidoptera, Diptera, Hymenoptera, and Coleoptera) and include in these orders the aberrant Siphonaptera, Mallophaga, Strepsiptera, the first in the Diptera, the others in the Orthoptera and Coleoptera, then we must also consider the Physapoda as Rhynchota and divide the Rhynchota into Heteroptera, Homoptera, and Physapoda.

But if, according to Brauer's classification, we break up the conglomeration of the Orthoptera s. l. into several orders of insects equivalent to the well-defined Coleoptera, Hymenoptera, Lepidoptera, Diptera, and Neuroptera, and also consider the aberrant Siphonaptera as a single order, just as the Bryozoa, Echinorhyncha, etc., represent aberrant types of worms, then there is no necessity for destroying the unity of the type of the Rhynchota by the incorporation of the Physapoda, but we can erect for Thrips a new order, the phylogenetic value of which we find in that they have branched off from the line of the Orthoptera-Homoptera-Heteroptera where the Orthopteroid characters of the Homoptera are not entirely suppressed, and that they exhibit special mouth parts which morphologically still remain somewhat Orthopteroid, but functionally are quite Rhynechotoid. The Mallophaga with their Rhynchota-like nervous system and their four malpighian vessels must have branched off before the Physapoda. Their special connection with the Physapoda arises from the form of the tracheal stigmata in the development of the thorax in which the metanotum, as in the Physapoda, is larger than the mesonotum in contrast with all Rhynchota and Orthoptera. If we collect the Mallophaga, Psocidæ, and Termitidæ as Corrodentia with Brauer, then we must place Physapoda in the system between Corrodentia and Rhynchota.

COLLECTION OF THYSANOPTERA.

As the life habits of species of this order differ very greatly, the methods of collection must be varied according to the species. The majority of these insects are to be found in flowers, grass, etc.; many are found exclusively in turf or near the surface of the ground; others are taken most commonly under the bark of trees, on foliage, etc.

For the grass-inhabiting species, I have found a short-handled sweeping net, made of fine muslin, most serviceable. Other cloths may be used, but the texture must be considerably finer than that of cheese cloth or many of the smaller species can easily pass through it and escape. As a white background greatly facilitates the observation of these small creatures, the contents of the net may be carefully examined by slowly turning it inside out without emptying it or the net may be emptied and the contents be examined upon a sheet of white paper carried for the purpose. Small phials serve as convenient recep-

taeles for the collections from various plants or other sources and thus they may be kept separate if desired. The most convenient method yet found for catching these lively little animals is to moisten a fine camel's-hair brush and place it directly upon the escaping actively jumping or flying forms. Those that are more sluggish in their movements can be easily lifted upon the point of the brush and transferred to the phial, which may be stoppered with a cork or wad of cotton. A label giving such data as it is desired to preserve may be placed in the phial or attached to the outside and a bit of the food plant may well be placed inside with the insects. In this bottle they may be kept alive for some time, if it is not convenient to preserve them at once.

Uzel recommends for collection from flowers, inclosing the flower head, insects and all, in a four-cornered paper bag, folding the upper edge over twice and fastening with a pin. Flowers of only one sort should be placed in a bag. The contents of the bags are examined at home upon a sheet of white paper and the escaping creatures captured with the aid of a fine brush dipped in alcohol. In winter, dried flowers and grass stems yield many hibernating forms.

Tree-inhabiting species may be found by beating over a white surface, or foliage may be collected and sifted by means of a fine beetle sieve, which is a great convenience for this work. In this way may be found also many species inhabiting turf, moss, fallen foliage, or decaying bark. The sifting may be done directly over white paper or the siftings collected by means of a fine bag fastened around the sieve and examined at the collector's leisure at home. Some species are known to inhabit certain oak galls and probably other galls will be found to shelter other species. The gall is, as a rule, the work of some other insect which the Thrips has appropriated for its home, but in Australia some galls are said to be formed by the Thrips themselves. Both Uzel and Jordan state that many inhabit fungi, but I have not yet found any in such a location.

PRESERVATION AND MOUNTING.

Various methods of preserving these tiny insects have been tried. Being so small that it is impossible to study them without the aid of a compound microscope, the method has been sought for which would best preserve the natural form and color of the insect and the most satisfactory results have been obtained in the following simple way:

The specimens to be mounted, having been brought into the laboratory alive in small bottles, are quickly killed, and at the same time cleared, by dropping them directly into xylol in which they are left for about an hour. They may then be mounted directly in balsam dissolved in xylol without danger of cloudiness resulting from moisture in the insect body. The mounts are clear, natural colors are well preserved, and when dried they are permanent and always available

for study. Working with such small insects, it is difficult to arrange them satisfactorily upon the slide, but with patience and care this can be accomplished fairly well. The wings should be spread, and this condition has, as a rule, been most easily obtained by transferring the insect from the xylol to the center of a clean slide, and then teasing the wings out to the desired position by means of a fine bristle. The balsam is then placed on the cover and gently lowered onto the insect. As the balsam spreads it tends to carry out the wings, legs, and antennæ so that they are in a position for study. It is a convenience in study to have two specimens on the same slide, one being dorsal, the other ventral side up. Specimens of different species should not be placed upon the same slide. If it is desired to keep a large number of duplicates, it is not, perhaps, advisable to mount them all in this way, as they can be fairly well preserved by placing the living insects directly in about 80 per cent alcohol. Alcohol is, however, liable, or even likely, to cause an abnormal distension of the body, especially with Tubulifera, and if some of these distended specimens are afterwards mounted permanently for study it will be found that their general appearance has become so changed that the species is scarcely recognizable. For this reason I can recommend alcohol only for duplicates of well known species and never for undescribed material.

While balsam mounts, made as described, seem to be best for preserving the general natural appearance of the insect, mounts made in another way are more useful for study of the chitinous structure. Everything but the chitin is dissolved by allowing the specimen to macerate for from twenty-four to thirty-six hours in a cold 10 per cent solution of caustic potash, or by boiling for a few minutes in a little of the same solution. When thoroughly cleared the specimen may be mounted directly in glycerin, or washed in water, dehydrated in alcohol followed by xylol, and then mounted in balsam. Such mounts can be examined under high-power lenses and reveal many fine details of chitinous structure which can not be seen in ordinary mounts.

A few words in regard to glycerin mounts may save some one such disappointment and loss as my experience with them has caused me. During one summer quite a large number of mounts were made by placing the insect directly into glycerin contained in a low cell, made either of white zinc cement or hard glycerin jelly, the cover glass being carefully sealed on with the white zinc cement in each case. These mounts were beautifully clear at first and were placed aside for study during the winter. When examined again after a few months they were found to be ruined and worthless. Nearly every specimen was more or less thickly covered, especially around the spiracles and thin membranous areas, with dense clusters of white, needle-like

crystals, many of which were also floating through the glycerin. As a result these slides, containing most of the results of a summer's collecting, had to be thrown away. The exact composition of the crystals was not determined, but it is supposed that they were mostly phosphates which had been dissolved in the juices of the insect's body. As the juices were gradually drawn out, the phosphatic salts, not being soluble in the glycerin, were deposited as the white crystals.

There are still other objections to glycerin as a mounting medium for Thysanoptera, though it may be all right for other insects. The dark pigment of the eyes is frequently dissolved out by glycerin, and spreads all through the head, suffusing it with a dark color, which obscures all details in that region. Furthermore, glycerin does not preserve the tissues of the body for a very long time. They gradually go to pieces, the segments spread apart, and the mount becomes worthless in the course of a few years. Of course this objection to glycerin does apply to the mounting of chitin which has been cleared from all soft tissues by treatment with caustic potash solution, as chitin is unaffected by glycerin.

EXTERNAL ANATOMY.

INTEGUMENT.

Adult.—The chitinous skeleton of these insects is quite firm. The body wall is made up of strongly chitinized, rigid plates joined together by thin and very flexible membranes. The texture of the plates appears usually to be quite uniform in different parts of the same specimen. In the head, especially, several of them are so smoothly joined that no sutures are visible. The thin connecting membrane may be smooth and of a uniform thickness, or, as in many parts of the Tubulifera, it may show a peculiar structure in the nature of regular, distinct, very minute, plate-like thickenings, varying in form but often circular or hexagonal, giving a decidedly granular appearance to the area.

The chitin is frequently thrown into more or less distinct folds or ridges, most frequently transverse in direction, but often branching and running together to form a reticulated structure. The back of the head and the pronotum are most frequently marked in this way. Sometimes the ridges become very thick and pronounced, and form a regular network over the surface so conspicuous as to be of use in classification (*Heliiothrips*, *Parthenothrips*, see Plate VI, fig. 64). This reticulation may extend over the whole outer surface of the body, legs, and even the fore wings, but always seems to be heaviest upon the head and pronotum. It is not known to occur in the *Æolothripidae*, but is found in several species of *Thripidae*, and I have discovered it in an undescribed species of *Phleothripidae*.

In certain parts of the body there are found invaginations of the chitinous, external skeleton serving as advantageous points for the attachment of muscles. These can best be seen on the meso and metasternal plates of winged species of Thripidae, and are darker than the plates in color. Many species show a narrow, transverse line across the second to seventh dorsal abdominal plates near the anterior edge of each. This dark line is caused by a chitinous, ridge-like thickening forming an arch on the inside of each of these plates.

The chitin of the skeleton is rarely entirely unpigmented. Pigmentation may take place in the cuticle itself, when the color is usually gray, yellow, brown, or black, or color may appear from pigments deposited in the hypodermis or fat-body. Such deposits are usually very irregular and of a yellow, red, or purple color. Pigments are frequently present in both places in the same individual. Metallic colors do not occur.

Larva.—The chitin of the larva is much less firm than that of the adult, and there is scarcely any differentiation in texture or structure between the plates and connecting membranes. The surface is not reticulated, but is usually considerably wrinkled transversely and roughened, though sometimes it is quite smooth.

Pigments are rarely present in the chitin of the larva, and when they do occur the colors seem to be limited to gray, yellow, or brown. Larvæ are usually of yellow or red color, but these colors are due to hypodermal or fat-body pigments, and to some extent, perhaps, to the body fluids.

Pupa.—The delicacy of the chitinous covering of the early stages can be seen during the period of transformation. It is then thin, smooth, and often shining. The cuticle forms a delicate sheath around the wings, antennæ, and legs, and toward the end of this stage can be plainly seen separated from the body of the inclosed adult.

Integumental appendages.—These are present in the form of hairs, bristles, or spines which are variously modified. They are frequently borne upon small warts or tubercles which can be most distinctly seen upon the cheeks of many Tubulifera. The membranes of the wings are thickly set with microscopic hairs, usually either darker than the membrane itself or sharing its color. In some species (*Sericothrips*, various species) the abdomen is also thickly set with microscopic hairs, giving it a sleek, velvety appearance, and whorls of similar minute hairs often mark the antennal segments. The posterior fringes of the wings are always composed of long slender hairs, usually more or less spiral or wavy in appearance and inserted either directly into the edge of the wing (Tubulifera) or attached by a joint to a fixed base upon the edge (Terebrantia). This joint allows of motion only in the plane of the wing and toward its tip; it facilitates the folding of the hairs into line with the edge of the wing when the latter is brought to rest.

In nearly all species numerous short, small spines are borne upon the various parts, especially upon the prothorax, legs, and antennæ. Larger and more conspicuous spines or bristles mark especially the exposed parts of the body such as the vertex of the head, the angles of the prothorax, the veins of the wings in the Terebrantia, and the last two or three segments of the abdomen. Special modifications of these larger spines are found in many adult Tubulifera in the form of hairs which have usually a slender shaft and at the tip are roundly knobbed or irregularly funnel-shaped, though sometimes they are short and cut off squarely at the tip where they are fully as large as at their base.

Larvæ and pupæ of both suborders, in many cases, bear such knobbed or funnel hairs which, when present in the pupæ, are even longer and more slender than in the larvæ. The spines in many cases are placed in quite regular segmental rows, both in transverse and longitudinal directions.

HEAD.

The form of the head is peculiar and extremely variable. (See figs. 4, 14, 27, 55, 93, 107, etc.) But while this variation is great between different species, the proportion of length to breadth in the same species is very constant. The different sclerites forming the head are so completely fused as to be indistinguishable and we can therefore designate the regions of the head only in a general way. The dorsal portion back of the eyes is called the occiput, that between the eyes and extending forward to the bases of the antennæ is the vertex, between the bases of the antennæ and the attachment of the mouth cone on the ventral side is the frons, while the sides of the head are called the cheeks (*genæ* of other orders). The usual appendages of the insect head are present and will be considered separately.

Antennæ.—These are inserted upon the extreme front of the head and stand quite closely together upon the front margin between the eyes. They are always much longer than the head and may be two or three times as long. The number of segments is a character of much importance in classification and varies from six to nine. The form of the segments ranges from cylindrical to almost spherical, and this character is also of importance in classification. The spines upon the segments become more numerous as the apex is approached, and on the intermediate segments are mostly borne upon the apical half of each. The *Æolothripidæ* lack the specialized form and arrangement of the spines which is found in *Thripidæ*; their antennæ are quite uniformly clothed with short hairs or bristles. In the *Thripidæ* this general hairiness is lost, except in those species having whorls of hairs around intermediate segments, while a few much longer and usually more conspicuous spines are developed. The antennal spines of *Phleothripidæ* resemble in a general way those of *Thripidæ*. In both

these families certain spines seem to have undergone much modification and to have become specialized as sense organs of some particular sort. (See Plate XI, figs. 123, 124.) They are larger than the unspecialized spines, thin walled and almost transparent, and usually end in a blunt point. In some species they are quite prominent, but as a rule are inconspicuous and require a careful adjustment of the light to be clearly seen. They are always simple in Phlæothripidæ and are usually borne upon segments three to five, sometimes three to seven.

In the Thripidæ similar structures are found, but they have undergone even greater specialization in most cases. In a few genera (*Chirothrips*, *Limothrips*, *Aptinothrips*, and *Parthenothrips*) they are simple and stand singly, one to a segment, upon the outer angles of segments three, four, and sometimes five, and upon the inner side at about the middle of six. In most cases, however, it appears that two of these specialized spines have approached and united at their base, so that we find upon the upper side of segment three and the under side of four, near their tips, a peculiar crescentic organ having the same apparent structure as the specialized spines just described and borne upon a small stalk standing in a clear, membranous area. (Plate XI, fig. 123.) In some cases these organs are shaped much like the horns of cattle and are curved in two directions, being curved forward and also toward the axis of the antenna. The fifth segment sometimes bears a simple spine and another one is also well developed upon the inner side of the sixth. The function of these structures is uncertain, but they are usually called sense cones.

In the Elothripidæ an entirely different type of sense organ is found, though the two may possibly have much the same function. Upon the underside of segments three and four are narrow, much elongated longitudinally, thin, membranous areas, situated upon the outer half of each segment and a very small round spot of similar structure is similarly placed near the tip of segment five. (Plate XI, fig. 122.) These membranous areas strongly suggest an auditory function, but this is, perhaps, only a possibility.

Abnormal antennæ are not uncommon, and one or both may be deformed. The most common variation is in the line of a reduction in the number of segments through the fusion of two or more of the apical ones. Such deformed antennæ may not be shorter than the normal ones, but there is usually some reduction in length. In one case, at least (*Aptinothrips rufus* var. *connaticornis*), there occurs a regular and apparently normal fusion of the two segments constituting the style of the typical form with the sixth segment (Plate V, figs. 52, 54), which in this case is considered as a varietal distinction. An increase in the number of segments above the normal, by a division of one or more, is not known.

The antennæ are carried extended forward in front of the head, and

are not normally laid back along the body when at rest. In the Terebrantia the first two segments are usually markedly broader than the others.

Larval antennæ vary considerably from those of adults. The number of segments is constantly smaller, and the form is generally changed. Sense cones are not present, and the arrangement of spines is quite different from that in the adult.

ORGANS OF VISION.

Eyes.—Adult Thrips possess faceted eyes, which are borne upon the front angles of the head and extend downward onto the frons about as far as they do upward onto the vertex; rarely they are situated farther back upon the sides of the head, but still near the front. They are circular, oval, or reniform in outline. The size and number of facets varies considerably in different species, as does also the closeness of the facets to each other. The eyes are quite large, as compared with the size of the head, being together about one-half the width of the head through them. In many species, especially in Terebrantia, they are strongly protruding (*Heliothrips*, *Parthenothrips*). The individual facets are usually considerably swollen, and small hairs project from between them, thus giving the eye a peculiar resemblance to the surface of a raspberry. The cornea is quite thick, transparent, usually slightly tinged with yellow, and appears like a light-colored margin around the outside of the eye. The part of the head closely adjoining the eye is frequently also much lighter in color than the remainder of the head.

The pigmentation of the eye is dense and dark, so that, as a rule, by transmitted light the eye is entirely opaque, while by reflected light it may be red or very dark purple in color.

The eyes of larvæ are much smaller and simpler than those of the adults. They consist of but few large, separated facets, and are situated farther back upon the sides of the head.

Ocelli.—These are adult structures, and are not present in larvæ, though the pigment of the developing ocelli can sometimes be seen late in the larval stage. They are not always present, however, even in the adults. They are three in number, situated more or less closely together between the eyes on the vertex of the head, and are placed always in the form of a triangle, with its apex forward. Rarely only two ocelli are present, and it is then the front one which is wanting. Ocelli are present in all winged forms, and usually also in the short-winged forms of winged species. They are absent, however, in entirely wingless species.

MOUTH PARTS.

The mouth parts of Thrips are difficult to study, and so peculiarly modified that it has been found hard to determine their homologies.

This fact accounts largely for the many changes which have been made in the classification of this group. It is now generally admitted that their action is largely suctorial. They exhibit structures which seem to show a transition from a mandibulate to a haustellate form, and for this reason are of peculiar interest.

As a whole the mouth apparatus appears as a broad, unjointed cone attached to the extreme posterior edge of the under side of the head, being carried so far back that its attachment to the rest of the head lies largely under the pronotum (Plate X, fig. 111). The apex of the cone is usually quite sharp, but never as slender as in the Hemiptera, and lies, when at rest, in a depression of the prosternum between the fore coxæ. In many species the mouth cone is bluntly rounded. In the Terebrantia it is attached to the frons by a strongly chitinized thickening, running more or less obliquely across the under side of the head. In most species this dark thickening is nearer the left eye than the right and is connected by a similar thickening with the margin of the left eye (Plate XI, fig. 120). This connection is wanting on the right side, though a portion of the thickening still remains close to the right eye. In the Tubulifera the base of the mouth cone is much more nearly symmetrical and the connections with the eyes are entirely wanting (Plate XI, fig. 127).

Asymmetry.—So far as we can learn, Prof. H. Garman was the first to call attention to the very peculiar asymmetry which is characteristic of the mouth parts of the members of this order, and he gave a new interpretation to certain of these parts, which we believe to be correct.

Not only is the connection of the mouth cone, as a whole, with the frons asymmetrical, but also some of the individual parts of the mouth are markedly so. The most striking of these are the form of the labrum and the absence of the right mandible. These parts will be considered more in detail by themselves.

Labrum.—The labrum forms the front wall of the cone (Plate XI, figs. 120, 127). It is decidedly asymmetrical in all Thysanoptera, but especially so in the Terebrantia. It is irregularly triangular in form, does not reach to the endocranial thickening, but is attached by its broad base to the clypeus by an indistinct membranous connection. From the base it narrows to the tip, where it is more or less rounded in Terebrantia, but is quite pointed and spine-like in many Tubulifera, though bluntly rounded in others. It is drawn out much farther toward the right cheek than toward the left, and on the right side also approaches most closely to the transverse thickening. The labrum is usually abruptly darker in color than the area between its base and the transverse thickening.

Mixillæ.—The mixillæ are broad, flat, and external. Like the labrum, they are wedge-shaped or triangular in general form, and they constitute the side walls of the mouth cone. They taper toward their

tips, where they are quite sharply pointed and strongly chitinized, and may reach slightly beyond the labrum. At about the middle point of the side of each maxilla is borne a two or three segmented palpus. In the *Æolothripidæ* this is always three segmented and geniculate; in the *Thripidæ* it is composed of two or three approximately equal segments and is straight, the segments being cylindrical but decreasing successively in diameter; in the *Phlæothripidæ* it is always two segmented and the segments are very unequal in length, the basal one being short and rounded while the second is long, slender, and cylindrical. The terminal segment is in all cases provided with a few touch bristles which are but rarely distinctly and easily visible.

Labium.—The labium is believed to be formed by the union of the second pair of maxillæ and in many insects evidence of this can be seen, but in the *Thysanoptera* there is no visible suture along the median line, though sometimes a deep median notch is present at the tip. It forms the hind wall of the mouth cone and is, as a rule, considerably broader at the tip than the other parts. In many species, of *Tubulifera* especially, it is very broad and heavy at the tip, but in others it is narrowed and the whole mouth cone is then usually elongated and pointed. Standing closely together, each upon a membranous space a little to one side of the middle of the tip, are the two or four segmented, cylindrical, labial palpi. The maximum number of segments is here found also in the *Æolothripidæ*, and the minimum number in the *Thripidæ* and *Phlæothripidæ*. Around the tips of the labial palpi are borne a few touch bristles similar to those upon the maxillary palpi.

Within the hollow cone formed by the parts just described lie the protrusile, piercing organs of the *Thysanopteran* mouth. These organs are three in number and of two kinds. Their homologies have been confused by various writers.

Mandible.—This is the large, unpaired, piercing spine lying on the left side in the mouth cavity. It has been variously interpreted as epipharynx, mouth spine, etc. In the right side of the head there is no trace, or but a mere vestige, of the corresponding organ. The absence of the right mandible appears to be closely correlated to all the asymmetry of the mouth parts of these insects. The mandible consists of two parts, though these are not separated in any way. The large bulbous base appears to be mostly muscular and is attached to the endocranial thickening behind the left eye close to the angle which is made by the endocranium at this point, and about in line with the branch from this thickening running to the left eye in *Terebrantia*, which branch thus appears to form a strong brace. On the right side the absence of this endocranial branch is doubtless due to the non-development of the right mandible, and the labrum has grown out farther on the right side to take the place in some measure of the

wanting structures. The muscular base is short and abruptly constricted, and from this point to the tip the mandible continues as a slender, strongly chitinized spine having a very sharp point. This structure is capable of protrusion for only about one-fourth of its length, and therefore appears to be used only for piercing the outer, tougher tissues of plants. The mandible in the Tubulifera is decidedly shorter and more bent than is that in the Terebrantia.

Maxillary lobes.—This pair of piercing organs has been considered by the majority of writers as the mandibles, but such they surely are not. Dissection shows that they are attached by a movable joint to the bases of the maxillæ. Each lobe is composed of two parts: A short basal, muscular arm or lever attached to the maxilla, and at the other end united to the enlarged, muscular base of the spine which is very slender and strongly chitinized. These spines are longer and more slender than the mandible and are developed alike on each side. When retracted into the mouth, the basal arm or lever extends obliquely forward so that the lever forms an acute angle with the spine, which then reaches just to the mouth, but when protruded the lever is brought down toward the mouth so as to straighten this joint, and the spine is thus thrust out from the mouth opening to a considerable distance. As these spines are more slender and protrude farther from the mouth than does the mandible, it appears probable that the latter is used to start the puncture through the hard, tough outer tissues, while the weaker lobes of the maxillæ, penetrating deeper through this opening, reach into the inner tissues. Some writers have stated that the three spines are hollow and used as suction tubes, but I have not found this to be the case in the species examined.

There is a marked difference in length of the maxillary lobes in the two suborders. In the Tubulifera they are extremely long, and when retracted curve far forward under the eyes, while in the Terebrantia the bend of the lobes scarcely reaches beyond the transverse thickening. In the Tubulifera these lobes are altogether longer than the entire head and can be protruded in many species as far as the hind edge of the mesosternum.

Other mouth structures.—Attached to the inner surface of the labium are certain other chitinized structures hard to describe and of uncertain homology, but considered by some as an hypopharynx.

Larvæ.—The mouth parts of the larva are much the same as those of the adult, though weaker and less strongly chitinized. The chitin of these structures is shed at each molt, and may then be seen connected with the cast-off skin.

Movements of mouth parts.—The parts forming the external-wall of the mouth cone are not free, being united by a membranous connection along their sides. At the tip of the cone there is a small opening. It thus appears that structurally these insects are incapable of biting or

chewing their food to any degree, though it has been stated that particles of leaf tissue have been detected in their excrement. This may be accounted for by the fact that the mouth parts are quite strongly chitinized at their tips, and so may serve, to some extent, to rasp or tear the tissues, small particles of which may be drawn into the alimentary canal with the sap.

THORAX.

(Plate XI, figs. 116-119, 125-127.)

The thorax is composed of three distinct segments, each of which is well developed. The prothorax is separated from the mesothorax by a deep constriction and is freely movable. The other thoracic segments are closely grown together and form what is conveniently called the pterothorax. The larval thorax shows no particular chitinized plates and its whole structure and the arrangement and development of the spines have been but little studied.

Most previous descriptions of the thoracic structure of these insects have been very brief. Unfortunately Dr. Uzel has given the entire anatomical part of his monograph in Hungarian, and therefore his description of the thorax has not been available. It is evident that there is considerable variation in the thoracic structures in different species, and it may be that when carefully worked out these parts will be found to have considerable importance in classification, whereas they have not been used in this way heretofore. A general description of the parts of the thorax is difficult to give and must be subject to much modification in many species as the homologies of some parts are not well established.

Prothorax.—This segment is as wide or wider than the head and varies much in its proportions and form. It is rarely much longer than wide, usually exceeds the mesothorax in length, and in most cases approximately equals the metathorax. The form in the Terebrantia is usually more or less rectangular, with the sides and hind edge especially somewhat rounded. This form is also found in some Tubulifera, but as a rule among them the thorax is trapezoidal, being much wider at the hind edge than at the front. This trapezoidal form appears to be closely related to the development of the fore legs, since in the genus *Chirothrips* where the fore legs are extremely thickened there is found the same form of prothorax as in the Tubuliferan genera where the fore femora are also enlarged.

The pronotum is strongly chitinized. In the Thripidae it is usually more or less transversely striated and often bears numerous small spines. In the other families it is generally smooth.

In most Thysanoptera the prothorax bears long conspicuous spines, the number and arrangement of which are much used in classification. These stand usually around the outside of the pronotum—one or two

at each angle and a pair on each of the transverse margins, and in some species one in the middle of each side. The maximum number is therefore twelve. When only one or two pairs are present they are at the hind angles. The form and size of these spines is also variable. They may be quite short and inconspicuous or nearly as long as the pronotum itself. In many *Pleothripidae* they are knobbed or funnel shaped at the tips.

In a number of species of *Tubulifera*, a division of the pronotum into plates near the hind angles has been observed. Two triangular plates coming up from behind the middle on the side and at about the hind angles meet at a point considerably within the margin and above the fore coxæ. The prosternum is less strongly chitinized than the pronotum and at about the middle of the fore edge is often indented to accommodate the mouth cone. The insertions of the fore coxæ are at the hind angles and the distance between them depends upon the width of the hind edge of the prothorax. In some species the prosternum appears to be entirely membranous, while in others there are two small plates between the coxæ near the hind margin. The episternum and epimeron are more easily distinguishable in most *Tubulifera* than in *Terebrantia*.

Mesothorax.—The mesothorax is a broad, short segment, often the broadest of the body. The mesonotum is shorter than the mesosternum, though the latter approximately equals the metasternum as a rule, in consequence of which the division between the meso and metathoracic segments is oblique. The mesoscutum is usually a rather hexagonal plate, somewhat broader than long, and has thickened edges which are bent inward and used for the attachment of muscles, as is shown by cross sections of this region of the body. A narrow prescutum can be easily distinguished in some species, though in others it appears to be closely fused with the scutum. On each side of the scutum is a membranous area upon which the fore wings are inserted, at the bases of which there are chitinous thickenings for the attachment of muscles and also serving as pivotal points. A small, curved, triangular tegula is present in many, if not all, *Terebrantia*. Upon its broad edge, next the base of the wing, it is furnished, in *Eolothrips*, with a row of five or six small, stout spines which point directly toward the base of the wing, upon which, very near its base, there stands a somewhat larger, curved spine which, when the wings are extended in flight, points toward and would appear to engage some one of those upon the tegula. This is a peculiar and interesting structure the purpose of which can only be conjectured. In *Thripidae* the tegula is present, but I have found no species having the spines fully developed, though little knobs or vestiges of such structures are present in some cases. The tegula is not always distinctly visible. At each anterior angle of the mesothorax there is a larger or smaller spiracle, which is

usually much elongated and narrow in Terebrantia, while in Tubulifera it is more rounded. In front of the spiracle a narrow plate extends up over the shoulder and meets the mesoscutum. This plate in some cases is only an upturned portion of the broad mesosternum, but in others is distinctly separated therefrom. This plate may be called the episternum, either separate or fused with the mesosternum. Behind the spiracle and below the attachment of the fore wings, there are one or two quite broad skeletal pieces which are rather triangular in shape. The mesosternum usually covers the whole ventral surface of the segment and its edges bend upward at the sides (e. g., *Heliothrips*, see Plate XI, fig. 119). In some species, however, it is an hexagonal plate similar to the mesoscutum and but little larger, while the episternal and epimeral plates are elongated and meet the sternum upon the ventral surface. Upon the median line of the sternum there is in all species, though very weak in the wingless ones, a quite deep chitinous invagination more or less forked and serving for the attachment of strong muscles (Plate XI, figs. 117, 119, 127). These endothoracic structures are plainly visible in most species. The middle legs are inserted far apart at the very hind angles of the mesosternum.

Metathorax.—This segment is usually slightly narrower than the preceding and generally tapers slightly to the base of the abdomen. Its dorsal plates are two, usually distinctly separated: a scutum and a scutellum. On each side of these a membranous strip continuing that from the mesothorax, extends backward to the base of the abdomen. The hind wings are attached quite close to the fore wings and in a similar manner. Near the bases of the hind wings lies in Tubulifera a very distinct rounded or oval spiracle. This spiracle is present and visible in many (Uzel says "all") Terebrantia, but I have been unable to find it in some species; in others it is extremely small and apparently functionless, while in still others it can be distinctly seen. The metasternum is broad and its edges curve upward around the sides of the body. At the front edge of this side lies a narrow triangular plate, the meta-episternum, while the meta-epimeron is here a narrow elongated plate lying above and close to the upturned edge of the sternum. The metasternum bears also a prominent endothoracic structure in the middle and the edges of the plates are often bent inward and thickened. The attachment of the abdomen is so oblique that the hind coxæ lie beneath the first abdominal segment. The hind coxæ are well separated and the sternum usually projects back between them as a distinct lobe or conical protuberance.

Variation in the structure of the pterothorax in wingless species.—The pterothorax is similar in both short and long winged individuals and we may expect to find at times long winged specimens of usually short winged species. In species which are entirely wingless, however, or in those one sex of which is always wingless, a marked variation in

the structure of the pterothorax is evident in the wingless individuals (Plate XI, fig. 125). The size of the pterothorax becomes greatly reduced in such cases as no great muscular development is needed to move the legs alone and the pterothorax is, perhaps, but little larger than the prothorax. The dorsal plates of both segments lose the usual form and become rectangular and transversely broadened, extending over the membranous space which is usually present along each side. No traces of wings are present and there is no longer any place for them. As a consequence of the decrease in musculature the endothoracic structures have become very much weaker, though still plainly visible.

APPENDAGES OF THE THORAX: LEGS.

The legs of Thrips are among their most characteristic structures and can hardly be mistaken for those of any other insects, whether short and powerfully thickened or long and slender. They are composed of the usual parts of the insect leg, which may be readily distinguished. The attachments to the thorax are quite far apart and at the very hind edge of each segment. The fore legs are often shorter and thicker than the others and more specialized.

Coxa.—This basal segment is large, usually subconical and quite freely movable. The fore coxæ, especially in Phleothripidæ, often bear a few short, very stout, sharp spines and one long spine at the outside, but aside from these spines the coxæ exhibit little that seems to be worthy of note.

Trochanter.—This is a short, small segment between the coxa and the larger femur, its line of attachment with the latter being often considerably oblique.

Femur.—This, the first prominent segment of the leg, is quite long and more or less cylindrical or fusiform. The fore pair is frequently distinguished by much greater thickness than those of the other legs, (especially in Phleothripidæ), the enlargement taking place in the upper side of the base and diminishing toward the outer end. In *Chirothrips* the lateral surface is strongly chitinized and bent backward somewhat at the tip so as to appear almost tooth-like at that point. In thickened femora, especially, the inner side toward the base is grooved to receive the base of the tibia when the latter is closed inward, and in a few species with this kind of femur the angles here have become sharply pointed and chitinized so as to form two sharp teeth at the tip (Plate VIII, figs. 89, 90).

Tibia.—The tibia is, as a rule, about as long as the femur and more nearly cylindrical or often club-shaped in form. It is most slender near its base where it is often slightly bent. At the extremity within, in a few species, the tibia bears an erect, stout, recurved hook or tooth as it is usually called.

Tarsus.—This is the most distinctive part of the leg. As a rule it is composed of two segments, though in larvæ and the fore tarsi of many species but one is present. The division between the two is oblique so that the under surface of the first segment is longer than the upper. Both segments are more or less cylindrical. The last segment terminates in a cup-shaped or hoof-like end which has been mistaken sometimes for a third tarsal segment. Upon the inner side of the fore tarsi are found structures which are nearly always characteristic of families. The *Eolothripidæ*, in both sexes and it is stated also in the pupal stage, bear upon the tarsus a peculiar hook-like structure the function of which is not understood. (See Plate I, fig. 9.) The finger-like hook is bent back upon itself, pointing toward the base of the tarsus and almost touches the point of a short, stout spine standing erect at its tip. In many species of *Phlæothripidæ*, though not in all, there is on the inner side of the tarsus a more or less stout tooth which stands nearly erect and is slightly recurved at its tip, and when this tooth is strongly developed, the tarsus, so far as is known, has only one segment. The development of this tooth seems also to be in proportion to the degree of development of the fore femur and its function appears to be to act as a hook in giving a firm hold and thus assisting the little creature in crawling through small places. Some *Phlæothripidæ* show no traces of such a tooth and all grades of development can be found in different members of this family. Both sexes usually possess such a tooth, though that of the male is sometimes much stouter than that of the female. In the *Thripidæ* the tarsi are simple, without either of these structures in nearly all species, only a few having a small tooth.

The tarsi are usually said to be clawless, but I do not consider this to be always the case, for some species have one and some two distinct, apparently movable claws on the sides near the end.

Spines.—Each segment of the leg may bear numerous spines, and some of these may be particularly well developed and worthy of note. In many *Tubulifera* there is upon the inner and lower side of the femur near its base a slender spine very much longer than any of the others. The hind tibia in most species of *Thripidæ* is furnished with a row of stout spines along the inner side and in many species a pair of similarly stout spines is borne at the tip of each tibia. Other specialized spines are sometimes found.

Bladder.—This structure, so remarkable and characteristic as to suggest the name *Physopoda* for the order, is protrusile from the end of the last tarsal segment. It is found in all species and in both adults and young, but its structure and action does not seem to be quite the same in the mature and immature stages.

As has been said, the end of the adult tarsus is cup-shaped. The wall of the cup is firm and in some parts, especially the underside,

strongly chitinized. Into the mouth of this cup is fitted a very delicate, protrusile, membranous lobe or bladder. When the foot is raised or at rest, the bladder is wholly withdrawn into the end segment and becomes invisible, as is the case in a majority of mounted specimens. The end of the tarsus is now blunt and flat and often seems to be minutely haired. The bladder is, however, always protruded and brought into action when the tarsus is put down or brought into contact with an object. The membrane is then pushed out and forms a lobe, larger in many cases than the cup portion which had previously wholly contained it. The mechanism of this complicated structure is very interesting but difficult to study. It has, however, been worked out, partially at least, by both Jordan and Uzel. The following paragraph on this point is gathered from Jordan's description and my own observations:

Bladder mechanism.—A strong chitinous rod, attached to muscles in the tibia, runs out through the tarsus and ends in the broadened, heavily chitinized under surface of the cup. The end of the plate is drawn out into weak cords running to the outer parts of the cup wall. Opposite the chitinous rod lies a double fork provided with a joint. The fork is cut short at a chitinous rod lying in the terminal segment of the tarsus and is movably joined thereto. Both arms of the fork are connected with the chitinous rod at their base by a tendon. Between the fork and the terminal plate of the chitinous rod the wall of the cup is usually thin and quite transparent, but in Phlæothripidæ especially it is quite strongly chitinized and opaque. Looking down upon a foot that is inactive (bladder retracted) so that the chitinous rod lies along its middle line, the end appears more or less pear-shaped and small. Upon the surface lies the terminal enlargement of the rod, while the double fork occupies the sides. Between the tips of the fork the extremity appears folded in toward the middle. When the foot is brought into action the chitinous rod is drawn back somewhat, so that the attached fork is erected and spread out. The previously invisible bladder is now thrust out from the end of the tarsus. The ends of the fork and the chitinous rod continue into the bladder wall as fine rays. The bladder is elastic and very mobile, easily accommodating its shape to the surface upon which it rests. Looking at a larval tarsus from the side, the chitinous rod is seen to run obliquely from the middle of the tibia to the under wall of the cup. Here it appears to end suddenly without being broadened into a plate as in the adult; still the end of the rod is continued into the wall of the cup as fine rays. The dorsal part of the cup is occupied by a curved claw, the basal part of which is attached to a sort of bracket-like thickening of the wall of that part of the end segment at the base of the cup. Furthermore, the base of the claw is united to the chitinous rod by a sinew, and above the extremity of the claw the tarsus is drawn out into a membranous, longitudinally folded lobe. When viewed from

above, it is seen that the bases of the claws are strongly broadened within and somewhat less so without, and that the inner prolongations touch and are flexibly joined together. Both claws are supported upon the bracket-like ring at the base of the cup, while the folded membranous wall reaches beyond the claws. The chitinous rod unites near the support with the two tendons coming from the outer projections of the claws. When the bladder is brought into an active condition, the claws bend out from each other and the folded portion between them spreads out, while the distal portion, unseen in the inactive foot, becomes pushed out as the bladder. By a proximal pull upon the chitinous rod the tendons are drawn back and the claws thereby are spread out, moving around the bracket-like support with which they are connected as on a pivot. As the claws are grown together with the folded lobe, the lobe must be unfolded, but this does not explain how the membranous lobe can be protruded as a swollen bladder. If a swollen bladder be pricked or ruptured the blood pours out and the bladder collapses quickly. We must therefore conclude that blood pressure, acting with the mechanism just described, is largely instrumental in the protrusion of the bladders.

Other organs of doubtful function.—In the basal segment of the tarsus or the extremity of the tibia there has been found in a few European species a small, pear-shaped organ which has been considered as a gland, and some have thought this the structure which produced the swelling of the bladders, but as this supposed gland is much smaller than the bladder which it is supposed to fill, this can not be, and its function remains still problematical.

Near the line of union of the femur with the trochanter, Trybom has found in certain Phæothripidæ an organ or a group of organs which suggest to him the auditory organ on the base of the tibia in some Locustidæ. Trybom speaks of 'this structure as an elongated, thinly chitinized area, almost transparent. The areas are found on the side of the base of each femur near the line of its union with the trochanter. They are variable in shape and may be different on the opposite legs of the same pair. In each light area is a row of round structures having a dark point in the center of each.

These peculiar structures are small and easily overlooked, but Trybom has seen them in many species of Terebrantia as well as Tubulifera, and the writer has seen them in every species in his own collection. It appears, therefore, that they are always present, but as to their function we can only guess.

WINGS.

The wings of Thysanoptera are no less characteristic than are their feet. To be sure each character shown by them may be found in the wings of some other group of insects; nevertheless the combination of characters found here is unique. They are long, slender, membranous,

fringed, and not folded; they have few veins, and upon the hind edge of the base of each there is a usually distinct lobe or scale. The fore and hind wings are formed quite similarly. When at rest, the wings are folded back flat upon the abdomen, the fore wing covering the hind one completely and the pairs lying parallel in the Terebrantia, while in the Tubulifera the wings all overlap at their tips so that the full surface of only one can be seen when they are at rest. The wings are usually about as long as, though sometimes much longer than, the abdomen, but in many Tubulifera they are shorter. The wings of *Æolothripidæ* are proportionally the broadest in the order, being in the middle about one-seventh as broad as their length. Those of *Thripidæ* are much more slender, ranging from one-tenth in the fore wing of *Parthenothrips* to about one-twenty-sixth in that of some *Sericothrips*; the average in the species of this family known to me is about one-fifteenth. Three general types of wing are found in the order, each of which is characteristic of a family.

Family types.—*Æolothripidæ* possess wings which are comparatively broad, as we have seen. Their breadth continues nearly to their tips, where they are broadly rounded. (Plate I, fig. 2.) The hind wings resemble the fore wings closely in general outline and size.

The wings of *Thripidæ* are distinctly different from the preceding. Besides being much more slender, they taper from base to tip, where they are sharply pointed, the whole wing being usually slightly curved so as to be quite sabre-shaped. (Plate II, figs. 16, 23.) The fore wing of *Parthenothrips* approaches most closely that of *Æolothrips*, being broad and straight but pointed instead of rounded at the tip, and the venation is very different. The hind wings are somewhat shorter and narrower than the fore wings.

The third type of wing (Plate VII, fig. 75), found in the *Phlæothripidæ*, resembles that of *Æolothrips* in being broad and rounded at the end. The hind wing is also similar in size and form to the fore wing. In some species the wing is narrowed in the middle so that it resembles somewhat a shoe sole. Other characters, as venation, fringing, etc., separate them very decidedly from the *Æolothripidæ*.

Venation.—The venation is even more characteristic of the families than the form of the wings. In the *Æolothripidæ*, the fore wings show the most complex venation found in the order. They are entirely bounded by a strong ring vein and pierced by two longitudinal veins extending from the base to near the tip, where they bend outward and join the ring vein. Four or five cross veins are also present, two uniting each long vein with the ring vein at about the first and second thirds of the wing and one cross vein uniting the long veins before the middle. The hind wings have no fully developed veins.

In the *Thripidæ* the veins are much less prominent, except in *Parthenothrips*. One or two longitudinal veins are present, but cross veins have very nearly disappeared, though vestiges of most of those

found in *Æolothripidæ* can sometimes be observed in this family. The hind wings have always one longitudinal vein, but no ring or cross veins.

The wings of *Phlæothripidæ* are marked by the absence of veins. In both fore and hind wings alike there is but a partial development of one median longitudinal vein. This is quite strong and marked at the base, but rarely reaches to the middle of the wing before it disappears. There is no trace of a ring vein.

Fringing.—As a rule, fringes of long, slender hairs are borne upon both margins of the wing and so make up for the narrowness of the membrane. The hind fringe is always present, but the fore fringe is nearly absent in *Æolothripidæ*, always present in *Phlæothripidæ*, and more or less fully developed in *Thripidæ*. The front fringe consists of a single row of hairs which, when fully developed, are stouter in *Terebrantia* than those upon the hind edge, but in *Phlæothripidæ* they are similarly developed on both edges. In some *Thripidæ* the front fringe is vestigial, being very weak and sparse, or it may be entirely absent. On the hind wings the front fringes are more uniformly well developed than upon the fore wings, and both fringes are single. The hind fringe of the fore wing in *Terebrantia* consists of two rows of hairs so placed that they stand, when in flight, at different angles to the edge of the wing and thus by crossing give mutual support and form a mesh-work which is more strongly resistant to the air. The hind fringe hairs of both wings in *Terebrantia* are more or less wavy or spiral in form while those of the front fringes are straight, as are also both fringes in the *Tubulifera*. The hind fringes of both wings of *Tubulifera* are single except that near the end of the fore wing the fringe is double for a short distance. The length of the hind fringes is from two to seven times the breadth in the middle of the wing. Fringes are wanting near the base of the wings.

The method of insertion of the fringes differs in the suborders and is of interest. In the wings of *Tubulifera* the hairs are inserted directly for some distance into the membrane of the wing, where they gradually disappear. They are so flexible near the base that they can be bent back along the edge when the wings are folded at rest. In *Terebrantia*, however, the fringe hairs are borne upon small supporting bases on the edge of the wing and are in general stiffer than are those of *Phlæothripidæ*. One row of those upon the hind margin is attached differently from the other. The hairs stand upon small, conical, basal enlargements, to which they are attached by a joint so as to allow an easy folding of the long hairs toward the tip. Toward the base of the wing, however, the side of the somewhat conical support is drawn out into a point, which prevents the folding of the hairs toward the base and keeps them at nearly right angles to the edge of the wing during flight.

Spines upon wings.—In the Terebrantia the entire upper surface of the wing is thickly set with microscopic spines which are wanting in Tubulifera. Besides these there are usually borne along the longitudinal and costal veins some larger, prominent spines, which vary in number, size, and arrangement sufficiently to give in many species of the Thripidæ characters of specific and generic value. Those borne upon the costa appear intermixed with the fringe hairs, though really they are not in the same plane. Their development seems to be in inverse proportion to that of the fringe, so that when the latter is strongly developed the costal spines are not larger than those upon the other veins, but when the fringe is weak or absent the costal spines develop greatly and to some extent replace it.

In Ælothripidæ the spines upon the veins are always quite small, while the front fringe of the fore wing is wanting. In Phleothripidæ there are usually three stout, erect spines near the base of the vein in the fore wing.

Taking flight.—It has been frequently noticed and mentioned that many of these insects throw up the end of the abdomen, much as do the rove beetles (Staphylinidæ), as though threatening to sting. This movement is made to assist in the proper spreading of the wings for flight. When at rest, the fringe hairs lie along the hind edges of the wings and are more or less interlaced. As the abdomen is raised, the wings are drawn down over its sides in such a manner as to make it appear that the spines upon the sides of the abdominal segments are used to some extent as a comb by means of which the hairs are straightened out and put in their proper position. This operation often has to be repeated several times before the wings are brought into a condition for successful flight. The power of springing, possessed by some species, also seems to be of assistance in taking flight. These statements apply only to Terebrantia, however, no observations having been made upon Tubulifera.

Coordination of the wings.—This is accomplished in a manner strongly suggestive of the Hymenoptera, though the structures concerned are less highly developed. Upon the costa of the hind wing, near its base, stand about five short spines in Terebrantia and two or three in Tubulifera, which are hooked at their tips. When the wings are spread in flight these tiny hooks engage a membranous fold on the underside of the scale of the fore wing. Beyond these small hooks stands a single stouter spine which also forms a hook. From the hind angle of the scale of the fore wing proceed two long, stout spines, standing so closely together as to often appear like one, and these engage the solitary stouter hook on the hind wing. Thus united the wings move together, but as the connection is so near the bases of the wings it can not be very strong.

Reduction of the wings.—It is an interesting fact that in this order

the wings may be fully developed, reduced to short pads not reaching beyond the thorax, or even entirely absent. Intermediate conditions are rare, though I have found a few specimens in which the wings were about one-half their normal length and entirely functionless. These three conditions may occur even in the same species (*Chirothrips manicatus* Haliday). When the wings are reduced, the little pads are rounded or oval in shape and are laid closely upon the thorax. The fore pad is larger, bears a few small spines, and covers the spineless hind pad completely. No fringes are present, but the fore pad has a distinct scale. Trybom, who has made quite an extensive study of this subject (425), recognizes eight classes into which these insects may be divided according to the varying conditions of the wings.

1. Both sexes entirely wingless.
2. Males and some of the females wingless.
3. Males entirely wingless, but females with normally developed wings.
4. Long winged and wingless individuals of both sexes occur.
5. Males and a majority of females with reduced, but a number of females with normally developed wings.
6. Both sexes always short winged.
7. Long winged as well as short winged individuals of both sexes occur.
8. Both sexes always long winged.

The appearance of a long winged generation following several which have short wings is strongly suggestive of a similar condition among the Aphidæ. In at least some species of Thysanoptera where this condition obtains the summer generations develop long wings while the fall generations are almost entirely short winged, so that nearly all the hibernating females have only wing pads. Long and short winged forms commonly alternate in the same sex, but short winged and entirely wingless forms of the same sex are not known. When only one sex is wingless it is the male. Wing pads are usually rather difficult to see, but their presence or absence can be deduced from the structure of the thorax, even though they are themselves invisible.

ABDOMEN.

The form of the abdomen varies from cylindrical to elongate-ovoid. In Terebrantia the segments are nearly cylindrical in cross section, while in Tubulifera the abdomen is flattened, giving the cross section an elliptical outline. The terminal segments especially are differently formed and characteristic of the suborders. The abdomen is always composed of ten segments, of which the second to the seventh, inclusive, are similarly formed in nearly all cases, while the others are variable and bear the most distinctive characters of the abdomen.

Terebrantia.—In the Terebrantia each segment except the first and the last three is composed of a broad dorsal plate reaching to the sides, a somewhat narrower ventral plate, and one or two very narrow plates on each side connecting these. Jordan states that one of the two pleural plates comes from the ventral, the other from the dorsal plate, but the dorsal pleural plate is sometimes wanting or indistinct. The dorsal plates of segments, two to seven inclusive, are usually strengthened, especially in the Terebrantia, by a chitinous ridge along the inside somewhere in the anterior third, and this appears externally as a darker, narrow stripe on these segments. The first segment has a well-developed dorsal plate covering the hind part of the oblique metathorax, and small side plates are present in some cases, while the ventral plate is so short and small as to be easily overlooked. In the females the ventral and pleural plates are wanting upon segments nine and ten, the broad dorsal plate bending around the sides and approaching beneath to form the sheath for the ovipositor. In both sexes all the segments are similar except the last two or three, which in the females usually form a more or less sharp cone, while in the males, as a rule, the end is bluntly rounded; only a few species are formed alike in both sexes.

Spines.—Each segment bears, as a rule, but few spines, which are small upon the anterior segments, but increase in size and prominence posteriorly. These are most prominent upon the sides of the segments and especially around the last two, where they are called anal spines and are frequently very long and stout. In some species, as Quaintance has observed (454), these stout anal spines are the weapons of offense and defense.

Tabulifera.—In this suborder all but the first and the last one or two segments are formed alike. Each is composed of only a dorsal and a ventral plate joining at the sides by an indistinct suture. The ventral plate of the first segment is only slightly, if at all, developed, while the terminal segment appears to be a simple cylinder or tube and is formed alike in both sexes. The dorsal plate of the first segment, in some species, is drawn out anteriorly into a rounded projection, attaching to the metathorax, and on each side of the projection is a separate side plate. The arrangement and relative development of the lateral spines is much the same as in the Terebrantia. As a rule, upon the dorsal plates of segments two to seven inclusive, on each side at about one-fourth the cross diameter of the segment from the edge, there stands a pair of peculiar, inwardly bent, acute spines, and outside of these there is frequently a segmental row of much longer, straight, blunt spines. These dorsal spines appear to serve entirely for the confinement of the wings when at rest. The last segment bears at its tip a circlet of long, slender hairs, usually as long as, or longer than, the segment itself.

Stigmata.—Either three or four pairs of stigmata are present in Thysanoptera. In the adult they appear constantly at the anterior angles of the mesothorax, and on the sides of the first and eighth abdominal segments, while the fourth pair, always present in Tubulifera and sometimes distinguishable in Terebrantia as well, occurs close behind the attachment of the hind wings. Uzel states that four pairs of spiracles are present in the Terebrantia. This is surely often the case, but the metathoracic pair is very small, and in some species I can not find it even in specially prepared mounts, and in some cases where traces of the stigma can be found, I am convinced that it is vestigial and really functionless. The mesothoracic stigma is frequently elongated dorso-ventrally, sometimes being very narrow.

In the larvæ the stigmata are situated at the front angles of the mesothorax and upon the sides of the second (instead of the first) and eighth abdominal segments.

The structure of a stigma is peculiar. In a surface view at the sharpest focus, upon an anterior abdominal stigma of, e. g., *Amyphothrips striatus*, cleared in caustic potash, the stigma appears to be made up of a number of irregularly polygonal, cell-like bodies, separated from each other by dark lines and each cell showing one or more dark spots near its center. In focusing down onto its surface, its appearance changes quite strikingly. As it first comes into view, though before it is clearly seen, it appears as a dark field with quite regular, small, light spots, the dark lines giving a reticulate appearance. When a little more nearly in focus, the cells appear dark, while the central spots and the intercellular lines and angles are very much lighter. Brought into sharp focus, the cells are seen to be more irregular than they appeared at first, the surface appears light colored, whereas formerly it appeared dark, while the intercellular lines and central spots have now become dark (Plate X, fig. 112.) This reversal of the light and dark parts is peculiar and very noticeable. On one side of the center a larger, rather indistinct, rounded area can usually be seen, which is the bulbous enlargement at the end of the trachea opening by a quite large orifice to the exterior. A cross view of a stigma (Plate X, fig. 113) shows a remarkable structure. The cellular areas are now found to be mushroom-like bodies with slender stalks, standing with their heads close together. These are quite strongly chitinized and dark. Whether the little air chambers between them connect in any way with the trachea has not yet been determined.

SEXUAL CHARACTERS: TEREBRANTIA.

Female ovipositor.—The most prominent external sexual character of the female is the ovipositor which is attached to the ventral side of the eighth and ninth abdominal segments (Plate XI, fig. 121) and is

plainly visible through the body of the insect. It is composed of four distinct plates or valves, two of which, forming the under or anterior pair, are attached to the very narrow ventral plate of the eighth segment and two, forming the upper or posterior pair, are attached to the sides of the ventrally extended dorsal plate of the ninth segment. The ovipositor as a whole is curved either upward (*Æolothripidæ*) or downward (*Thripidæ*) and terminates in a very slender, sharp point. The valves lie very closely together, but their inner surfaces are grooved, forming a passageway for the egg. The two plates on each side are fitted together in such a way as to slide back and forth upon each other without being displaced. The upper edge of the lower plate is grooved and into this groove fits a ridge or tongue formed by the lower edge of the upper plate. The upper edge of the upper plate, except at its base, is fitted with sharp, saw-like teeth pointing toward the base of the valve. The lower plate is provided with similar teeth on the under side of its distal third, while the middle third bears a number of peculiar, broad-cutting teeth. The ovipositor is movably connected with the abdomen by a number of small supporting plates or levers which also assist in its manipulation.

In at least two species of *Thripidæ* known to me, the ovipositor does not appear to be functional though it is plainly present (*Chirothrips obesus* and *Thrips perplexus*).

When not in use, the ovipositor is drawn up close to the body and is received into, and entirely enveloped by, a membranous sheath along the last two segments which is made possible by the absence of the ventral plates at this place. The sexual opening is between the eighth and ninth segments in all Terebrantian females.

As a rule the conical form of the tip of the abdomen also indicates a female. In many of the light colored species, just in front of the base of the ovipositor, is a plainly visible internal organ which has sometimes been called the seminal receptacle. It usually appears as a small spherical or rounded body of an orange or brownish color, agreeing closely in this respect with the color of the spermaries of the males in species where males are known. This organ presents the same appearance, however, in certainly unfertilized females of bisexual species, and it is also always present, having the same size and color in several species known to me in which the males are extremely rare or possibly wanting altogether. Certainly a seminal receptacle can not be functional in parthenogenetic species, yet I have found this organ constantly present through eight or ten generations of a species bred in the laboratory where males were never produced.

Male.—Males are, as a rule, considerably smaller than the females. The abdomen is usually bluntly rounded at the end instead of sharply conical, though a few species resemble the females in this respect. The stoutest spines are usually at the sides of the ninth segment. In

Eolothripidæ this segment is much larger than the others and is drawn out at its hind angles into hooks and processes which apparently assist in copulation. The sexual opening is between the ninth and tenth segments, and frequently from this point there protrudes more or less of the retracted copulatory apparatus, which is usually entirely drawn into the ninth segment through the walls of which it can be more or less distinctly seen. Three separate outer parts, which are strongly upcurved, can be seen proceeding from a complex basal part and the entire apparatus is protrusile. Within the abdomen the two elongated, irregularly pear-shaped, orange or brownish colored spermaries are plainly perceptible, lying usually in about the seventh and eighth segments. Upon the ventral surface of the second to the seventh abdominal segments, inclusive, in many species there are distinct rounded or transversely elliptical depressions found only in the males. Males are often lighter in color and quicker in movement than the females.

TUBULIFERA.

Female.—The sexual characters of Tubulifera are much less distinct and numerous than are those of the other suborder. The end of the abdomen is tubular and the sexual opening is between the ninth and tenth abdominal segments in both sexes. In this region are also found the strictly distinctive characters. In the female the basal edge of the tube is regular and entire. Near the hind edge of the ninth segment below there is a short, strongly chitinized rod (Plate X, fig. 115) which is dark and plainly visible in light colored species, but when the body at this point is nearly opaque, the rod can not be seen and the question of sex is often in doubt.

Male.—The male is usually smaller and more slender than the female, the sixth, seventh and eighth segments of the abdomen being noticeably narrower. The base of the tube is cut out below in the form of a semicircular notch (Plate X, fig. 114), which can usually be plainly seen except in very dark specimens, and through the opening formed by this notch the sexual apparatus can be protruded. The structure of this apparatus is much the same as in the Terebrantia and in light colored specimens it can be seen wholly retracted within the ninth segment. In some species this segment bears a broad scale at the base of the tube. In a few species the sixth segment bears on each side a thick, fleshy, unjointed appendage. The males in many species have more strongly thickened fore femora and stouter teeth upon the fore tarsi than do the females.

Copulation.—This I have rarely observed, and therefore the following statements are mainly gathered from Jordan's article (306).

In the Tubulifera the male rests upon the back of the female, and holding firmly to her thorax by his legs, he places the ventral surface of his abdomen along the side of the abdomen of the female and bends

the extremity under the abdomen of the female, so that the ventral surfaces of the last segments are toward each other. The copulatory apparatus of the male is then pushed out, while the female bends the tube upward so as to leave the sexual opening free. Copulation lasts for about half a minute, when the female begins to move and the male leaves her back, but the connection is not at once broken, and the stronger female drags the attached, struggling male behind her for some distance. One male fertilizes a number of females successively. In one case Jordan states that a male of *Phlaeothrips brunnea* Jordan, in one-fourth of an hour, fertilized six females, and his spermaries were still about half filled.

In the Terebrantia the males are carried around upon the backs of the females and the union takes place in much the same manner as has just been described for the Tubulifera.

DEFORMITIES.

Slight deformities are by no means rare. The most common form consists in a reduction in the number of segments in one or both antennae, brought about, in most cases, by the fusion of two or more segments at the end, though intermediate segments are sometimes wanting. It frequently happens that the antenna with fused segments is scarcely shorter than the normal one. Only very rarely does it appear that a reduction in number is the result of injury, though this would seem very possible. So far as is known, an increase over the normal number by a division of segments never takes place. Sometimes the wings are so deformed as to be useless. Deformities in the abdomen are very rare, but I have found two cases. One in which the posterior segments were constricted being abruptly smaller than the preceding, the other with a half segment wanting on the left side at about the middle of the abdomen. The right half of the segment was wedge-shaped, reaching in to the median dorsal line and giving the abdomen a corresponding crook at that point.

REPRODUCTION.

The method of reproduction in this group is of interest and also has an important bearing upon its distribution. So far as known, it is always oviparous and sexual, but two distinct forms are common in most species.

Bisexual reproduction.—This is the normal and most common form, but the two sexes are not found in anything like equal proportions, as females are almost always more abundant than males. This may be the case and reproduction yet be entirely bisexual, as in some species, perhaps in all, one male fertilizes a number of females. In a few species the males are found abundantly throughout the year; in others they are abundant only at certain seasons; in others males are rarely found at

any time; in still others, while the females are very abundant, males are unknown. The explanation for the relative scarcity or absence of males is found in the second method of generation.

Unisexual reproduction.—Parthenogenesis is the usual mode of reproduction in at least ten species, all Terebrantia, and probably occurs very frequently in many others, though positive statements can not be made upon this point until more extensive collecting has been done and life histories have become better known.^a

It seems that parthenogenesis must take place to some extent in those species in which the males are comparatively rare or are active for only a short season. However, no such thing as a regular alternation of generations, as in Aphidæ, is yet known to exist among Thysanoptera. In his studies of *Parthenothrips dracænæ* Jordan found that the normal method of reproduction in warm greenhouses was unisexual, while on plants standing in a cool room an abundance of males was developed, and this condition lasted in the cool room throughout the winter season. The males of *Aptinothrips rufus* have been found only at haying time, and then only very rarely.

DISSEMINATION.

It has already been noted that in most species there appear for some part of the season, in some generation or in one sex, individuals bearing fully developed wings, and we can not doubt that the wings play a large part in the distribution of the species. Certain it is that the power of flight is greater than would seem possible with such delicate wings as these insects possess. After harvest or toward autumn some species fly in large numbers, and in some instances have caused considerable annoyance by entering houses for hibernation. Winds may easily carry them for considerable distances, and when so scattered it is evident that their power of parthenogenetic reproduction is of great assistance in the establishment of the species in a new locality. Species living under the bark of trees growing upon the banks of streams are probably often carried for long distances on wood floating in the water, as some species which have been observed are found to endure a large degree of moisture and even submersion for some time without injury, and moist, decaying wood is their normal food. Species living upon cultivated plants, as in greenhouses, have doubtless been disseminated in commercial ways. Strange as it may seem, a species which is entirely wingless (*Aptinothrips rufus* Gmelin) is one of the most widely distributed. It is hard to believe that this species can have attained its present distribution in both Europe and America through the slow method of crawling.

^a Males of the following species included in this paper are rare or unknown: *Parthenothrips dracænæ*, *Heliothrips hæmorrhoidalis*, *Aptinothrips rufus*, *Anaphothrips striatus*, *Thrips tabaci*. Some others are too little known to be placed here.

Perhaps it may not be too much out of place here to speak more particularly of other movements aside from flying. The Tubulifera are very slow and deliberate in their movements, both in crawling and flying, and they never spring or run. Terebrantia vary in this respect, though in general they are much more active, and many run quite rapidly and take flight quickly. Some possess a power of springing which is well developed and often used in place of flight. The abdomen, head, and prothorax are raised and the little creature balances itself by its middle legs. Then suddenly the upraised parts are brought down together and the insect is thrown a considerable distance by the force of the contact.

DEVELOPMENT.

Oviposition.—As may be inferred from what has been said of the sexual apparatus of the two suborders, each has its own method of oviposition. The Terebrantian female cuts a slit with her saw through the epidermis and deposits her eggs singly in the tissue of the plant. The process of oviposition is as follows in *Anaphothrips striatus* and will doubtless hold in most points for the group:

The abdomen is raised somewhat and the ovipositor is let down from the sheath till it is nearly at right angles to the body. The abdomen is arched to bring the weight of the body to bear upon the slender saw, the valves of which are then moved back and forth upon each other by powerful muscles in the ninth segment. The toothed blades are gradually worked down somewhat obliquely into the tissue, and when the slit is sufficiently large there may be seen successive contractions of the abdomen as the egg is pushed out between the valves of the ovipositor and under the epidermis till it is nearly concealed. The entire operation requires about one and a half minutes, and upon its completion the female moves off a short distance to rest or feed. Occasionally the ovipositor becomes so firmly wedged in the plant as to hold its possessor prisoner for some time, frequently until death results (469).

I feel sure that *Thrips perplexus* and *Chirothrips obesus* will be found to deposit their eggs externally.

The number of eggs laid by a single female has been observed only in the case of *Anaphothrips striatus*, from a number of which an average of from 50 to 60 was obtained, the maximum average from a lot of 5 females being 72. These observations were made in the laboratory upon females confined in bottles. The percentage of eggs which hatched was also observed in this species and was found to vary in the laboratory from 35 to 40 per cent. It seems very probable that the artificial conditions under which these experiments were made must have in this case greatly reduced the percentage that hatched below the normal.

Tubulifera deposit their eggs externally, either singly or in groups, upon leaves and flowers or under bark, etc., according to their habitat. The period of oviposition in all species in this order is quite long.

Egg.—The eggs of Terebrantia are more or less elongated and slightly bean-shaped. They are colorless, delicate in structure, and no micropyle is apparent. The position of the eggs in a thin leaf is easily seen upon holding the leaf before a bright light, when they appear as brighter spots in the darker green tissue of the leaf. Eggs are laid in almost any green part of the plant, but not in the petals of flowers.

The eggs of Tubulifera are of an elongate-oval shape, attached with the long axis perpendicular to the surface, and have at the free end a thickening of the chorion with a micropyle in the middle. The eggs vary from yellow to brownish in color.

Embryology.—The development of the embryo can be observed in the translucent eggs of Terebrantia. Various writers agree in stating that the germ band is immersed. Before revolution the appendages of the embryo lie along the convex side of the egg, after revolution along the concave side. The length of the egg stage varies considerably in different species and, even within the same species, according to the weather conditions. So far as life histories are known, this stage appears to last from three to fifteen days in Terebrantia, but no record is found upon this point for the Tubulifera. The pigmented eyes of developing embryos are particularly prominent. If the egg bed dries the egg is quickly destroyed, but if moist, even though decaying, the development continues.

Emergence of the larva.—When ready to emerge, the young Terebrantian larva breaks through the tender chorion and pushes up through the slit in the epidermis made for the insertion of the egg. The larva works its way up till all but the tip of the abdomen is free, but remains supported by the tip in this upright position until the antennae and legs have separated from the body, to which they are at first closely applied, and have become sufficiently dried and hardened for use. It then falls forward onto its feet and is ready to travel or to feed almost immediately. No observations have been found on this point for the Tubulifera, but just as their eggs are laid singly or in groups, so also do we find the larvæ.

Larval stage.—The length of the larval stage varies with the species, and the statements recorded place it at from five to forty days.

When just hatched the head of the larva is very large in proportion to the body and the mouth parts are essentially like those of the adult. The thoracic segments are subequal. The abdomen is strongly contracted and very rough. As the larva grows the thorax and abdomen enlarge noticeably, while the head shows little change. In some species (*Heliothrips*) the abdomen becomes strongly distended and shining as though under considerable pressure, and a globule of fluid excre-

ment is frequently held by the hairs around the anus. The larvæ are less active than the adults and have no power of springing. The larval antenna always has fewer segments than the adult. In Phlebotripidae the number is constantly seven. Thickened femora and tarsal hooks do not occur, the tarsus appears to be one segmented, and claws may or may not be present. The structure of the foot is much more distinct than in the adult. The eyes are not compound, but composed of a few separated facets, which are strongly elevated and always circular in outline. The number of facets increases in successive molts, but the circular form is retained. The rudiments of the ovipositor or genital apparatus appear on the under side of the eighth and ninth segments as indistinct lobes. The food habits of the larvæ are just as varied as are those of the adults, and some species are also found upon the roots of plants.

Molts.—From two to four molts appear to occur while in the larval stage, the last marking the change to the pupa. The chitinous covering of the internal mouth parts and of the bladders can be distinctly seen in the cast skin. When larvæ have become full grown they cease to feed, become restless, and seek some very secluded place in which to molt. In this search they are so successful that in many species pupæ are hard to find.

Nymph or Pupa.—The metamorphosis of Thysanoptera is peculiar, for though complete in many respects, it is much less so in others. Two stages are distinguishable while in the nymph condition. After the last larval molt, the insect still retains its larval appearance, the antennæ are extended, and the pro-nymph is moderately active. The wing pads are partially developed, extending to about the second abdominal segment, and the beginning of the formation of the adult appendages can be seen. After another molt, the true nymph stage is reached and the animal remains quiet unless disturbed, when it is capable of slight movement. No food is taken during this period. The antennæ are laid back upon the head and prothorax; their segmentation has become indistinct and the adult antenna can be seen within the nymphal skin. The number of facets in the eyes greatly increases, producing the adult condition. The legs are inclosed in loose sheaths and the wing pads reach to and from the sixth to the eighth segments. The pads extend obliquely outward along the sides of the body and do not cover each other. The fringes appear along the edges of the forming wings, the fore fringe being directed toward the tip and hind fringe toward the base of the wing. The forming lobes representing the ovipositor elongate, and those on each side overlap but remain separate. Within them develop the pointed valves of the adult ovipositor, which now extends to the tip of the abdomen. The development of the male genital apparatus takes place in a very similar way to that of the ovipositor of the female. The nymph stage

is passed in some secluded place, pupæ being found in the loose soil about the base of the plant, in the leaf sheath, or some similarly protected place, and many have been recorded as transforming in galls. When these changes have been completed, another molt takes place and the adult emerges.

The most noteworthy points in the metamorphosis may be summarized as follows: The larva resembles the adult in general form and in mouth parts; wings are developed in external sheaths; the transitional stage between larva and adult is quiet, and during it no nourishment is taken. The metamorphosis is therefore intermediate between complete and incomplete.

Hibernation.—Thysanoptera pass the winter in either larval, pupal, or adult stages. Many species, without doubt, hibernate in very nearly the same places in which they have fed. The bark-inhabiting forms remain in such places, together with many of the leaf forms which migrate onto the trunk. The dried stems of flowers and grasses shelter many species, while many of the leaf-inhabiting forms fall to the ground and are among those which may be found under fallen foliage, in moss, etc. Lichens and fungi shelter some as winter guests, while dead grass and turf contain many forms. It appears very probable that some of the larvæ which have been found upon the roots of plants were hibernating there rather than feeding thereon, as has been supposed.

The hibernating individuals appear to be able to withstand extreme degrees of cold and moisture. I have brought in a number of species gathered by pulling the frozen grass from bare mowings in midwinter after a temperature of -21° F. Upon being brought into a warm room, they very soon became active and ran about.

Thrips emerge from hibernation very early in the spring, and as soon as their normal food plants begin to grow most of them are in a condition to deposit eggs for a new generation, which in some cases in Massachusetts hatch during the latter part of April or the first of May.

Length of life.—Few observations have been recorded upon this point, but it seems improbable that even the longest lived exceed a single year. Among those species which produce several generations in a season, the hibernating individuals must live for at least seven months in the northern United States while the summer generations are much shorter lived. Their age however, as a rule, considerably exceeds the length of the life cycle, for oviposition is a slow process, and in *Anaphothrips striatus* is known to extend over a period of five or six weeks. As a result of this there is an indistinguishable overlapping of broods. I have kept a female of a midsummer generation of *A. striatus* confined in a bottle in the laboratory for almost five weeks. This species has eight or nine generations in a season, and may therefore be expected to be one of the shortest lived in summer.

ECONOMIC CONSIDERATIONS.

INJURIOUS FORMS.

Small and apparently insignificant though these insects are, they can not be disregarded from an economic standpoint. Only a few species, to be sure, must be considered as decidedly injurious, but these are widely spread and hard to control. Doubtless much damage, really caused by these tiny foes, has been attributed to more conspicuous but less injurious insects. The most important species in this country belong to the family Thripidae. The economic importance of each of these species is considered in connection with its description, but there are, however, some general points worthy of note which may be considered together here.

Feeding habits.—Thrips are found upon most flowering and some flowerless plants. The general mode of feeding is the same throughout the order. The green parts of the plant, chiefly, are punctured by the piercing mouth parts and the sap withdrawn therefrom by suction. The emptied plant cells become white and shriveled as they dry up and the insect, standing usually parallel to the veins of the leaf, moves on to fresh cells. The traces of their feeding are thus left in irregular streaks of dried, whitened cells. Behind them, as they feed, they leave rows of dots of dark colored excrement, which, it seems, have sometimes been mistaken for eggs.

On flowers Thrips are most abundant in summer. Burmeister states that the nectar of flowers furnishes them with nourishment, and Pergande has expressed a similar opinion (219): but this does not seem to me to be the case, as when present on flowers they are found sucking sap, not nectar. They feed to some extent upon the petals, but not so freely as upon the green parts. The inner surface of the sepals is a favorite place for feeding and oviposition. The essential parts of the flower come in for their part of the general attack and it is just here that the greatest injury to the plant is caused. Injury of this sort has been reported, especially upon strawberries by Quaintance (454), and upon apple and other fruit blossoms by Osborn (218, 223, 224), in which cases they caused so much injury to the styles by their punctures as to prevent fertilization and the setting of the fruit. (See *Euthrips tritici*, p. 152.) Probably *Euthrips tritici* and *Thrips tabac* are guilty of most of such injuries. Mally has recorded a very similar injury to cotton bolls by an undetermined species of the family Thripidae (341). Many other flowers, though perhaps of less economic importance, are similarly attacked. Flower species feed also upon leaves.

On the leaves of plants and trees may be found a large variety of species, most of which feed mainly upon the under surface of the leaves, probably chiefly for protection from sun, rain, and enemies

though it is also possible that more tender tissues may be an attraction. Such species avoid the light and, if a leaf be turned over, the insects will move around to the under side again. The constant sucking of myriads of larvæ and adults soon causes the feeding ground to wither, the leaf becomes encrusted with dead cells and dark colored spots of excrement and it is not long before its death results. Unless disturbed, most species do not travel much, and thus in time there appears to be something of a colony feeding around the place where the mother has fed and deposited her eggs. Though many plants thus suffer from the destruction of their leaves, the onion seems to be most severely afflicted. (See *Thrips tabaci*, p. 183.)

Grasses and cereals may be included in a third class in which the nature of the injury is somewhat different. Besides the abstraction of sap from the leaves of these plants, Thrips cause a greater injury by attacking the tender axial stems, thus cutting off directly the supply of sap to the head, which therefore fails to bear fruit and may be entirely killed. This is the way in which "Silver Top" is caused, and it is impossible to estimate with any degree of accuracy the damage which results to the hay crop. Besides working in this way, Thrips are charged with attacking directly the growing kernels of cereals. In the case of wheat, rye, oats, etc., they suck the nutritious milk directly from the growing kernels in the ear and produce an abortive condition of much, if not all, of the head, which is then called "pungled."

Greenhouse species appear to be becoming more numerous and more injurious each year. The principal injury here is done to the leaves, and nearly all kinds of greenhouse plants are subject to attack. *Thrips tabaci*, which has recently come into prominence, especially in cucumber and carnation houses, has an unusually wide range of food plants. It has already proved to be a serious pest, capable of the complete destruction of a crop, and is exceedingly difficult to control.

BENEFICIAL FORMS.

Predaceous Thrips.—The late B. D. Walsh once expressed the opinion that Thrips "are generally, if not universally, insectivorous, and that those that occur on the ears of the wheat, both in the United States and in Europe, are preying there upon the eggs or larvæ of the Wheat Midge (*Diplosis tritici*), and are consequently not the foes, as has been generally imagined, but the friends, of the farmer" (127 and 132). Such an opinion from so eminent an entomologist is likely to have some basis in fact, though we question whether his conclusion is even usually correct. Thrips have been frequently found in the galls caused by other insects, either with the makers of the galls or alone, and the conclusion has been drawn, though frequently, we suspect, without a direct observation to that effect, that the Thrips were preying upon the makers of the galls. Walsh also writes that he has

“found Thrips preying upon the gall-making larvæ of more than twenty different galls, so that there is now no manner of doubt in my mind that Thrips is a true cannibal insect” (132). All recorded observations which I have seen seem to agree that such gall-frequenting forms belong to the Phlæothripidæ, and in very many of the cases noted it is said that they are in the pupal stage (123).

It seems to me entirely possible that in many cases their presence in the gall may be incidental, they having entered it for protection. It is impossible for Thrips to make for themselves an entrance into any closed gall, and when present in such it can only be after the exit of the gall maker or some parasite upon it, so here certainly the Thrips is not predaceous. Furthermore, it does not seem improbable from what we know of the food habits of the Tubulifera, which feed mainly upon leaves or decaying wood or fungi, that they may live peacefully in company with the true maker of an open gall which they can readily enter, finding there the same favorable conditions for abundant food and a secure retreat as does the gall maker. Phylloxera galls have often been found to contain Thrips, but the same doubt exists as to the real purpose of their being there. Walsh states that he has found six or seven red Thrips pupæ in nearly every gall of *Phylloxera caryæ-foliæ*. This observation shows plainly one object for which these insects seek out and enter galls, as a safe refuge during pupation, and this will account for the frequent presence of larvæ and adults in both inhabited open galls, as those of Phylloxera, and deserted closed galls, as those of Cynipidæ. It may be true that Thrips prey upon the gall makers, but further observations upon this point are desirable before we can fully accept that conclusion.

“*Thrips phylloxeræ*” of Riley’s manuscript (one of the Phlæothripidæ) is said by him to “do more than any other species to keep the leaf-inhabiting grape Phylloxera within bounds” (165). A species of *Phlæothrips* has been observed destroying eggs of the Gypsy Moth (353).

Some species of Thripidæ have been observed feeding upon other insects and are undoubtedly beneficial. *Thrips 6-maculatus* has been repeatedly observed feeding upon “mites” or “red spiders,” and other species have been said to do the same. Riley observed a Thrips larva feeding upon the eggs of the Cureulio in Missouri (143a and 144). *Thrips trifasciatus* Ashmead is apparently predaceous and was observed feeding on the cotton Aleurodes (*Aleurodes gossypii*) in Mississippi (386). I have occasionally noticed that under the influence of confinement without plant food *Anaphothrips striatus*, which is certainly normally herbivorous, becomes cannibalistic and will feed upon its own species.

Flower fertilizers.—It is very probable that a few flowers, of which the “wild pansy” is one, are fertilized by Thrips, although such a relation must be exceptional. Few flowers are adapted to thus profit

by the presence of Thrips, as their action would tend almost entirely to self-fertilization of the flowers, which Nature does not generally approve. Therefore I believe that their value in this way must be very limited.

NATURAL CHECKS.

Insects and Acari, etc.—The most important insect enemy appears to be *Triphleps insidiosus* Say, which is very common on flowers and may often be found with a Thrips impaled upon its rostrum and held in the air while the captor sucks the juices from the body of its victim. The eggs of *Triphleps* are laid in a similar manner to those of Thrips and the larvæ of the former also prey upon the larvæ of the latter. The length of the life cycle of *Triphleps* is about the same as that of Thrips. *Megilla maculata* also devours Thrips in great numbers when both are abundant. *Chrysopa* and *Syrphus* larvæ have been found feeding upon the larvæ of *Thrips tabaci*. Heeger has recorded *Scymnus ater*, *Gyrophæna manca*, and some fly larvæ as preying upon them, and Uzel has found *Triphleps minuta* also.

I have frequently found *Anaphothrips striatus* bearing one or more small, scarlet Acari (probably the larvæ of a *Trombidium*) attached to some membranous area of the body.

Both Uzel and Quaintance have found the eggs and adults of Nematode worms in the bodies of Thrips, Uzel recording over 200 worms from one specimen.

Plant parasites.—Thaxter (297) has taken *Empusa* (*Entomophthora*) *sphaerosperma* Fries from a species of Thrips which it was destroying in larval, pupal, and adult stages. Pettit has found in Michigan another parasite which he thinks will prove to be a Gregarinid (464). It was most abundant in the moist breeding cages, causing the insects to die and turn black. I have rarely found a fungus growing in a dead specimen which appears to be a species of *Macrosporium*, but it was not possible to tell whether the fungus caused the death of the insect or came in later.

Rain.—Of all the natural checks, none can compare in efficiency with a hard dashing rain. It has been noted that *Thrips tabaci* and *Anaphothrips striatus*, which become extremely abundant during hot, dry weather, disappear almost entirely as soon as the heavy showers of midsummer begin, and as long as such showers continue at frequent intervals the Thrips do not again become abundant. The same result will probably be found true in most outdoor leaf-inhabiting species.

ARTIFICIAL CHECKS.

These fall naturally into two groups, insecticides and cultural methods.

Insecticides.—So far as we know, no attempts to control Thrips by means of insecticides have been made outside the United States. Here

each of the three most important economic species, *Thrips tabaci*, *Euthrips tritici*, and *Anaphothrips striatus*, has been experimented with considerably. Webster recommends, for *Thrips tabaci* in the field, spraying thoroughly with 1 pound of Standard whale-oil soap in 8 gallons of water (476), and he says also, "The grassy borders of ditches have been sprayed with kerosene with excellent results." Quaintance (454) tried many insecticides for *Thrips tabaci* and *Euthrips tritici* in Florida and found that "rose leaf insecticide"—1 pint in 8 gallons of water—killed from 65 to 70 per cent of the insects, and was the most successful of anything tested. For *Thrips tabaci* he recommends "whale-oil soap (Anchor brand), at the rate of 1 pound of soap to 4 gallons of water," or "rose leaf insecticide at the rate of 1 pint to 4 gallons of water."

Sprays must be very thoroughly applied to do even fair service, and ditches and margins around fields, as well as the ground between rows, should be treated also. Even with the most careful treatment many of the tiny insects will escape the spray, and the embedded eggs are entirely unharmed. Therefore, spraying, to be at all successful, must be repeated after a short interval. It must be admitted that at best spraying is an unsatisfactory remedy: still, it is perhaps the best method we know of at present for field work.

In greenhouses spraying may be more successful than in the field, but fumigation methods are here preferable. These also must be repeated in about a week to be successful. The most satisfactory results have here been obtained by the vaporization at night of 20 cc. of "Nikoteen" in 750 cc. of water for 5,000 cubic feet of space. This treatment did not injure the cucumber plants, while nearly all of the *Thrips tabaci* were killed (471).

Cultural methods.—These are undoubtedly too important to be neglected, even if insecticides be used, and in some cases they may prove even more efficient than the latter. For the Onion Thrips, Webster says: "All culls, tops, and other refuse of onion fields should be burned in the fall." He also recommends the burning of the grass along ditches and around the margins of the fields in winter or early spring to destroy the hibernating insects (476).

For the Grass Thrips it seems that cultural methods are the only ones that can be of any considerable help. A thorough burning of the old grass in early spring before growth begins destroys large numbers of hibernating insects—Thrips and many others. The attacks of the Grass Thrips are worst upon old, worn-out meadows, fields, and lawns, largely because *Poa pratensis* (June grass) is most common in such places. Infested grass should be cut as early as possible or fed green. So far as I can learn, the seed of June grass is sold only in lawn mixtures and is not used for field seeding, though it comes in naturally as the other stouter-growing species which are usually sown run out. The appearance of a large amount of "Silver Top" is there-

fore a sign that the field is becoming exhausted. Such fields should be plowed, and it is advisable to plant with some cultivated crop for at least one season before re-seeding.

CHARACTERS OF THYSANOPTERA.

Small insects; length ranging from one-fiftieth to one-third of an inch. Wings usually present; four in number, long, narrow, membranous, never folded, with at most two longitudinal veins and few or no cross veins; hind margin always, front margin usually, fringed with long, slender hairs much exceeding in length the breadth of the membranous part of the wing; wings laid horizontally along the abdomen when at rest; wings sometimes reduced to short pads not reaching beyond the hind edge of the thorax and entirely absent in a few species.

Mouth parts intermediate in form between those of sucking and chewing insects, but probably used almost entirely for sucking; arranged in the form of a cone situated on under side of head and placed so far back that it lies almost entirely under the prothorax (see Plate X, fig. 111), and is more or less concealed from the side by the fore coxæ and femora. Mouth cone formed by the labrum, the broad, flat, triangular, external portion of the maxillæ bearing each a two or three segmented palpus, and the labium bearing two or four segmented palpi; these external parts grown together and not freely movable. Mouth always asymmetrical, only the left mandible being developed. Mandible and lobes of the maxillæ modified as internal, protrusile, bristle-like piercing organs.

Antennæ quite slender, six to nine segmented, situated closely together upon vertex of head. Ocelli always present when long wings are present, always absent in entirely wingless forms; usually present, sometimes absent, when wings are reduced to pads. Prothorax distinctly separated from mesothorax* and freely movable. Meso and metathorax firmly and closely united; metanotum longer than mesonotum. Tarsi usually two but sometimes one segmented; the terminal segment fitted at the tip with a protrusile, bladder-like organ which can be withdrawn entirely within the segment so as to be invisible. Abdomen ten segmented. Terminal segment either conical or tubular. Three pairs of stigmata are always present and a fourth pair is found in all Tubulifera and many Terebrantia. In the adult these are situated one pair each upon mesothorax and first and eighth abdominal segments. The metathoracic pair in Terebrantia is small, invisible except in carefully prepared specimens, and in some cases I have been unable to find any trace of it. In the larva the stigmata are distributed in the same way except that they are present on the second abdominal segment and not on the first.

Young resemble adults in general form, structure of mouth parts, and in food habits. There is, however, a distinct pupal stage during

which the insect moves very little or not at all, and takes no food. The wings develop entirely during this stage and are outside the body skin. The metamorphosis approaches closely to a complete one, but on account of the similarity of larval and adult forms and mouth parts it must still be considered as incomplete. Reproduction is oviparous and frequently parthenogenetic.

METHOD OF MEASUREMENTS.

A few of the descriptions of Thysanoptera previously published have been found to be too brief and general for the recognition of the species. Another difficulty which has been noted in some descriptions is the giving of comparative dimensions relative to other species. This may be useful to the collector if he happens to have or know all the species referred to; otherwise he is at an utter loss to know what is meant. Having experienced these difficulties at various times, the writer came to the conclusion that each description should be absolutely complete in itself and independent of all others, and that therefore a system of measurements based entirely upon the species under consideration would frequently prove of service in the determination and separation of these insects. The eye can not be relied upon for exactness in this matter, as has been frequently found in the course of this work, and therefore all measurements given in the following descriptions have been made in the same way, by means of an eyepiece micrometer, as follows: A stage micrometer of reliable make was first proven to be accurate by comparison with a steel millimeter scale, then with each combination of lenses used the number of spaces on the image of the stage micrometer covered by the scale of the eyepiece micrometer were determined, two points being selected where the divisions coincided. Then the number of spaces covered on the stage micrometer was divided by the number of spaces of the eyepiece micrometer covering them, and the quotient was, evidently, the fraction of a micromillimeter upon the stage shown by one division of the eyepiece micrometer. This quotient may be called the factor of the eyepiece micrometer for that combination of lenses and will hold unchanged for any object measured with that magnification, but will of course vary for every other magnification. Illustration: Using a 1-inch objective and a 1-inch eyepiece (Bausch and Lomb) with the tube closed, I find that the fifty divisions of the eyepiece micrometer cover, say, exactly 1 millimeter of the stage micrometer. Dividing then 1 millimeter by 50, I have two one-hundredths millimeter, which is the factor for that combination of lenses. Now, placing the object to be measured upon the stage, we find, e. g., that forty-five spaces of our eyepiece micrometer just cover the object to be measured. Multiplying by the determined factor, we have two one-hundredths millimeter times forty-five, which equals ninety one-hundredths millimeter as the length of the object measured. This method has been used in

the determination of length and breadth of the species herein described.

When comparative lengths only are desired, as e. g. in the comparative lengths of segments of antennæ, relative length and breadth of the head, etc., there is no need to determine the actual measurement. It is sufficient to compare directly the number of spaces read upon the eyepiece micrometer, and this is the method used in such cases. In the case of the comparative lengths of segments of the antennæ, all measurements have been made with a $\frac{1}{4}$ -inch objective and a 1-inch eyepiece. The measurements given show, therefore, not only a comparison between the segments of one antenna, but also between the segments of all antennæ so measured. The number of the segment has been given above the line, and directly below it the number of spaces of the eyepiece micrometer covering that segment. Illustration:

Number of segment,	$\frac{1}{5}$	$\frac{2}{10}$	$\frac{3}{14}$	$\frac{4}{12}$	$\frac{5}{9}$	etc.
Spaces of micrometer,						

It has been found that there are slight individual variations in the lengths of corresponding segments in different specimens of the same species, and even in the two antennæ of the same specimen, still there is in general a quite close agreement in this respect and the proportions hold very well. The antennæ were selected for such critical study, because there is an evident variation in the proportional lengths of segments in each species, and because the antennæ are the most surely available for a careful, accurate study of any organs of the insect. Then, again, proportional measurements do not vary nearly as much as do the absolute measurements of different sized individuals.

All statements made as to lengths, both actual and comparative, in the descriptions herein given are based upon actual measurements made in one or the other of these ways, an average being taken of the total number of specimens used in the description.

In describing colors it has been my intention to follow a few definite rules, which are given herewith: First, to name colors in plain, well-known terms when possible; second, when the color being described appears to result from a mixture, in equal proportions, of two more elementary colors, they have been given together in the same form and connected by a hyphen (gray-brown): third, when a predominant ground color is modified by more or less mixture with another color, the name of the ground color has been given last with the modifying color preceding it (grayish brown). Depth of coloring is indicated by such words as light, dark, etc.

INDIVIDUAL VARIATIONS.

Individual variation must always be considered in specific determinations and due allowance made therefor. The most common variation will naturally be found in the line of color. It is probable that to a slight extent the age of the individual may influence the depth of the

coloring, because a short time is required, in several species which have been observed at least, after the emergence of the adult from the pupal stage before the full depth of coloring is acquired. There is, however, a common variation in color, apparently not due to difference in age, producing in some of the most variable species color varieties. These may be either lighter or darker than the color of the typical form, but, so far as our observations have gone, complete intergrades are to be found.

A variation from the usual number of segments in the antennæ is quite frequently met with, but this is always in the line of a reduction in number due usually to a fusion of the last two or more segments.

The length and breadth of the abdomen is, perhaps, the most variable character, as in most species the segments are slightly telescoped naturally, and being connected with each other by a flexible membrane are capable of great distension. This may be caused naturally by the simultaneous development of a number of eggs in the ovaries of a female. When specimens are mounted in balsam, glycerin, or any such medium for study, there is danger of compressing the body of the insect if care be not taken to have present plenty of the mounting medium, and the usual result of this compression is the distension of the abdomen.

Measurements of a series of specimens show that a variation, often amounting to one-sixth, sometimes as high as one-fourth, frequently occurs between the extremes in the size of individuals in the same species.

SYNOPSIS OF SUBORDERS AND FAMILIES.

- | | | | |
|---|---|---|-------------------------|
| 1 | { | Female with a saw-like ovipositor. Terminal segment of abdomen of female conical; that of males rarely like females, but usually bluntly rounded. Fore wings with at least one longitudinal vein reaching from base to tip of wing. | TEREBRANTIA (p. 124). 2 |
| | | Female without an ovipositor. Terminal segment tubular in both sexes. Both pairs of wings similar in structure with only one median longitudinal vein, and this only partially developed, never reaching to tip of wing.TUBULIFERA (p. 187). Includes single family Phleothripidae. | |
| 2 | { | Antennæ with nine segments. Wings broad and rounded at the tips; fore wings with cross veins. Ovipositor of female up-curvedÆOLOTHRIPIDÆ (p. 126). | |
| | | Antennæ with six to eight segments. Wings usually narrow and pointed at tips, without cross veins. Ovipositor of female down-curvedTHRIPIDÆ (p. 132). | |

CHARACTERS OF TEREBRANTIA.

Antennæ have from six to nine segments, the terminal segments being usually much smaller than the preceding. Ocelli absent in the entirely wingless forms (*Aptinothrips rufus*) as in all wingless Thysanoptera, and sometimes in the wingless males of species in which the females are winged, they are present in all long winged forms. Maxillary palpi usually three, sometimes two segmented, and labial palpi usually two, sometimes four segmented.

Prothorax rarely longer than broad, but usually transverse, frequently twice as wide as long, ordinarily rectangular in general outline and scarcely wider at the hind edge than at the fore edge, except in the genus *Chirothrips*, in which it is strongly broadened behind, where it is about twice as wide as at front edge. The fore wings are broader, stronger, and much more specialized than the hind wings, shaded darker, if shaded at all. As a rule they have more veins, there being usually two, sometimes apparently only one, fully developed longitudinal veins besides frequently a strongly developed vein following the border of the wing and known as the ring vein; cross veins are present in some cases. The veins are usually set with more or less numerous and conspicuous spines which vary in size, the smallest being minute and indistinct, the largest extremely stout and conspicuous, exceeding in length the breadth of the membrane of the wing. The membrane itself is thickly set with numerous microscopic spines. A fringe is always present upon the hind margin, consisting on the hind wing of one, on the fore wing of two rows of long usually wavy hairs. On the fore wing these rows appear to be placed at different angles to the edge, so that instead of the hairs being parallel when the wing is in action, they cross each other at a slight angle, thereby forming a mesh-work which must add materially to the strength and resistant power of the wing. Spines such as are found on the other veins are wanting upon the hind margin. The fringe upon the front is always shorter than that upon the hind edge and is composed of a single row of stouter, more bristle-like hairs. The development of the fore fringe appears to be in inverse proportion to that of the spines borne upon the costal edge, and when these last are very stout the fringe is vestigial, though sometimes both fringe and spines are wanting on the costa. In many cases the shading of the fore wings takes the form of dark cross bands alternating with light or almost white bands or areas. The hind wings are more slender and more delicate than the fore wings and have but one median longitudinal vein, usually fully developed, and no ring or cross veins. The median vein is without spines such as are borne upon the veins of the fore wing. The hind fringe is single instead of double and the fore edge always bears a more or less well-developed fringe. Shading of the hind wings is very slight and a distinct banding of them is not known. When at rest the wings are laid straight back upon the abdomen, the fore wing of each side completely covering the hind wing and each pair lying parallel to but not upon the other. The hind fringes are very flexible or jointed at their attachment to the wings and when at rest point backward between them. The wings are very frequently reduced to small, rounded or oval pads which are usually invisible even when present. Rarely they are entirely absent, but when this is the case the structure of the thorax indicates the fact. The fore legs are often more thickened

than the others—in the genus *Chirothrips* they are extremely thickened. The hind legs are usually longest and sometimes exceed the abdomen in length.

The abdomen is constricted somewhat at its junction with the thorax and is always ten segmented. The terminal segments are usually shaped differently in the two sexes; in the females the last three segments form a cone the apex of which is quite pointed, and rarely the last segment is rather tubular instead of conical. The abdomen of the male is usually more slender and lighter than that of the female, and as a rule its end is much more blunt, though occasionally shaped much like that of the other sex. The ninth segment is comparatively large and contains the genital apparatus, and frequently the tenth segment is also much retracted within it. In the females the sexual opening is between the eighth and ninth abdominal segments, but in the males it is between the ninth and tenth.

The female has a four-valved, saw-like ovipositor fitted to the underside of the eighth and ninth segments and reaching to about the tip of the abdomen, sometimes a little beyond. When at rest this apparatus lies partially concealed in a sheath on the underside of the last three segments; when in action it can be let down so as to work at almost any angle less than 90 degrees. The copulatory apparatus of the male is almost or entirely withdrawn into the body, but it is freely protrusile.

The males are often quicker motioned and more active than the females. Most of the members of this suborder move rapidly, though some are quite sluggish; they run rapidly and take flight readily. Some species, provided with well-developed wings, seem loath to use them, and many possess a considerable power of leaping.

Family AEOLOTHRIPIDÆ.

The antennæ are nine segmented. Ocelli are present in both sexes. The maxillary palpi are three segmented, and the labial palpi two or four segmented. The wings are large, broad, and rounded at the outer ends. In addition to a heavy ring vein, each fore wing has two longitudinal veins extending from its base to tip, where they unite with the ring vein on each side of the tip, while the hind wings have only a vestige of a median longitudinal vein. Four or five cross veins are present in each fore wing. The fore wings are without a fringe upon the front edge, though some more or less stout hairs are there present in some species. Both sexes bear a peculiar hook-like appendage on the underside of the second segment of each fore tarsus. (See Plate I, fig. 9.) The ovipositor of the female is bent upward so that its convex side is ventral. The males have the first abdominal segment much longer than the second. The members of this family run rapidly, having very long legs, but they do not appear to have the power of springing.

The genus *Eolothrips* is the only one of the three genera of this family found in the United States.

Genus *ÆOLOTHRIPS* Haliday.

Head about as broad as long. Ocelli present in both sexes. Antennæ nine segmented, the last three or four segments being very much shorter than the preceding and closely joined together: third segment much longer than any other. Maxillary palpi three segmented, geniculate. Prothorax about as long or a little longer than the head, without large bristles. Legs very long and slender; fore femora somewhat thickened in both sexes; hind femora broadened; fore tibiae unarmed; second fore tarsal segment, in both sexes, with hook-like appendage. Wings usually present in both sexes; fore wing somewhat narrowed before the middle; fore part of the ring vein furnished with very short hairs, which hardly overreach the edge of the wing. Fore wings white, with two broad, dark cross bands. First abdominal segment in the males much longer than the second, and the ninth segment is drawn out at the hind angles into short clasping organs or hooks.

The two species which I place here can be distinguished by the presence of a white band around abdominal segments two and three in the female of *A. bicolor*, which band is wanting in the female of *A. fasciatus*. The last four segments of the antenna taken together are much longer in *A. bicolor* than the fifth, while in *A. fasciatus* the last four segments together are approximately as long as is the fifth alone.

ÆOLOTHRIPS FASCIATUS (Linnæus).

Plate I, figs. 1-3.

Thrips fasciata LINNÆUS, Syst. Nature, 10th ed., 1758, p. 457.

Thrips fasciata LINNÆUS, Fauna Svecica, 1761, p. 266.—GEOFFROY, Histoire abrégée des Insectes, 1764, p. 385.

Thrips fasciata LINNÆUS, Syst. Nature, 12th ed., Holmiæ, and 13th ed., Vindobonæ, I, Pt. 2, 1767, p. 743.

Thrips fasciata FABRICIUS, Systema Entomologia, 1775, p. 745.

Thrips fasciata SCHRANK, Enumeratio Insectorum Austriæ indig., 1781, p. 297.

Thrips fasciata FABRICIUS, Species Insectorum, II, 1781, p. 397.

Thrips fasciata FABRICIUS, Mantissa Insectorum, II, 1781, p. 320.

Thrips fasciata GMELIN, Linn. Syst. Nat., 13th ed., Pt. 4, 1788, p. 2223.

Thrips fasciata BERKENHOUT, Synop. Nat. Hist. Gt. Br. and Ire., 1789, p. 123.

Thrips fasciata FABRICIUS, Entom. Systematica, IV, 1794, p. 229.

Thrips fasciata STEW, Elem. of Nat. Hist., II, 1802, p. 114.

Thrips fasciata FABRICIUS, Systema Rhyngotorum, 1803, p. 314.

Thrips fasciata TURTON, A General Syst. of Nat. (Transl. from Gmelin's Syst. Nat., 13th ed.), II, 1806, p. 717.

Eolothrips (*Coleothrips*) *fasciata* HALIDAY, Ent. Mag., III, 1836, p. 451.

Eolothrips fasciata BURMEISTER, Handbuch d. Entom., II, 1838, p. 417.

Eolothrips fasciata AMYOT and SERVILLE, Hist. nat. d. Ins. Hemipt., 1843, p. 646.

- Eolothrips* (*Coleothrips*) *fasciata* HALIDAY, Walker, Homiopt. Ins. of Brit. Mus., Pt. 4, 1852, p. 1117, pl. VII, figs. 31-42.
- Eolothrips fasciata* HEEGER, Sitzungsab. d. Acad. d. Wiss. Wien, VIII, 1852, pp. 135-136, pl. XXI.
- Coleothrips trifasciata* FITCH, Count. Gent., VI, Dec. 1855, p. 385.
- Coleothrips trifasciata* FITCH, Second Rept. Nox. Ins. N. Y. 1857, p. 308 (or 540).
- Thrips fasciata* DE MAN, Tijdschr. v. Entomol., 1871, p. 147.
- Eolothrips* (*Coleothrips*) *fasciata*, REUTER, Diagnoser öfver nya Thysanop. från Finl., 1879, p. 7, or Öfv. Fin. Soc., XXI, 1879, p. 214.
- Coleothrips fasciata* PERGANDE, Entomologist, April, 1882, p. 95.
- Coleothrips trifasciata* WEBSTER, Rept. Dept. Agr., 1886, p. 577.
- Coleothrips trifasciata* THAXTER, Rept. Conn. Agr. Exp. Sta. for 1889, (1889), p. 180.
- Coleothrips 3-fasciata* RILEY-HOWARD, Ins. Life, III, 1891, p. 301.
- Coleothrips trifasciata* TOWNSEND, Canad. Ent., XXIV, 1892, p. 197.
- Coleothrips trifasciata* GILLETTE, Bull. 24, Col. Agr. Exp. Sta., 1893, p. 15.
- Coleothrips trifasciata* DAVIS, Bull. 102, Mich. Agr. Exp. Sta., 1893, p. 39, fig. 10.
- Coleothrips trifasciata* COCKERELL, Bull. 15, N. Mex. Agr. Exp. Sta., 1895, p. 7L.
- Eolothrips fasciata* UZEL, Monographie d. Ord. Thysanop., 1895, p. 72, pl. I, fig. 4; pl. v, figs. 46-48.
- Coleothrips trifasciata* DAVIS, Special Bull. No. 2, Mich. Agr. Exp. Sta., 1896, p. 13, fig. 4.
- Eolothrips fasciata* TÄMPEL, Die Geradflügler Mitteleuropas, 1901, p. 286, pl. XXIII.

Female.—Length, 1.63 mm. (1.36 to 1.76 mm.); width of mesothorax, 0.30 mm. (0.27 to 0.34 mm.). General collar yellowish brown to dark brown. Head slightly wider than long, rectangular in outline, retracted slightly within prothorax; cheeks arched but slightly behind eyes; front nearly straight; surface of head but faintly striated and bearing numerous minute spines. Eyes large, black, elongated downward; borders of eyes light; ocelli small, well separated, orange-yellow with maroon crescents. Mouth cone sharply pointed; maxillary palpi geniculate, three segmented; labial palpi four segmented; chitinous thickening extending from left eye connected with that at juncture of mouth cone with frons; just a trace of such thickening extends down from right eye; the two spines standing at base of frons close to transverse thickening are less than twice as long as subantennal pair of spines. Antennæ nine segmented, nearly three times as long as head and very slender, approximate at base; relative lengths of segments:

1	2	3	4	5	6	7	8	9
5.5	15	31	26	17	17			

Segment one thickest, cylindrical; two is a little thicker than three; last five segments are closely joined and from base of six they taper gradually to the tip. Antennæ brown except tip of two and all but extreme tip of three nearly white; all segments quite thickly and uniformly clothed with short spines; those around tip of two being much the stoutest; no sense cones present, but both three and four

have an elongated, narrow, membranous sense area on under side of outer half; five bears a small, rounded spot of similar texture near tip below.

Prothorax somewhat wider than long, and a little wider than head, nearly rectangular in shape; sides but slightly arched, without conspicuous spines but with numerous minute ones. Mesothorax smoothly rounded at front angles. Metathorax slightly narrower at front end than mesothorax and tapering somewhat posteriorly. Wings always present, about one-seventh as broad as long, rounded at tips; fore wing heavily veined having a ring vein and two longitudinal veins which extend from the base and join the ring vein just before the tip of the wing; fore vein united to costa by two cross veins at one-third and two-thirds its length; longitudinal veins united by one cross vein just before the middle and the hind vein is joined to the hind ring vein opposite the outer front cross vein; hind wing veinless. No fringe upon costa of either wing, but costa and longitudinal veins set with a number of short, dark spines; hind fringe hairs short and straight, double row on fore wing. Fore wings with three white bands (at base, middle, and tip) and wider dark brown cross bands between these; hind wings with similar areas, but the two darker bands are so pale gray that they are hardly noticeable. Legs gray-brown, dark brown in dark specimens, very long and slender; fore femora slightly thickened and tarsi armed with a peculiar, hook-like structure opposed to a stout tooth something like a forefinger and thumb (Plate I, fig. 9); first segment of all tarsi very short; all legs thickly set with short spines; all tibiae armed with very stout spines at tips.

Abdomen about two-thirds the length of the whole body, small at base, enlarging to the middle; segments frequently overlapping considerably in the last half; last three segments long and tapering to tip; ovipositor very long and up-curved; spines upon last two segments long, dark, and conspicuous. Entire body yellowish brown to dark brown; connective tissue red.

Redescribed from seven specimens. No males found.

Food plants.—Alfalfa, buckwheat, celery, clover, Compositæ, oats, onion, tansy, wheat, various grasses and weeds.

Habitat.—England (Haliday). Vienna (Heeger), Finland (Reuter), Germany (Jordan, Bohls, near Berlin, Uzel), United States: Connecticut, Indiana, Iowa, Massachusetts, Michigan, New Mexico, New York, Ohio.

Larva.—"Larva yellow, the abdomen behind deeper orange, a whorl of hairs on each segment, more conspicuous on the last two; prothorax elongate; antennæ shorter than in the perfect insect, the number of joints similar; mouth nearly perpendicular, not inflected under the breast; joints of maxillary palpi not very unequal."—Haliday.

Life history unknown. Fitch observed that it was abundant on

wheat early in the season and afterward passed to later-flowering plants, such as tansy (*Tanacetum vulgare*). Webster found it common in all stages on buckwheat in Ohio.

Thaxter believed that this species caused the rust of oats in Connecticut. Davis has reported it as the most common species on the heads of clover in Michigan, and found it both in and out doors on many plants.

ÆOLOTHRIPS BICOLOR, new species.

Plate I, figs. 4-9.

Female.—Length, 1.9 mm.; width of mesothorax, 0.29 mm.; width of abdomen, 0.38 mm. General color light yellowish brown to dark brown.

Head as wide as long, also as long and as wide as prothorax; cheeks slightly arched behind eyes; anterior margin slightly arcuate; occiput transversely striated, quite thickly clothed with minute spines. Eyes large, black, elongated downward, coarsely granulated, each facet distinct, slightly pilose; ocelli separated, bright reddish yellow, margined inwardly with maroon crescents. Mouth cone sharp; maxillary palpi three segmented, geniculate, third segment very small; labial palpi four segmented, first segment very short. Chitinous thickening around left eye connected with that uniting mouth cone to frons; only a short vestige of such thickening below right eye; two long, slender spines are borne upon frons in front of the middle of the transverse thickening and one equally long spine upon middle of labrum; these spines are many times as long as any others upon the head. Antennae as long as head, pro and mesothorax together, slender, filamentous, approximate at base; relative lengths of segments as follows:

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
8.1	13.2	37.1	2.9	19.6	12.6	7.3	3.8	2.9

Segment one thickest, as long as wide; three to six slightly narrower than two; seven to nine tapering; the last very minute and conical. All segments, except three, of uniform brown color; three is very pale yellowish white, except brown band around apex; two is brown at base fading to light yellowish at apex. Segments three to nine quite evenly clothed with fine hairs of uniform size; three and four bear each a narrow, light-colored, membranous strip on outer part of underside, indistinct upon three on account of its light color; a small elliptical spot of similar structure near tip of five beneath.

Prothorax nearly square, slightly constricted in middle, with numerous minute spines, but none conspicuous. Mesonotum transversely striated; fore angles of mesothorax broadly rounded. Metanotum reticulate; metathorax tapering posteriorly. Wings broad, rounded at tips; fore wing with two longitudinal veins which bend outward

just before the tip and unite with the ring vein; fore longitudinal vein united to front part of ring vein by two cross veins at about the first and second thirds of its length and to the hind vein by one cross vein just before the middle of the wing; hind vein united to hind part of ring vein by one cross vein at about three-fifths the length of the wing. Fore part of ring vein and both longitudinal veins set with numerous short, dark spines; both pairs of wings thickly covered with microscopic spines; no fringe upon front edge of fore wings, but a very light one upon hind wings; posterior fringe on fore wings double, on hind wings single; hind wings veinless. Wings clear white; fore pair conspicuously marked with two broad, brown bands so that there are narrow white bands across the base, middle, and tip of the wing; hind wings almost clear white. Legs concolorous with body, very long and slender; fore femora slightly thickened, but less than half as wide as long; second segment of fore tarsus fitted with a peculiar hook-like structure recurved toward base of segment and at tip opposed to a stout tooth. All legs quite thickly set with small spines; hind legs much the longest, nearly as long as wings; each tibia armed at apex with two or more stout spines.

Abdomen small at base, enlarging gradually to its sixth segment, where it is about one-fifth as wide as the body is long; eight, nine, and ten tapering uniformly and quite abruptly; no marked difference in length of segments. Posterior part of segment one and segments two and three white or yellowish in color; remainder of abdomen yellowish brown to dark brown. No spines apparent upon the abdomen, except on last three segments; nine bears a circle of eight long slender bristles near its posterior edge; ten bears six similar bristles. Ovipositor very powerful, up-curved, and extending a little beyond the tip of abdomen.

Described from nine females.

Cotype.—Cat. No. 6323. U.S.N.M.

Male.—Length but little more than 1 mm.; width of mesothorax slightly less than one-fourth body length. General color tawny yellowish with brown extremities to appendages, not nearly as dark as female.

Head subequal in length and breadth and slightly smaller than prothorax; spines in front of transverse thickening at base of mouth cone not conspicuously long. Antennæ three and one-half times as long as head, almost equal to length of abdomen; relative lengths of segments as follows:

1	2	3	4	5	6	7	8	9
7.7	11	34.3	28	22.3	17	11	2	2

Outer two-thirds of antenna dark brown; first three segments light gray-brown, two and basal half of three being lightest; antennæ very

hairy. Hind legs very slender, longer than abdomen; all femora and fore tibiae brownish yellow shaded darkest above; middle and hind tibiae and tarsi gray-brown to dark brown.

Abdomen very small, but slightly longer than antennæ and not as broad as mesothorax, narrowed somewhat at attachment to thorax, increasing gradually in breadth up to ninth segment; tenth segment very abruptly smaller and conical. Segment one very long and marked by two brown, longitudinal carinæ dividing it into thirds dorsally. Ninth segment also peculiar, being very long and as broad as any in the abdomen; hind angles produced into a pair of claspers, also bearing a pair of stout spines; tenth segment small and set with quite long, stout spines. Second, third, and fourth segments nearly white, sometimes irregularly suffused with yellow; rest of abdomen tawny yellow.

Described from three males.

Cotype.—Cat. No. 6323, U.S.N.M.

These males differ much more than is usual from the description of the female but it seems that they are more closely allied structurally to *A. bicolor* than to *A. fasciatus*, and so I place them with the former species.

Food plants.—*Brumella vulgaris*, *Panicum sanguinale*, bindweed, and various grasses in mowings.

Habitat.—Amherst, Massachusetts.

Family THIRIPIDÆ.

The members of this family have from six to eight segmented antennæ (apparently nine segmented in *Anaphothrips striatus* and *Pseudothrips inequalis*); the segments beyond the sixth are usually short and form what is called the style. Maxillary palpi are usually three, sometimes two segmented; labial palpi never composed of more than two segments. The wings of Thripidæ are usually slender, gradually tapering more or less and pointed at the tips. The fore wings, as a rule, present two parallel longitudinal veins, the front one running from the base to near the tip of the wing; the hind vein appears usually as a branch from the fore vein at about one-third the length of the wing. Sometimes, however, all connection between these veins is wanting. Cross veins are rarely visible, though traces of them can sometimes be seen. The ring vein is not usually very heavy or prominent. A fringe is generally present upon the front margin of the fore wing, but may be vestigial. More or less stout spines are found along the veins and costa of the fore wing. The hind wing has one median, longitudinal vein without spines and no cross or ring veins, but the costa bears a fringe. The ovipositor of the female is bent downward, i. e., concave side ventral.

SYNOPSIS OF THIRIPIDÆ.

1	{	Antennæ with eight segments	2
	{	Antennæ with seven segments	11
2	{	Body with markedly reticulated surface..... <i>Heliothrips</i> (p. 168)	
	{	Body without reticulate surface	3
3	{	Abdomen clothed with fine hairs and having a silky luster. <i>Sericothrips</i> (p. 141)	
	{	Body without clothing of fine hairs.....	4
4	{	Last two segments of the antenna longer than the sixth... <i>Raphidothrips</i> (p. 158)	
	{	Last two segments shorter than sixth	5
5	{	Terminal segment of abdomen with a pair of extremely stout, short spines near the tip above..... <i>Limothrips</i> (p. 138)	
	{	Terminal segment without unusually stout spines.....	6
6	{	Antennæ with second segment drawn out into an acute process on outer angle..... <i>Chirothrips</i> (p. 133)	
	{	Second segment of antennæ normally symmetrical.....	7
7	{	Ocelli and wings wanting	<i>Aplinothrips</i> (p. 166)
	{	Ocelli and wings present	8
8	{	With spines at hind angles of prothorax.....	9
	{	Without spines at hind angles of prothorax..... <i>Anaphothrips</i> (p. 160)	
9	{	With two long spines at each hind angle of prothorax	10
	{	With one long spine at each hind angle of prothorax..... <i>Pseudothrips</i> (p. 146)	
10	{	Without a long spine at middle of each side of prothorax <i>Euthrips</i> (p. 147)	
	{	With a long spine at middle of each side of prothorax..... <i>Scolothrips</i> (p. 157)	
11	{	Fore wings broad and without front fringe..... <i>Parthenothrips</i> (p. 175)	
	{	Fore wings slender, spines on outer half fewer than on basal... <i>Thrips</i> (p. 178)	

Genus CHIROTHRIPS Haliday.

Body thickened. Head very small and in front of the eyes drawn out into a three-cornered process upon which the antennæ are situated. Ocelli present in the females and located very far back; wanting in the males. Antennæ eight segmented, the second segment ending in a blunt prominence at the outer angle. Maxillary palpi three segmented. Prothorax nearly twice as long as the head, and trapezoidal in form, being about twice as broad at the hind edge as at the fore edge. Two prominent spines present at the hind angles or wanting in some species. Legs short; the fore pair extremely thickened, so that the tibiae are short and broad and the tarsi small. Wings long and very slender; fore wing with two veins upon which there stand a few small spines; front fringe well developed. Males wingless.

SYNOPSIS OF SPECIES.

1	{	With two moderately long spines at each hind angle	<i>manicatus</i> (p. 134)
	{	Without long spines at the hind angles.....	2
2	{	Abdomen light yellow	<i>obesus</i> (p. 137)
	{	Abdomen light brown	<i>crassus</i> (p. 136)

CHIROTHRIPS MANICATUS Haliday.

Plate II, figs. 14-16.

Thrips (Chirothrips) manicata HALIDAY, Entom. Mag., III, 1836, p. 444.*Thrips manicata* BURMEISTER, Handb. d. Entomologie, II, 1838, p. 413.*Thrips longipennis* BURMEISTER, Handb. d. Entomologie, II, 1838, p. 413.*Chirothrips manicata* AMYOT and SERVILLE, Ins. Hemipteres, 1843, p. 642.*Chirothrips longipennis* AMYOT and SERVILLE, Ins. Hemipteres, 1843, p. 642.*Thrips (Chirothrips) manicata* HALIDAY, Walker, Homopt. Ins. Brit. Mus., 1852, p. 1106, pl. vi, fig. 12.*Thrips (Chirothrips) manicata* REUTER, Diagn. öfv. nya Thysanopt. f. Finland, (1878-79), pp. 5, 6.*Chirothrips antennatus* OSBORN, Canad. Ent., XV, 1883, p. 154.*Chirothrips antennatus* LINDEMANN, Bull. d. Soc. Imp. d. Nat. d. Moscow, LXII, 1886, No. 4, pp. 322-325, fig. 12.*Chirothrips manicata* JABLONOWSKI, Termes. Fuzetek, XVII, 1894, p. 47.*Chirothrips manicata* UZEL, Mon. d. Ord. Thysanoptera, 1895, p. 80, pl. I, fig. 2; pl. vi, fig. 49.*Chirothrips manicata* TÜMPER, Die Geradflügler Mitteleuropas, 1901, p. 287.

Female.—Length 1 mm. (0.84 to 1.18 mm.); width of mesothorax 0.27 mm. (0.24 to 0.32 mm.). General color quite uniform dark yellowish brown.

Head somewhat shorter than wide, almost conoid in shape, frequently hidden up to the eyes in the prothorax; cheeks only about one-third the length of the eye; head prolonged into a triangular process in front of the eyes; a row of four small spines across the head between the front edges of the eyes and one small spine on each side of the anterior ocellus. Eyes large, black, rather coarsely faceted; ocelli subapproximate, almost white or pale yellowish with heavy maroon crescentic inner margins, placed in a low triangle far back between hind half of eyes. Mouth cone short, broad and blunt; maxillary palpi three segmented. Antennæ less than twice the length of head; segments thick and more or less rounded; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
5.8	5.9	6.4	7.5	6	8	2.5	2.5

Basal segments very broad and almost contiguous; two drawn out into a short, blunt angle on outer side; three and four bear each one very stout, blunt sense cone on outer angle. All segments brown; tips of two and three frequently yellowish.

Prothorax large, trapezoidal, a little less than twice as long as head, as wide as head in front and twice as wide behind; sides nearly straight; surface dotted with numerous very small spines and marked with transverse, arched wrinkles, giving it a scaly appearance; numerous small spines stand at hind edge, and two spines at each hind angle are much larger than the others. Mesothorax a little broader than

the prothorax, widest behind, sides curving forward; metathorax abruptly somewhat narrower, and its sides curve inward to base of abdomen. Wings nearly always fully developed in females, about four-fifths as long as body and in middle about one-seventeenth as broad as long, sharply pointed at ends, heavily fringed on both edges. Hind longitudinal vein branches from the fore at about one-fourth the length of the wing; fore vein bears six or seven spines before the branching off of the hind vein; beyond this the fore vein bears usually two and the hind vein four spines; costa bears numerous short spines. Fore wings gray-brown; hind wings gray. Legs short and powerful; fore femora extremely short, nearly as broad at base as long, wrinkled on surface and at tip outside with chitin turned up into a sort of tooth; fore tibiae also extremely short and thick; each tibia bearing a row of spines of gradually increasing length and stoutness on inner side toward tip; these are most strongly developed on hind legs. Legs dark brown except tarsi more or less gray or yellowish.

Abdomen broader than mesothorax, hardly twice as long as broad (segments usually overlapping considerably and giving a dark and light brown banded appearance); spines around last two segments moderately long and stout, dark brown and conspicuous; ovipositor of good length. Color of abdomen uniform dark brown; receptaculum seminis inconspicuous or invisible.

Redescribed from ten females.

Male.—Length 0.83 mm. (0.66 to 0.96 mm.); width of mesothorax 0.22 mm. (0.20 to 0.24 mm.).

Ocelli wanting; spines on head as in female. Relative lengths of antennal segments as follows:

1	2	3	4	5	6	7	8
5.2	5.2	5.9	6.5	4.4	5.6	1.8	1.8

Segments two and three pale yellowish. Wings entirely wanting. Abdomen more narrow than in female and bluntly rounded at the end. Ninth segment very large, conoid; tenth segment retracted therein; ninth with a short stout spine on each side of the hind edge above; genital apparatus protruding beyond the tip of tenth segment; a rounded light depression in middle of ventral plates on segments three to six.

Described from five males.

Food plants.—Flowers of various grasses and cereals, clover, wild carrot.

Habitat.—England (Haliday), Germany (Burmeister, Jordan, Bohls), Finland (Reuter), Russia (Lindeman), Bohemia (Uzel), United States: Manchester, Iowa; Amherst, Massachusetts.

Life history unknown except that they hibernate in dried flower stems and in turf.

I have compared my specimens with those of Osborn's *C. antennatus* and they are identical.

CHIROTHRIPS CRASSUS, new species.

Plate II, figs. 17-20.

Female.—Length 0.78 mm.; width of mesothorax 0.26 mm. General color of head and thorax brown; abdomen gray-brown or yellowish brown.

Head very small, slightly wider than long, narrowed in front between the eyes and elongated anteriorly; distance between eyes equal to one-half the width of head; frons between antennæ bluntly acuminate. Eyes reddish orange by reflected light; ocelli placed in a low triangle far back between hind edge of eyes; each ocellus pale, margined inwardly with a dark-red crescent. Mouth cone very short and broadly rounded; maxillary palpi short, three segmented. Antennæ approximate at base; relative lengths of segments as follows:

$\frac{1}{4.5}$	$\frac{2}{6}$	$\frac{3}{7}$	$\frac{4}{6.5}$	$\frac{5}{6}$	$\frac{6}{8.3}$	$\frac{7}{2.8}$	$\frac{8}{3}$
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Basal segments large, longitudinally compressed, nearly twice as wide as long; segment two drawn out at outer angle into an acute process; three with slender peduncle, subpyriform, bearing one prominent sense cone on outside, as does also four; four and five rounded; four nearly as thick as long; five somewhat narrower; six elongated; seven and eight moderately slender. One and two pale straw yellow; three to six shading gradually to a medium brown; seven and eight also medium brown.

Prothorax one and one-half times as long as head, one and three-fourths times as wide as long, twice as wide at posterior edge as at anterior; sides nearly straight, indented above fore coxæ, with prominent spines at posterior angles. Mesothorax one and one-fourth times as wide as prothorax, quite a deep constriction between mesothorax and metathorax; pterothorax with more or less rusty tinge. Wings long, saber-formed, slightly overreaching the tip of the abdomen; fore wings shaded with gray, hind wings nearly clear. Fore longitudinal vein extends through the wing; hind vein arises from fore vein at one-third its length; both veins disappear before reaching the tip of the wing. Fore vein bears two spines on distal half; hind vein bears five spines. Legs short; fore pair strongly thickened; all femora grayish or yellowish brown; fore tibiae and all tarsi pale yellowish; middle and hind tibiae brownish at bases and above, fading to pale gray or yellow beneath and at extremities.

Abdomen elongate-ovate in outline, bluntly pointed at tip, one and four-fifths times as long as broad; spines upon last two segments short, weak, and inconspicuous; ovipositor short and weak. Color rusty-gray brownish upon sides, and pale yellowish upon last two segments.

Described from two females.

Cotype.—Cat. No. 6324, U.S.N.M.

Male.—Length 0.66 mm. (0.58 to 0.78 mm.); width of mesothorax 0.23 mm. (0.19 to 0.25 mm.). General color of head and prothorax grayish or yellowish brown; pterothorax abruptly pale yellowish, shading through gray to chestnut brown upon last two abdominal segments.

Head as wide as long, without ocelli; relative lengths of antennal segments as follows:

$\frac{1}{4.4}$	$\frac{2}{5.9}$	$\frac{3}{5.9}$	$\frac{4}{5.9}$	$\frac{5}{5.2}$	$\frac{6}{7.9}$	$\frac{7}{2.2}$	$\frac{8}{2.6}$
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Prothorax one and one-third times as long as head, and one and one-half times as wide as long; mesothorax one and one-sixth times as wide as prothorax; wings wanting; terminal two segments conoid; spines thereupon slightly more prominent than in female.

Described from seven males.

Cotype.—Cat. No. 6324, U.S. N.M.

Food plant.—*Panicum capillare*.

Habitat.—Amherst, Massachusetts.

Life history unknown.

CHIROTHRIPS OBESUS, new species.

Plate II, figs. 21, 22.

Female.—Length 0.78 mm.; width of mesothorax 0.29 mm.; width of abdomen 0.275 mm. General color of head and thorax yellowish brown; abdomen pale yellow.

Head very small, as wide as long, narrowed anteriorly, much elongated between the eyes, acuminate between basal segments of antennae. Eyes dark, relatively large, occupying sides of head from close to base of antennae almost to posterior edge of head; distance between eyes one-half the width of head; ocelli rather small and placed very far back between hind edge of eyes; anterior angle of triangle formed by ocelli is very obtuse; color pale yellow, margined inwardly, or entirely surrounded by red patches. Mouth cone very short and blunt; maxillary palpi short, three segmented. Antennae one and three-fourths times as long as head, situated upon the elongated portion thereof; relative lengths of segments as follows:

$\frac{1}{4.5}$	$\frac{2}{6}$	$\frac{3}{7}$	$\frac{4}{6.5}$	$\frac{5}{6}$	$\frac{6}{8.3}$	$\frac{7}{2.8}$	$\frac{8}{3}$
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First segment much compressed longitudinally; transverse diameter more than twice its length; two very strongly drawn out externally into a stout, conical elongation; segments three, four, and five rounded; three with a quite long peduncle; three and four each bear one stout, transparent sense cone upon outer angle. Color of one and two clear pale yellow; three to six becoming gradually more brownish; six to eight uniformly chestnut brown.

Prothorax one and one-third times as long as the head; anterior edge but slightly wider than hind edge of head; sides slightly concave, divergent so that width at posterior edge is more than twice that at anterior edge; hind angles acute, without long spines; sides quite deeply indented above fore coxæ. Sides of mesothorax rounded, converging anteriorly; metathorax narrower than mesothorax, its sides also rounded but converging posteriorly. Color of thorax light yellowish brown, sometimes splashed with red. Fore legs very short and extremely thickened; other legs short, but not thickened. Legs pale yellow, middle and hind tibiae slightly brownish on upper side, basal part of fore femora shading to light brown. Wings long, sabre-formed, overreaching tip of abdomen, shaded with gray. Two long veins, the hind one branching from the fore at about one-third the length of the wing; both veins disappear before reaching the apex. Each vein bears four to six spines; basal third of wings unfringed; fore fringe sparse, long and slender.

Abdomen ovoid, acuminate at apex, broadly attached to metathorax, one and two-thirds times as long as broad. Spines upon last two segments very short and weak, and those upon ventral plates weak and inconspicuous. Ovipositor very short and weak, apparently not functional; tenth segment split open above. Color of abdomen uniformly clear pale yellow, except apex brownish and posterior edges of segments faintly brownish, receptaculum seminis over base of ovipositor bright reddish orange.

Described from three specimens.

Cotype.—Cat. No. 6325, U.S.N.M.

Male unknown.

Food plants.—*Festuca ovina*, *Poa pratensis*.

Habitat.—Amherst, Massachusetts.

Genus LIMOTHIRIPS Haliday.

Body powerful. Head longer than wide, broadened behind, and in front of the eyes extending into a triangular projection upon which the antennæ are borne. Ocelli present in females, but wanting in males. Antennæ eight segmented; third segment drawn out into a blunt, triangular process at outer angle. Maxillary palpi two segmented (*L. cerealium* three?). Prothorax somewhat shorter than the head, slightly broadened at hind edge; hind angles provided with

one long, stout spine. Legs rather short and thick. Wings quite long and of medium breadth; costa bearing a fringe; veins bearing a few short spines. Terminal segment of abdomen in female elongated somewhat and approaching a tubular form, split open above; each side bears a short, extremely stout spine and similar stout spines are borne upon the sides of the eighth segment.

Male entirely wingless. End of abdomen bluntly rounded; ninth segment bears a stout spine at middle of each side and a pair of similar spines stands closely together near the dorsal line above.

Species of this genus move slowly and have no power of leaping.

I found only the new species *avenæ* of the genus.

LIMOTHIRIPS AVENÆ, new species.

Plate I, figs. 10-12; Plate II, fig. 13.

Female.—Length 1.57 mm. (1.48 to 1.66 mm.); width of mesothorax 0.28 mm. (0.26 to 0.30 mm.). Form elongated, slender. General color dark yellowish brown.

Head a little longer than wide, tapering a little anteriorly; cheeks very slightly arched; surface of head not at all, or but very faintly, cross striated and bearing a few scattered minute spines; front strongly arcuate, produced considerably between bases of antennæ; color of head dark brown. Eyes of moderate size, black with yellow margins, triangular above, protruding slightly; ocelli fairly well separated, anterior one smallest, pale yellow with very dark red crescents on inner margins. Mouth cone short and moderately thick; maxillary palpi short, only two segmented. Antennæ rather short, about one and one-half times as long as the head, considerably separated at bases; relative lengths of segments as follows:

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>
4.4	9.1	11.8	10.2	10.5	14.4	3	3.8

Segment one much wider than long; two cup-shaped; three to five clavate; six fusiform; seven and eight slender, cylindrical; one and two dark brown; three to eight shading gradually from pale brownish gray to more or less dark brown; outer angles of three and four strongly developed (three especially so, though obtuse), and each bears one long pointed sense cone; six also bears one long, slender sense cone on inner side at two-thirds its length.

Prothorax a little shorter than head and about one and one-third times as wide as long; sides diverging from head posteriorly; only one long stout spine at each posterior angle; other spines scattered and minute; transverse margins nearly straight; sides slightly rounded; concolorous with head. Mesothorax about one and one-third times as wide as prothorax; metathorax abruptly narrower; sides nearly par-

alle; pterothorax more or less rusty brown in color. Wings present, quite long and slender, about one-seventeenth as broad in middle as long, tapering gradually from base to tip; two longitudinal veins in fore wing, the second branching from the first at about one-fourth its length; both veins and costa bear a few short, rather stout, dark brown spines: costa about twenty, fore vein about twelve, of which only two stand beyond the middle of the wing; hind vein about nine spines; fore wings dark, smoky gray; hind wings very slightly gray; costal fringes long. Legs rather short, but not thickened; femora and middle and hind tibiae dark brown: all tarsi, fore tibiae and extremities of middle and hind tibiae yellow; fore tibiae shaded with brown above; hind tibiae alone bearing stout spines.

Abdomen about two-thirds the length of the body and only about one-fourth as wide as long, almost cylindrical in form; segments not overlapping, width of segments increasing very gradually up to the sixth, then diminishing rapidly; last three segments conoid, prolonged at tip of tenth. Spines on sides of abdomen weak and inconspicuous before the seventh segment; eight bears three or four short, very stout, slightly curved, dark brown spines on each side; nine bears a circle of long, slender spines; tenth segment split open above, sharply pointed at tip, and on each side above is a short, very stout, straight, dark brown spine reaching but slightly beyond the tip; color of abdomen gray-brown, shading to almost black at tip; connective tissue pale yellow; surface of segments finely reticulated.

Described from eight long-winged females.

Cotype.—Cat. No. 6326, U.S.N.M.

Male.—Length 1.05 mm. (1.02 to 1.08 mm.); width of mesothorax 0.22 mm. (0.20 to 0.22 mm.).

Head as broad as long. Ocelli generally wanting, though sometimes vestiges are present. Antennae only one and one-third times as long as the head; relative lengths of segments:

1	2	3	4	5	6	7	8
$\frac{1}{4}$	8	$\frac{9.7}{7.7}$	$\frac{7.7}{7.3}$	11	$\frac{2.3}{3}$	$\frac{7}{8}$	$\frac{3}{3}$

Color paler than in female, with more of a yellowish tinge, becoming yellowish brown at tip. Pterothorax without traces of wing pads; the dorsal plates very broad, being as wide as first abdominal segment. Head and thorax yellowish brown; legs yellow; femora and tibiae considerably shaded with brownish.

Abdomen but little more than twice as long as wide, though segments overlap considerably, giving it a yellowish brown and dark-brown cross-banded appearance; bluntly rounded at tip; segment nine very large and bluntly conoid; segment ten small, cylindrical, and plainly visible retracted within the ninth; copulatory apparatus projecting a little from ten. Close together in middle of nine above stand two extremely short blunt spines borne upon broader black, chitinous

projections, the inner edges of which are parallel and the black marking tapers to a point anteriorly; on each side of these peculiar processes stands a long, slender spine; at about the middle of each side of ninth segment is a very abrupt, angular, chitinous projection shaded almost black, supporting on the inside of it an exceedingly short, stout, dark brown, blunt spine; other spines on this segment slender, but not very long. Segment ten is blunt at end and bears a row of short, small spines above, close to hind edge; nine is cut out on upper side over about half of ten, which at tip does not quite reach to tip of nine or under side; abdomen yellow-brown.

Described from four specimens.

Cotype.—Cat. No. 6326, U.S.N.M.

Food plants.—Oats, *Festuca pratensis*.

Habitat.—Pennsylvania, Massachusetts.

Life history unknown.

This species was very abundant upon and caused much damage to oats at State College, Pennsylvania, during the summer of 1898.

Genus SERICOTHRIPS Haliday.

Body broad and having a silky luster due to the presence of numerous minute spines on the abdominal segments. Head fully one and one-half times as wide as long. Eyes large and protruding; ocelli present in both sexes. Antennæ eight segmented. Maxillary palpi three segmented. Prothorax much longer than the head, without long spines at hind angles (one present in *S. variabilis*). Legs, especially hind pair, quite slender. Wings either reduced or fully developed; when present, the fore wing is broad at basal fourth, the remainder being very narrow; only one longitudinal vein developed; fore fringe long; spines on veins numerous and moderately developed. Abdomen in some species strongly arched and its segments broad and short; tip of abdomen conical in both sexes. Abdomen of male much more slender throughout.

Species of this genus leap readily.

The characters of this genus are extended to include the following species:

SYNOPSIS OF SPECIES.

Body nearly black except segments four, five, and six of abdomen almost white; wings reduced *cingulatus* (p. 141)
 Body yellow with brown or gray markings; wings present and with two spines on last fourth, where hind vein usually is *variabilis* (p. 143)

SERICOTHRIPS CINGULATUS, new species.

Plate III, figs. 27-29.

Female.—Length 1 mm. (0.84 to 1.25 mm.); width of mesothorax 0.25 mm. (0.22 to 0.31 mm.); width of abdomen 0.37 mm. (0.31 to 0.45 mm.). General color very dark brown; abdomen cross-banded with white in the middle.

Head narrow as compared with following segments, one-half as long as wide, widest through the eyes and constricted considerably behind them, neck-like and sunken slightly in the prothorax; front slightly depressed at the insertion of the antennae. Eyes small, rounded, strongly protruding, occupying together only one-half the width of the head, black, coarsely granulated; margins light yellow; ocelli present, very small, well separated, not prominent; anterior one indistinct. Color of head brown; surface bearing scattered small curved spines. Mouth cone reaching to about the posterior edge of prosternum; maxillary palpi three segmented. Antennae very nearly as long as head and thorax together, slender, eight-segmented; relative lengths of segments:

1	2	3	4	5	6	7	8
5.8	9.9	16.4	14.5	12.2	14.3	3.2	4.

Basal two segments thickest; spines slender and inconspicuous. Segments one, two, and three light yellow; third shaded with brown toward apex; remainder dark brown except four, which is yellowish at base and style is somewhat lighter brown.

Prothorax nearly twice as long as head and one and one-half times as broad as long; widest in middle, tapering abruptly to the head and less abruptly to posterior angles; surface marked with deep, transverse, reticulating wrinkles appearing like striae in dorsal view; each anterior angle bears a pair of short, divergently curved spines; one short, anteriorly curved spine at each hind angle; color dark brown. Meso and metathorax together scarcely as long as prothorax, only slightly wider than prothorax; yellowish brown, except notal plates dark brown; sides of metathorax not converging posteriorly; metanotum much wider than long. Wings reduced, the pads reaching only to the first abdominal segment. Fore and middle legs of approximately same length; fore pair thicker; hind pair longest and quite slender; all femora shaded with brown in middle but lighter at extremities; tibiae yellowish brown, more yellow at basal attenuations, fore pair lightest; tarsi uniformly yellowish, slender, and tapering evenly from their bases to tips. Surface of all femora and tibiae thickly covered with transverse ridges; spines upon hind tibiae especially long and slender.

Abdomen very large, acutely ovoid, about one-half as broad as long, uniformly thickly covered with minute spines which appear most clearly as a fine fringe at posterior edge of each segment; a transverse dorsal row of about twelve quite uniformly long, brownish spines regularly spaced across the middle of segments two to six, and six similar spines stand in as many small, dark depressions along the posterior edge of the sternal plates of these segments. First three abdominal segments light brown; four, five, and six abruptly pale gray, or yellowish gray, tinged with brown in middle of dorsum, most broadly on sixth segment; last four segments again abruptly dark brown. A narrow, dark-brown, transverse, chitinous thickening

(appearing as a stripe) extends across two-thirds of the width of the dorsal plates of segments two to seven near their anterior edges; spines upon terminal segments short and weak.

This species possesses a well-developed power of leaping.

Described from twenty specimens.

Cotype.—Cat. No. 6327, U.S.N.M.

Male.—Length 0.87 mm. (0.66 to 1 mm.); width of mesothorax 0.21 mm.; width of abdomen, 0.27 mm. (0.22 to 0.30 mm.).

Relative lengths of antennal segments:

1	2	3	4	5	6	7	8
$\frac{1}{5.8}$	$\frac{2}{9.3}$	$\frac{3}{15}$	$\frac{4}{12.8}$	$\frac{5}{10.3}$	$\frac{6}{12.8}$	$\frac{7}{2.8}$	$\frac{8}{3.7}$

End of abdomen shaped as in female; a transverse elliptical depression in the middle of ventral plates of segments five to seven. Segment nine long and tapering; tenth elongate and retracted within the ninth. Genital apparatus appears to be wholly protrusile. Testes large and brownish yellow in color.

Cotype.—Cat. No. 6327, U.S.N.M.

Food plants.—Various grasses.

Habitat.—Amherst, Massachusetts.

Life history unknown.

SERICOTHRIPS VARIABILIS (Beach).

Plate II, fig. 23; Plate III, figs. 24-26.

Thrips variabilis BEACH, Proc. Iowa Acad. Sci., 1895, III, 1896, pp. 220-223.

Female.—Length 0.84 to 1.23 mm.; width of mesothorax about one-fourth the length of the body. General color yellow, with more or less striking brown or gray-brown markings.

Head about two-thirds as long as broad, broadest through eyes, retracted considerably into prothorax; cheeks moderately full, converging somewhat posteriorly; anterior margin nearly straight, but slightly elevated between bases of antennæ. Spines upon head inconspicuous; but one moderately long spine on each side of fore ocellus, and one behind each hind ocellus; a row of four short, strongly curved spines across front near margin, and a few small spines upon cheeks; color of head pale yellow with dusky shadings. Eyes moderately large, protruding a little, nearly black, coarsely faceted, plainly pilose, occupying about three-fifths the width of the head; ocelli large, approximate, reddish orange, heavily margined inwardly with maroon, situated upon a slightly raised area between the eyes. Mouth cone tipped with black; maxillary palpi slender, three segmented. Antennæ eight segmented, more than twice as long as head, bases separated by about two-thirds the width of a basal segment; relative lengths of segments:

1	2	3	4	5	6	7	8
$\frac{1}{5}$	$\frac{2}{8.2}$	$\frac{3}{12.7}$	$\frac{4}{12}$	$\frac{5}{10}$	$\frac{6}{11.7}$	$\frac{7}{2.7}$	$\frac{8}{3}$

Segment one nearly spherical and slightly narrower than two which is broadest; three and four fusiform; five similarly formed to four at its base, but quite broad at its apex, and rather broadly joined to six which with style tapers gradually to tip. Color: One white and nearly transparent; two pale or brownish yellow; three and four pale yellow; three light brownish at tip and four in outer half; remainder of antenna light to dark brown, base of five somewhat lighter.

Prothorax about three-fourths as long as wide, a little longer and a little wider than the head; sides about parallel; angles rounded; transversely striated on dorsum; only one long, slender spine at each hind angle; anterior third of pronotum concolorous with head, remainder marked with a saddle-shaped patch of brown, the anterior edge of which is concave and sharply defined; six or eight medium-sized spines stand in this dark border, behind it there are six more or less well-defined brown spots. Pterothorax large and apparently symmetrically formed on account of first segment of abdomen being closely joined to metathorax and closely approaching it in color; meso and metathorax equally wide and about one and one-half times as wide as the prothorax; metanotal plate light brown; rest of pterothorax bright or dusky yellow, except small brown spots at anterior edge of mesonotum and at anterior angles. Wings long, reaching to tip of abdomen; fore wings very slender beyond the basal fourth, breadth at middle only about one twenty-sixth their length; only the fore longitudinal vein is fully developed, though vestiges of the hind vein may be seen at the base. Spines upon costa and fore veins dark brown and conspicuous; twenty-two to thirty on costa; twenty to twenty-six on fore vein placed at regular intervals; two isolated spines stand upon the last fourth of the wing on the line where the hind vein might be expected; the scale bears four spines along its inner edge and one discal near its base. Fore wings uniformly dusky or marked with three white and two gray-brown cross bands alternating; scale also gray-brown; anterior fringe long and fine on outer two-thirds of costa. Legs, especially hind pair, quite long and slender; general color pale yellowish with brown markings on fore femora above, both outer and inner sides of fore tibiae, around outer halves of middle and hind femora, around middle of these tibiae, and bases of all bladders. Tarsi slender and tapering; hind tibiae without stout spines within.

Abdomen cylindrical, tapering sharply from anterior edge of eight, or acute avoid; two to two and one-third times as long as broad; thickly clothed with minute slender spines appearing most prominently as a fringe on hind edges of dorsal plates. Eight to ten spines upon each segment from two to eight, two or three of these stand quite closely together in a group upon each side, and the middle pair stand very closely together upon segments two to five, but separate more widely upon following segments and become larger; spines upon last two seg-

ments short, weak, and not strongly radiating. Segments two to seven marked with a very prominent dark-brown cross line at anterior third of each; on each side of these segments behind this line is a more or less extensive brown shading which on seven extends clear across the back; ground color of these segments is white or pale yellowish gray; eight, nine, and ten are without the brown markings, and are pale or dusky yellowish.

Male.—Similar to female with the following exceptions: Length 0.64 mm.; width of thorax 0.19 mm.; abdomen only four-fifths as wide as thorax, and more than twice as long as wide, nearly cylindrical to seventh segment; eight to ten conoid; spines upon last segment short; the testes large and brownish orange.

Relative lengths of antennal segments:

1	2	3	4	5	6	7	8
$\frac{1}{4}$	$\frac{2}{7}$	$\frac{3}{10.3}$	$\frac{4}{10}$	$\frac{5}{9}$	$\frac{6}{10.5}$	$\frac{7}{2}$	$\frac{8}{3}$

Var. a. female.—Head and front third of prothorax clear, pale yellow; pterothorax darker yellow; hind part of prothorax and metanotum abruptly brown; abdomen pale yellowish with very conspicuous dark brown cross-streak at first third of segments two to seven; on each side behind this streak is a narrow brown shading which upon seven extends clear across the back. Fore wings slightly tinged with yellowish, darkest at base. Brown spot on femora above, darkest on hind femora. Abdomen acute ovoid.

Food plants.—Clematis, clover, elm, hackberry.

Habitat.—Iowa, Massachusetts.

“*Var. b. male and female*.—Body pale yellowish, immaculate; apical joints of antennae black, remainder pale; wings and fringes tinged with yellowish.”—Beach.

Food plants.—Hawthorn, hackberry.

Habitat.—Iowa.

“*Var. c. male and female*.—Wings nearly uniformly fuliginous; last three joints of antennae, distal half of joints 4 and 5 black, sometimes intermediate altogether dusky; brown markings very distinct, confined to two large spots on thorax and scutellum respectively, the latter oblong and approximating posteriorly; abdomen immaculate.” Beach.

Food plants.—Hawthorn, hackberry.

Habitat.—Iowa.

“*Var. d. male and female*.—This variety is characterized by having the wings fuliginous, trifasciate with white bands, and in being more

“I have seen and studied the specimens of Miss Beach labeled “*Thrips variabilis* Beach, Var. c. male and female types.” These specimens seem to me to fit much better her description of “Var. d.” An emended description based upon these specimens would not be distinguishable from the foregoing description of “Var. d.”

heavily marked with brown; the markings on the thorax and bands at bases of first, second, and third (sometimes of second and third only), and seventh and eighth segments of the abdomen are extended until they coalesce and form broad bands; the dorsal surface of the head is brown; sometimes all of the caudal segments are brown; the legs are white, with brown streaks on dorsal surface of femora, and frequently on tibiae also; antennae same as in preceding variety." Beach.

Food plants.—Cucumber, grass, smartweed.

Habitat.—Iowa, Massachusetts.

PSEUDOTHIRIPS, new genus.

Head much broader than long. Ocelli present. Maxillary palpi three segmented. Antennae eight segmented (apparently nine segmented, owing to an apparent division of the sixth segment). Prothorax much longer than head and somewhat broadened posteriorly; one stout spine at each hind angle. Wings with two longitudinal veins which, with the costa, are thickly and regularly set with quite prominent spines; fore fringe well developed. Abdominal segments two to eight, inclusive, bear across the middle of each dorsal plate four weak spines, of which the middle two are close together upon anterior segments but diverge posteriorly.

This genus is erected for the single species *inequalis*.

($\psi\epsilon\upsilon\delta\omega$, false; $\theta\rho\iota\psi$.)

PSEUDOTHIRIPS INEQUALIS (Beach).

Plate III, figs. 30–32.

Thrips inequalis BEACH, Proc. Iowa Acad. Sciences, 1895, III, (1896), pp. 223–224.

Female.—Length 0.88 mm.; width of mesothorax, 0.22 mm.; general color yellow; thorax and abdomen tinged with orange.

Head fully one and one-half times as broad as long, slightly constricted at hind edge, and retracted into the prothorax somewhat; cheeks full; anterior margin nearly straight. Eyes of medium size, rounded, slightly protruding, slightly pilose; ocelli large, well separated, with orange-red margins; ocellar bristles present, but not very long or prominent. Mouth cone moderately sharp and somewhat shaded with brown at tip; maxillary palpi three segmented. Antennae over two and one-half times as long as head; eight segmented, though there appear to be nine segments; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
4	$\frac{7}{2}$	8.5	$\frac{8.5}{2}$	$\frac{8}{3}$	$\frac{8+2}{2}$	$\frac{7}{2}$	$\frac{8}{3}$

Segment six has a distinct annulation around it at four-fifths its length, the outer part appearing much like a separate segment. Segments one and two quite stout and rounded; three irregularly, and four regularly clavate; seven and eight cylindrical. Segment one paler than two, concolorous with head; three to six pale yellow in

basal parts, shading to dark brown toward the tips; seven and eight dark brown; spines distinct but not prominent, becoming more slender toward the tip.

Prothorax about one and one-half times as long as head, and one and one fourth times as broad at posterior edge; sides nearly straight, diverging backward; dorsal surface bearing a number of small, dark spines, mostly near lateral and posterior borders; one stout, prominent spine at each hind angle. Mesothorax over one and one-half times as wide as head; sides rounded and converging anteriorly; fore angles prominent. Metathorax but little narrower than mesothorax; its sides nearly parallel, curving inward abruptly at hind angles. Wings reaching almost to tip of abdomen; two longitudinal veins quite prominent; both veins and costa thickly and regularly set with prominent dark brown spines; costal twenty-four to twenty-eight, fore vein eighteen to nineteen, hind vein ten to eleven, scale five, internal one. Fore wing about one-fifteenth as broad in middle as long, shaded faintly yellowish; costal fringe well developed. Legs dusky yellow, quite slender; fore femora slightly thickened; femora and tibiae bearing numerous short spines; inner side of hind tibiae with but few stouter spines except one pair at tip; each hind tarsal segment with one stout, dark spine on the side; a dark brown spot on under side of each tarsus at tip.

Abdomen elongate-ovate; few dark spines along the sides; segments two to eight bear across the middle of each dorsal plate four weak spines, the middle two are close together upon anterior segments, but diverge posteriorly; posterior edge of nine bears a circle of six stout spines, the median pair being only slightly more than half as long as the others. All spines on body, and spines and fringes on wings conspicuously dark brown; abdomen dusky yellow, dark brown at extreme tip.

Redescribed from one female, "Type" of Miss Beach.

Male unknown.

Food plant.—Aster.

Habitat.—Ames, Iowa.

This species bears a close general resemblance to *Euthrips tritici*, with which it was taken.

Genus EUTHRIPS Targioni-Tozzetti.

PHYSOPUS.^a

Ocelli usually present but sometimes more or less rudimentary. Antennae eight segmented. Maxillary palpi three segmented. Pro-

^aThe name *Physopus* was used by Amyot and Serville for this genus in 1843, but it can not hold, as this name was previously used by Leach for a genus of the Neuroptera in 1817.

I have been unable to see Targioni-Tozzetti's characterization of his genus *Euthrips*, but as nearly as I can tell it may include the species which have been placed in the genus *Physopus*, and I therefore adopt it for this genus.

thorax as long or somewhat longer than the head, with two long spines upon each hind angle and one similar spine upon each anterior angle in many species, but this is wanting in others. Legs usually unarmed, but in a few species with a stout tooth on under side of fore tibia at end. Wings usually fully developed but sometimes reduced. When present they are moderately broad, have two longitudinal veins which are set with numerous stout spines at regular intervals in those species having a spine at the fore angle of the pronotum. Spines upon abdomen moderately stout; anal spines long and slender.

These species are active and can spring.

SYNOPSIS OF SPECIES.

1	{General color of body yellow	2.
	{General color of body brown	3.
2	{Fifth antennal segment about five-sixths as long as fourth	<i>occidentalis</i> (p. 152).
	{Fifth antennal segment about two-thirds as long as fourth	<i>tritici</i> (p. 148).
3	{Antennæ about three times as long as head	<i>fuscus</i> (p. 154).
	{Antennæ but slightly more than twice as long as head.....	<i>neruosus</i> (p. 155).

EUTHRIPS TRITICI (Fitch).

WHEAT THRIPS.

Plate IV, figs. 36-39.

Thrips tritici FITCH, Count. Gent., VI, Dec. 13, 1855, p. 385.

Thrips tritici FITCH, Rept., II, Nox. Ins. N. Y., 1857, pp. 304-308.

Thrips tritici ASHMEAD, Orange Insects, 1880, p. 72.

Thrips tritici OSBORN, Canad. Entom., XV, 1883, pp. 152, 156.

Thrips tritici OSBORN, Trans. Iowa St. Hort. Soc., XVIII, 1883-1884, pp. 520-521;
Coll. Bull., 2, Iowa Agr. College, 1885, pp. 96, 97.

Thrips tritici HUBBARD, Ins. Affect. Orange, 1885, p. 164, fig. 77, pl. xi, fig. 5.

Thrips tritici FORBES, Centralia, Ill., Sentinel, 1887; Prairie Farmer, June 4, 1887.

Thrips tritici LINTNER, Cult. and Count. Gent., LII, June 9, 1887, p. 459.

Thrips tritici WEED, Prairie Farmer, LIX, 1887, p. 343; Trans. Ill. St. Hort. Soc.,
1887, pp. 230-233.

Thrips tritici OSBORN, Insect Life, I, 1888, p. 141.

Thrips tritici WEED, Popular Gardening, III, 1888, p. 176.

Thrips sp. COMSTOCK, Bull. XI, Cornell Agr. Exp. Sta., 1889, p. 131.

Thrips tritici RILEY-HOWARD, Insect Life, I, 1889, p. 340.

Thrips tritici FORBES, 16th Rept. St. Entom., Ill., 1890, p. ix, pl. v, fig. 4; 17th
Rept. St. Entom., Ill., 1891, pp. xiii, xv.

Thrips tritici WEED, Ins. and Insecticides, 1891, p. 95.

Thrips tritici FORBES, Insect Life, V, 1892, pp. 126, 127.

Thrips tritici WEBSTER, Bull. 45, Ohio Exp. Sta., 1892, pp. 207, 208.

Thrips tritici TOWNSEND, Canad. Ent., XXIV, 1892, p. 197.

Thrips tritici BRUNER, Rept. Nebr. St. Bd. Agr., 1893, (1893), p. 457, fig. 96.

Thrips tritici BRUNER, Nebr. St. Hort. Rept., 1894, (1894), pp. 163, 214, fig. 82.

Thrips tritici ASHMEAD, Insect Life, VII, 1894, p. 27.

Thrips tritici CRAW, 4th Biennial Rept. St. Bd. Hort., Calif. for 1893-94, 1894,
p. 88.

Thrips tritici WEED, Ins. and Insecticides, 1895, p. 146.

Thrips tritici UZEL, Mon. d. Ord. Thysanoptera, 1895, pp. 220, 278.

Thrips tritici SMITH, Economic Entom., 1896, p. 102, fig. 73.

Thrips tritici LINTNER, 11th Rept. N. Y. St. Entom., 1896, pp. 247-250.

Thrips tritici ROLFS, 10th Ann. Meet. Fla. St. Hort. Soc., 1897, p. 97.

Thrips tritici QUAINANCE, Bull. 42, Fla. Agr. Exp. Sta., 1897, pp. 552-564.

Thrips tritici POWERS, Fla. Farmer and Fruit Grower (editorial), March 27, 1897.

Thrips tritici QUAINANCE, Bull. 46, Fla. Agr. Exp. Sta., 1898, pp. 77-103, figs. 1-9.

Thrips tritici HOWARD, Bull. 18, N. S., U. S. Dept. Agri., 1898, p. 101.

Thrips tritici ROLFS, 11th Ann. Meet. Fla. St. Hort. Soc., 1898, pp. 34-38.

Female.—Length about 1.22 mm.; width about 0.26 mm. (General color brownish yellow, thorax tinged with orange.

Head three-fourths as long as broad and four-fifths as long as prothorax, but slightly withdrawn therein; cheeks but slightly arched behind the eyes and converging slightly posteriorly; anterior margin very nearly straight; back of head transversely striated. Eyes large, dark, and slightly pilose, occupying together about three-fifths the width of the head; ocelli present, sub-approximate, pale yellow, margined inwardly with bright reddish orange crescents; spines between ocelli on each side long and conspicuous; post-ocular spines shorter. Maxillary palpi three segmented. Antennæ nearly two and one-half times as long as the head; relative lengths of segments:

1	2	3	4	5	6	7	8
$\frac{1}{6}$	$\frac{2}{8.7}$	$\frac{3}{13}$	$\frac{4}{12.3}$	$\frac{5}{8.8}$	$\frac{6}{12.5}$	$\frac{7}{2.2}$	$\frac{8}{4}$

Color: One pale yellow; two light brown, base sometimes yellowish; three light yellow in basal half, remainder shaded light brown; four and five brown, yellowish at bases; six, seven, and eight brown. Spines upon antennal segments, especially two to five, quite stout and conspicuous.

Prothorax rather rounded, three-fourths as long as broad; one pair of stout spines at each angle, also one short anteriorly directed spine standing close to lower one of each fore pair; between each posterior pair and median line stands a row of five spines, number four alone being large; color of prothorax pale orange-yellow. Mesothorax rounded at anterior angles; mesonotal plate with one stout spine at each lateral angle and two pairs of small spines on posterior margin. Metathorax tapering but slightly posteriorly; metanotal plate bearing four spines close together at anterior edge, the middle pair being much more stout and conspicuous. Wings nearly reaching the end of abdomen; breadth at middle about one-twelfth their length; shaded but slightly; each fore wing has two longitudinal veins extending from base to tip of wing; spines on veins at regular intervals; costa twenty-six to twenty-eight; fore vein twenty to twenty-two; hind vein fifteen to eighteen; scale five, interior of scale one; a light, sparse fringe on costa of each wing; posterior fringes heavy and wavy. Legs clear pale yellow, sometimes slightly shaded with light brown above, quite thickly set with short brown spines; a pair of stout spines at extremity of each tibia; rows of spines on inner side of hind tibiae rather weak.

Abdomen cylindrical-ovate, pointed at the apex; dark brown stripe across segments two to seven near their anterior edges; dorsal plates, except nine and ten, shaded more or less with brown; three or four moderately stout brown spines stand out prominently upon the pale yellow sides of segments two to eight; terminal spines long, stout, and dark colored; tip of abdomen dark brown.

Redescribed from eight females.

Male.—Length about 0.7 mm. (0.64 to 0.80 mm); width of mesothorax 0.195 mm. (0.18 to 0.22 mm.). General color pale yellow, darkest upon pterothorax.

Eyes somewhat smaller than those of female. Antennæ about two and one-third times as long as the head. Relative lengths of segments as follows:

1	2	3	4	5	6	7	8
4.3	8	11	10.3	7.9	10.1	1.6	2

Wings large and reaching beyond the tip of the abdomen. End of abdomen (ninth segment) bluntly conical; tenth segment retracted and not reaching the tip of the ninth; nine bears four pairs of long, stout, dark spines, of which one pair stands on each side near the anterior end of the segment, and one pair on each side near the tip; near the middle above stand two short spines.

Described from four specimens.

Food plants.—Alfalfa, apple, asparagus, aster (cultivated), bindweed, blackberry, buttercup, canna, cherry, clover, cone-flower, dandelion, dog-tooth violet, English pea, goldenrod, grasses, hardhack, heal-all, heliotrope, honeysuckle, hydrangea, lilies, mesquite, orange, pea, peach, pear, pink, plum, potato, raspberry, red clover, rose, shrubby *Althea*, smartweed, *Solidago bicolor*, *Spiranthes simplex*, squash, strawberry, sunflower, sweet william, wheat.

Habitat.—California, District of Columbia, Florida, Illinois, Iowa, Massachusetts, New Hampshire, New Jersey, New Mexico, New York.

The following descriptions of early stages are taken from Quaintance:^a

Egg.—Size 0.25 by 0.1 mm.; clear whitish in color; oblong, curved in shape.

Larva, first stage.—Length about 0.5 mm.; width of thorax nearly 0.1 mm.; body fusiform, gradually tapering caudad from fifth or sixth abdominal segment. Color, clear whitish; eyes reddish. Antennæ distinctly four-jointed; basal joint cylindrical, short; second somewhat urn-shaped, with distinct distal rim, about as long as broad; third joint conical, apex of cone united to second; fourth fusiform, widest near basal fourth, quite as long as other three joints together. Joints two, three, and four ringed, two and three rather obscurely, but on fourth joint the rings are quite pronounced, where, on distal part, they

^aBull. 46, Fla. Exp. Sta.

appear to divide the joint into short, cylindrical segments. On the fourth joint the rings are minutely setate. Numerous large setæ are also present on all joints, most numerous on fourth. Legs stout; hind femur about as long as tibia; tarsus one-jointed, terminating in claw-like fork; bladder-like expansion of adults apparently wanting. Abdomen composed of ten segments, marked dorsally with four longitudinal rows of setæ and a row on each side. All of these setæ appear to be somewhat enlarged and rounded distally, except one pair on dorsum of last segment. On tenth segment these setæ are quite long, being from two to four times longer than the others.

Larva, second stage.—Length about 1 mm.; width of thorax about 0.22 mm.; shape about as in stage one. Color of body deep orange yellow; legs and antennæ lighter; eyes reddish; antennæ four-jointed, as in first stage; basal joint short, cylindrical, about one-half as long as wide; second, subcylindrical, somewhat longer than wide; third, subconical, about a third longer than wide; fourth, about as long as proximal three together, fusiform, thickest about basal fourth. Joints three and four plainly ringed, the rings of fourth joint quite distinct and minutely setate, as in first stage. Large setæ are also present about as in stage one. Femur of hind legs about as long as tibia; tarsus one-jointed, somewhat forked distally, and bearing a membranous expansion.

Nymph or pupa, young nymph.—Resembles the full-grown larva in shape; in color it is much lighter, being light yellow, with legs, antennæ, and wing-pads still lighter. Eyes reddish.

In the antennæ, legs, and wing-pads the nymph skin appears somewhat as a sheath to these parts of the forming adult. The antennæ are three or four jointed, apparently, thick and clumsy. The basal joint is large, swollen, slightly longer than wide; the second is about twice as long as wide and somewhat constricted in middle. Third joint is about a third longer than second, gradually tapering distally to an obtuse end. When the nymph stage is first entered the antennæ project cephalad in normal position. In six or eight hours, however, they are laid back over the head and prothorax. In the hind legs, femur and tibia of about equal length; tarsus indistinctly one-jointed, very short, and rounded distally. Wing-pads short, scarcely reaching caudal end of second abdominal segment, bearing one or two setæ. Abdomen as in larva, with dorsal and lateral rows of setæ, which, however, are acute. On the dorsum of ninth segment, near caudal margin, are four stubby, hook-like processes, curving cephalad, which appear to be the four modified setæ of this region.

Mature nymph.—Length about 1 mm.; width of thorax about 0.22 mm.; color light yellow; shape very similar to that of adult Thrips. Nymph skin more or less separated from the body of the adult within, particularly so in the legs, antennæ, mouth-parts, wing-pads, and

caudal end of abdomen. The wing-pads reach to about the sixth segment.

Life history.—The life cycle of *Thrips tritici* is quite short, requiring but twelve days. Eggs are deposited in the tissues of infested plants, and hatch in three days. The larval state lasts for about five days, during which time the insect makes two molts, the second when entering the nymph stage. The nymph stage continues for about four days, during which time they take no food, rarely move to any extent, but remain hidden away.

Economic considerations.—This is one of the most widely spread and generally injurious species in this country. The specimens from which Fitch described the species were taken at Geneva, Wisconsin, from a wheat field which was being injured by the little pests. At various times it has been noticed swarming in the blossoms of orange and causing injury thereto. It is a very common species on a large number of flowering plants, both wild and cultivated, but unless present in great numbers their injuries are likely to pass unnoticed. By far the greatest damage appears to be done to strawberries, in the blossoms of which they swarm, and by their punctures of the essential parts of the flower they prevent its fertilization and the consequent development of the fruit. This failure of bloom, though perhaps produced at times by other insects and in other ways, is known to growers as "buttoning." The most serious injuries have been reported from Florida and Illinois. In Florida the strawberry crop in some sections has been reduced to one-third in dry seasons.

EUTHRIPS OCCIDENTALIS Pergande.

Thrips sp. COQUILLETT, *Ins. Life*, IV, 1891, p. 79.

Euthrips occidentalis PERGANDE, *Ins. Life*, VII, 1895, p. 392.

Female.—Length about 1 mm.; width at mesothorax about one-fourth the body length. General color head pale lemon yellow, thorax orange yellow, abdomen brownish yellow.

Head about one and one-third times as broad as long, three-fourths as long as the prothorax and considerably withdrawn into the latter. Eyes rather large, occupying together about three-fifths the width of the head, dark, slightly pilose; ocelli subapproximate, pale yellowish, margined with reddish orange crescents; one very prominent spine between ocelli on each side; post-ocular spines very conspicuous. Maxillary palpi three segmented. Antennæ about two and one-half times as long as the head; first segment slightly shorter than the style; two is one and one-half times as long as one; three is longest; four is six-sevenths as long as three; five is five-sixths as long as four; six nearly as long as three; seven very short, about one-fourth as long as five; eight is one and three-fifths times as long as seven. Color of one translucent whitish; two brownish yellow (uniform), basal parts of

three, four, and five pale yellowish; apical parts shading quite abruptly to light brownish; six uniformly brown; style slightly lighter than six. Spines upon antennal segments, especially two to four, are unusually stout and prominent.

Prothorax nearly one and one-third times wide as long; color intermediate between that of head and pterothorax. One pair of prominent, stout spines at each angle; one short anteriorly directed spine close to the lower one of each fore pair; a row of five small spines (the fourth is stoutest) stands on each side of hind margin between pair at angle and median line. Anterior angles of mesothorax rounded; metathorax slightly narrower than mesothorax, its sides nearly straight and parallel; mesonotal plate bears one stout spine at each lateral angle and two pairs of small spines on posterior margin; metanotal plate bears two pairs of spines close to anterior edge, the middle pair being much the stouter; color of pterothorax bright orange. Wings very slightly yellowish; both longitudinal veins extend from base to tip of wing; both internal and the costal veins bear very stout, brown spines set at regular intervals; costa twenty-four to twenty-six, fore vein nineteen to twenty-two, hind vein fifteen to eighteen, scale five, internal on scale one. Fringe upon costal edge is very light, that upon hind edge is long and wavy; cross veins can sometimes be seen between the longitudinal veins and between the fore and costal veins at about two-fifths their length from base and sometimes a third at about four-sevenths between the fore and costal veins. Legs uniformly concolorous with head, bearing numerous small spines; a pair of strong spines at inner side of tip of each tibia.

Abdomen elongate-ovate in outline, conical at apex; a transverse, narrow, brown band extends across anterior part of segments three to seven; brownish tinge on abdomen fades behind sixth segment leaving only the apex of the cone brown; a group of three or four stout spines stands upon each side of segments two to eight; terminal spines long, stout; all spines brown.

Male.—Length about 0.65 mm.; width about 0.17 mm. Lighter in color than the females; nearly a uniform lemon yellow, slightly darker on throat; form more slender; apex of abdomen blunt, terminated on sides by two pairs of long, stout, inward curving spines; ninth segment also bears two pairs of very long, stout spines near its posterior border and near the dorsal line on this segment is a pair of short spines; the brown bands across the abdomen of female are wanting in males and they have fewer spines on sides of segments; the bright orange-colored testes are very prominent.

Food plants.—Apricot, orange, potato, and various weeds.

Habitat.—California.

Redescribed from specimens at the U. S. Department of Agriculture, Division of Entomology—presumably types.

Remarks. This species is very similar to *Euthrips tritici* (Fitch), but it has a longer though more retracted head, which is also slightly wider; the terminal segment of the antenna is one and three-fifths times as long as seven; spines on body stouter and more prominent. Both *Euthrips tritici* and *Euthrips occidentalis* approach very closely to *Physopus nigricentris* Uzel.

EUTHRIPS FUSCUS, new species.

Plate IV, figs. 40, 41.

Female.—Length 0.93 mm. (0.70 to 1.08 mm); width of mesothorax 0.21 mm. (0.18 to 0.24 mm.). General color brown. In dark specimens the abdomen is blackish brown; in light specimens the general color is yellowish brown.

Head about one and one-half times as wide as long, about one-fourth retracted into prothorax; occiput deeply wrinkled transversely; anterior margin of head slightly and smoothly elevated in middle; cheeks straight and parallel. Eyes moderately large, occupying together about one-half the width of the head, dark, slightly protruding; margins pale yellow; ocelli smaller than facets of eye, pale yellow, margined with dark red, widely separated, posterior ones contiguous with yellow margins around eyes; one stout spine in front of each posterior ocellus. Mouth cone short and tapering abruptly; maxillary palpi slender, three segmented. Antennæ inserted a little below the margin, about three times as long as dorsal length of head; relative length of segments:

1	2	3	4	5	6	7	8
5.5	8.8	10.4	10.2	9	11.7	2.3	3.3

First segment rounded, one-third broader than long; two is cup-shaped; three to six subequal in thickness; three to five somewhat clavate; three with very slender peduncle; six cylindrical-ovate. Antennæ quite uniformly brown (sometimes three, four, and five lighter gray-brown, especially at bases), only segment three somewhat more yellowish; spines on segments two to five quite stout and dark colored. Color of head uniform grayish to orange-brown.

Prothorax fully one and one-half times as wide as long and one and two-fifths times as long as the head; sides arched; angles rounded; wider behind than in front; one large curved spine at each anterior angle and another on anterior margin between this and the median line; two stout spines at each posterior angle, the inner one of which is much the weaker; also a stout spine on the posterior edge between the pair and the median line; other spines on prothorax small and not conspicuous. Mesothorax but very little wider than the prothorax; projecting prominences at anterior angles; mesonotum broad, without

prominent spines; posterior edge nearly straight for one-third the width of the segment; metathorax narrows abruptly after the anterior edge till narrower than prothorax, then sides run nearly parallel to abdomen; mesonotum with two pairs of spines near anterior edge, the outer one of each pair being much less stout than the inner one; mesothorax and metathorax together not longer than the prothorax. Wings reduced, barely reaching to the first abdominal segment; pads set with several stout spines. Legs of medium length and of moderate size, quite thickly set with short bristles, concolorous with, or usually lighter than body; bases of posterior femora and inner sides of posterior tibiae more yellowish; thorax colored nearly like head.

Abdomen one and one-half times as wide as the mesothorax (short-winged female) and twice as long as broad, or nearly twice as long as head and thorax together; elliptical in outline except that apex is conical; broad, dark bands cross the abdomen at the anterior edge of dorsal plates on segments two to eight. Each segment except one and ten bears two or three short, stout spines on sides; in addition to these nine bears a circle of eight unusually long, strong spines, and ten also bears a circle of six long spines though these are somewhat shorter than those on previous segment. Segment ten is split open above; color of abdomen yellowish brown to brown-black, usually considerably darker than head and thorax; segments usually more or less telescoped.

Described from eighteen short winged females taken in hibernation in February and November.

Cotype.—Cat. No. 6328, U.S.N.M.

Food plant.—Grass?

Habitat.—Massachusetts.

Life history unknown.

EUTHRIPS NERVOSUS (Uzel).

Plate III, figs. 33, 34; Plate IV, fig. 35.

Physopus nervosa UZEL, Monographie d. Ord. Thysanoptera, 1895, p. 102.

Thrips (Euthrips) maidis BEACH, Proc. Iowa Acad. Sciences, 1895, III (1896), pp. 219, 220.

Female.—Length 1.33 mm. (1.22 to 1.39 mm.); width of mesothorax 0.32 mm. (0.28 to 0.34 mm.). General color dark yellowish brown.

Head somewhat pentagonal in form, not as long as wide; cheeks straight and converging slightly posteriorly; front broad and obtusely angular; back of head transversely wrinkled and bearing a few minute spines. Eyes rather small, black with light yellow borders, rounded or oval in outline; ocelli yellow, widely separated, posterior ones contiguous with light borders around eyes; one very long slender spine on each side midway between ocelli. Mouth cone pointed, tipped

with black; maxillary palpi three segmented. Antennae slightly more than twice as long as head and very slender beyond second segment; comparative lengths of segments as follows:

1	2	3	4	5	6	7	8
6	10	14	12.5	11.4	15.3	3	4

Color of antennae dark brown, except segments three and four and extreme base of five abruptly yellow. Spines on first segments quite dark and conspicuous, becoming paler and more indistinct toward the tip.

Prothorax approximately as long as head and a little wider, almost rectangular in form, bearing many prominent spines; one at each fore angle and two at each hind angle are longest; one half way between fore angle and median line on front margin and one similarly placed on hind margin are intermediate in size; numerous others are smaller. Color of head and prothorax dark brown. Mesothorax approximately as wide as length of antenna; front angles obtusely rounded; metanotal plate bears four spines close to front edge, the middle pair being large and prominent, the others small; pterothorax yellowish brown. Wings present, fully as long as the abdomen, about one-twelfth as broad as long, sharply pointed at ends; surface of wings thickly covered with minute, dark-colored spines; both longitudinal veins and costa of fore wing thickly and regularly set with quite long, dark-colored spines; costa has from twenty-five to twenty-nine, fore vein from sixteen to twenty-two, hind vein from fourteen to sixteen; fore wings shaded with gray; veins not prominent; costal fringe of fore wings weak and less than twice as long as costal spines. Legs moderately long, not thickened; femora dark brown, yellow at extremities; tibiae and tarsi yellow; tibiae shaded more or less with brown around middle and tarsi with prominent dark brown spot at tip within; each tibia with a pair of prominent, dark brown spines at tip within and a row of from five to seven short brown spines on inner side of hind tibiae.

Abdomen about two and one-half times as long as width of mesothorax, somewhat cylindrical in shape, but enlarging from base to hind edge of second segment and tapering evenly from eighth segment to tip. Spines along sides and around tip of abdomen very dark brown and conspicuous; those on segments nine and ten are long and subequal on both segments. Color of abdomen dark brown, shading toward tip; connective tissue yellow; last segment split open above.

Redescribed from six females; no males found. Compared and identified with *Thrips (Euthrips) maidis* Beach.

Food plants.—Corn, various grasses (first spring flowers, Uzel).

Habitat.—Bohemia (Uzel); Ames, Iowa; Amherst, Massachusetts.

Life history unknown, except that it hibernates in turf.

SCOLOTHRIPS, new genus.

Head wider than long, retracted considerably into prothorax. Eyes protruding; ocelli present. Maxillary palpi three segmented. Antennæ short and thick; sense cones very long. Prothorax slightly longer than head and somewhat broadened posteriorly. Spines arranged as follows: One at each anterior angle, one halfway between these angles and the median line, one at the middle of each side, two at each hind angle, and one between this pair and the middle of the hind margin. Wings present, slender, with two longitudinal veins and ring vein strongly developed; fore fringe very weak but spines on veins very strong. Intermediate abdominal segments with one spine on each side at the hind angle.

This genus is erected for the species *6-maculatus*.

(σκαλωσ, prickly or thorny; θρυψ.)

SCOLOTHRIPS 6-MACULATUS (Pergande)

Plate IV, figs. 42-45.

Thrips 6-maculata PÉRGANDE, Trans. St. Louis Acad., V, 1894, p. 542.

Thrips pallida BEACH, Proc. Iowa Acad. Sciences, 1895, III, (1896), pp. 226-227.

Female.—Length, 0.83 mm. (0.72 to 0.97 mm.); width of mesothorax, 0.21 mm. (0.18 to 0.25 mm.). General color clear pale yellow.

Head about three-fourths as long as wide, frequently considerably retracted within prothorax, even to the eyes sometimes; cheeks straight and parallel; front margin rounded; vertex elevated between the eyes. Eyes large, protruding; posterior ocelli nearly contiguous with margins of eyes; one very long, backwardly curved spine stands in front of each posterior ocellus, and two pairs of curved spines stand upon the margin in front. Maxillary palpi slender, three segmented; labial palpi very long and slender. Antennæ rather short and compact; inserted below front margin; approximate at base, relative lengths of segments:

1	2	3	4	5	6	7	8
4.2	7	7.4	6.7	6.1	9	2.5	3.5

Segment one cylindrical, about two-thirds as thick as two, which is more rounded; seven and eight rather thick. Color of one and two nearly white, the remainder almost uniformly dusky gray; spines on segments two to five long and prominent as are the sense cones; the sense cone on the inner side of six arises below the middle of the segment and reaches beyond the end of the seventh.

Prothorax slightly longer than the head, but only about three-fourths as long as wide, broadened somewhat posteriorly and rounded at hind angles, sides curving gently inward anteriorly; spines extremely long and slender, arranged as follows: One at each anterior angle, one half

way between these and the median line, one at middle of each side, two at each hind angle; and one between this pair and middle of hind margin. Mesothorax about one and one-third times as wide as the prothorax, with one slender spine at middle of each side. Wings long, reaching nearly to tip of abdomen, at middle about one-seventeenth as broad as long, pointed at tips. Fore wing with two longitudinal veins and a very heavy ring vein; hind longitudinal vein branches from the fore vein at about one-third the length of the wing. Spines upon costal and both longitudinal veins very long and stout, fully equaling those upon the anal segments; costal vein bears from fifteen to twenty, fore vein from nine to eleven, hind vein five or six (the third and fourth spines, sometimes the second also, which I have counted as standing upon the fore vein, stand at the same angle to the wing as do those upon the hind vein and really belong thereto, though the veins have united); the front fringe of the fore wings is extremely sparse, short and weak, and does not extend to the tip; hind fringes also unusually short. Fore wings are characterized by three light brownish spots on each—one at base of wing, one immediately beyond separation of longitudinal veins, and the third halfway from the second to the tip of the wing (the third is a band extending clear across the wing). Legs concolorous with body, sparsely set with slender spines.

Abdomen cylindrical-ovate, pointed at extremity, surface smooth; only one spine of any prominence at posterior side angles of segments two to eight; spines upon segments nine and ten not as strong as those upon the wings; color nearly uniformly pale yellow without prominent markings.

Redescribed from ten specimens.

Male. Male smaller than female, but otherwise agreeing very closely with the foregoing description. Abdomen bluntly conical at tip; tenth segment partially retracted within ninth, which is cut out in last half above the tenth; spines borne on top and sides of nine are shorter and weaker than those on wings.

Described from one specimen.

Food plants.—"Found on many plants infested with red spider, on which it has repeatedly been observed to feed."—Pergande. "Feeding on mites in fold of cottonwood leaf."—Bruner. Taken on bean, blackberry, elm, and hop.—Beach.

Habitat.—Missouri?; Ames, Iowa; Barraboo, Wisconsin; Lincoln, Nebraska.

Thrips pallida Beach is positively identical with this species, as has been learned from an examination of her types.

Genus RAPHIDOTHrips Uzel.

Ocelli present. Antennæ eight segmented; the fifth segment short and cut off abruptly at the end so that it joins the base of the sixth by an unusually broad surface; style very slender, composed of two equally

long segments, which are together as long as are the fifth and sixth. Maxillary palpi three segmented. Prothorax a little longer than the head and somewhat broader at the hind than at the fore edge; no long spine at the front angles, but two at each hind angle. Legs unarmed. Wings usually reduced, but when present they are of medium length, and have two longitudinal veins which are set with small spines.

I find here only the new species *fuscipennis*.

RHAPHIDOTHRIPI FUSCIPENNIS, new species.

Plate V, figs. 46-48.

Female.—Length 1.32 mm. (1.20 to 1.66 mm.); width of mesothorax 0.24 mm. (0.22 to 0.27 mm.). General color nearly uniform chestnut brown.

Head as long as wide, but little shorter than prothorax, into which it is retracted a little; anterior margin slightly elevated and rounded; constricted a bit close behind the eyes; cheeks nearly straight behind the constriction and diverging slightly posteriorly so the head is widest at hind edge; back of head finely striated. Eyes quite large, rounded, protruding; margins light; ocelli present, larger than facets of eye, light colored with dark crescentic margins, well separated, but posterior ones not contiguous with margins around eyes; ocellar spines very long and conspicuous; post-ocular spines quite large. Mouth cone extending back to anterior edge of mesosternum, slender, so that head from below appears considerably elongated; labial palpi small; maxillary palpi quite long, slender, and three segmented. Antennae twice as long as head; relative lengths of segments:

$\frac{1}{5.8}$	$\frac{2}{9}$	$\frac{3}{11}$	$\frac{4}{10.3}$	$\frac{5}{6.25}$	$\frac{6}{10.5}$	$\frac{7}{8.2}$	$\frac{8}{8.25}$
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First segment shortest, cylindrical; second cup-shaped; third pedicellate; third, fourth, and sixth are approximately equal in thickness; third and fourth elliptical; fifth constricted at base and increasing in size to apex, where it is cut off abruptly and unites by its entire width to the equally broad base of sixth, which tapers gradually from one-third its length to its apex, where it is but slightly wider than seventh; seventh and eighth slender, cylindrical. Color: First and second uniformly slightly lighter brown than head; third and fourth pale yellow with slight brownish tinge; fifth shading from color of fourth to a little lighter than sixth; sixth, seventh, and eighth gray-brown; spines long and fairly conspicuous.

Prothorax slightly wider than long, widest at posterior angles; sides but slightly arched; no prominent spines at anterior angles; two stout spines stand close together at each posterior angle; surface finely striated and set with a few scattered small spines; bases of spines light

yellowish; pronotum frequently extending considerably over front edge of mesonotal plate. Mesothorax about one and one-third times as wide as the prothorax and considerably wider than metathorax, except at its anterior edge; anterior angles of mesothorax very acute; no conspicuously large spines upon pterothorax. Wings sometimes reduced; when present, long and about one-thirteenth as broad in middle as long; fore wings shaded with gray, pale brownish along veins, clear at base; second longitudinal vein arises at about two-fifths the length of the wing, its origin indistinct. Spines upon all veins quite long and slender, but not thickly set or very conspicuous; costa bears seventeen to nineteen, fore vein eight or nine, hind vein eight or nine. Wing pads, when present, not overreaching the pterothorax. Legs moderately strong, but not thickened; femora and tibiae dark brown like body; inside of fore tibiae, extreme tips of the others and all tarsi pale gray or yellow; legs scatteringly set with fine spines, apex of hind tibiae alone bearing a pair of stouter spines.

Abdomen very long—almost twice as long as head and thorax together—and three times as long as broad, nearly cylindrical, tapering abruptly from anterior edge of eighth segment to the apex; segments overlapping more or less when abdomen contains no eggs; color uniform dark brown without conspicuous markings or spines except those upon two terminal segments, which are quite long and slender.

Described from six females, five of them long-winged.

Collype.—Cat. No. 6329, U.S.N.M.

Male unknown.

This species agrees very closely in most respects with *R. longistylus* Uzel, but differs in the following points: Head as wide as long; second antennal segment somewhat shorter than third, fourth, and sixth; fifth segment lighter colored at tip than sixth. Body length, average (exclusive of egg-filled females), 1.25 mm.

Food plant.—Grass.

Habitat.—Massachusetts.

Life history unknown.

Genus ANAPHOTHRIPS Uzel.

Ocelli present. Antennae eight segmented (apparently nine in *A. striatus*). Maxillary palpi three segmented. Prothorax about a long as head. Legs unarmed. Wings usually present (usually absent in the fall generations of *striatus*), with two longitudinal veins; spine upon veins small and inconspicuous. No stout spines at angles of prothorax; all spines on body short except the anal spines, which are short and slender (in *striatus* they are short and stout).

Males have usually two pairs of very short, stout spines upon the ninth abdominal segment above, of which the anterior pair is stronger than the posterior.

Species of this genus have no power of springing.

In this genus I find only the species *striatus*.

ANAPHOTHRIPS STRIATUS (Osborn).

GRASS THRIPS.

Plate V, figs. 49-51.

Limothrips poaphagus COMSTOCK, Syllabus of Course of Lectures at Cornell and Peoria, 1875, p. 120.

Limothrips poaphagus LINTNER, Rept. N. Y. Agr. Soc., 1881-82.

Thrips striata OSBORN, Can. Ent., XV, 1883, p. 155.

Limothrips poaphagus FERNALD, Grasses of Maine, 1885, p. 42.

— — N. E. Farmer, June 19, 1886.

— — LINTNER, 3d Rept. Ins. N. Y., 1887, pp. 96-98.

Limothrips poaphagus COMSTOCK, Introd. to Ent., 1888, p. 127.

Thrips striatus PACKARD, Ent. for Beginners, 1888, p. 73.

— — FLETCHER, Ent. Amer., IV, 1888, p. 152.

— — HOWARD, Ent. Amer., IV, 1888, p. 152.

Limothrips poaphagus OSBORN, Ins. Life, I, 1888, p. 140.

Thrips striatus PACKARD, Stand. Nat. Hist., 2d ed., II, Append., 1888.

— — FLETCHER, 19th Rept. Ent. Soc. Ont., 1888, p. 11.

— — FLETCHER, Ann. Rept. Exp. Farms, 1888, pp. 59-62.

Limothrips poaphagus LINTNER, Rept. N. Y. Agr. Soc., 1888.

Phlocothrips poaphagus FLETCHER, 20th Rept. Ent. Soc. Ont., 1889, pp. 2, 22.

— — BRODIE, 20th Rept. Ent. Soc. Ont., 1889, p. 8.

Limothrips poaphagus LINTNER, 5th Rept. N. Y. St. Ent., 1889, pp. 153, 304.

— — OSBORN, Can. Ent., XXIII, 1891, pp. 93, 96.

— — FLETCHER, Ins. Life, V, 1892, p. 124.

— — FORBES, Ins. Life, V, 1892, p. 127.

— — FLETCHER, Ann. Rept. Exp. Farms, 1892, p. 3.

Limothrips poaphagus COMSTOCK, Man. for Study of Ins., 1895, p. 120.

Limothrips poaphagus UZEL, Mon. d. Ord. Thysanopt., 1895, pp. 279, 435, 446, 448.

Thrips striata UZEL, Mon. d. Ord. Thysanopt., 1895, p. 220.

— — HOPKINS-RUMSEY, Bull. 44, W. Va. Agr. Exp. Sta., 1896, pp. 270, 271.

— — SMITH, Economic Ent., 1896, p. 102.

— — PUTNAM, N. E. Farmer, July 2, 1898.

Anaphothrips striata HINDS, 37th Ann. Rept. Mass. Agr. College, 1900, pp. 81-105, 4 pls., 33 figs.

Anaphothrips striata FERNALD and HINDS, Bull. 67, Mass. Agr. Exp. Sta., 1900, pp. 3-9, pl. I, figs. 1-6.

Female.—Length 1.3 mm. (1 to 1.6 mm.); width of mesothorax 0.25 mm. (0.23 to 0.26 mm.). General color yellow, with more or less dusky or brownish shading upon some parts.

Head very slightly wider than long, rounded in front; cheeks straight and parallel; surface back of eyes faintly striated; head yellow with brown posterior border, without long spines. Eyes small, rounded, black or very deep purplish red; ocelli subapproximate, yellow, with orange-red margins. Mouth cone moderately sharp, and very prominently tipped with black; maxillary palpi three segmented. Antennae approximate, about twice as long as head, eight segmented, though

apparently nine segmented, owing to the division of the sixth segment by an oblique suture at about three-fourths its length. Relative lengths of segments:

1	2	3	4	5	6	7	8
5	8.5	11	10	10	9.5+3.5	2.25	3.25

Segments one and two rounded; three to six fusiform. One is pale, almost white; two light brown; three lighter than two; three to six shading gradually to dark brown, almost black; spines pale and not conspicuous.

Prothorax but slightly longer and a little wider than the head; sides rounded slightly and without prominent spines. Mesothorax much wider than prothorax; fore angles obtusely rounded. Metathorax quite smoothly joined with mesothorax and tapering gradually to base of abdomen. Wings usually present in summer generations, reduced to mere pads in hibernating females; when present, approximately as long as abdomen, about one-thirteenth as broad as long and tapering gradually; two longitudinal veins in fore wing extending from base to tip; veins quite prominent, being darker than rest of wing. All veins bear a few very small, rather indistinct spines; fringe on fore edge well developed, being nearly half as long as posterior fringe. Fore wings shaded with yellowish gray; hind wings nearly white. Legs of medium length and size; stout spines only on inner side and at tip of hind tibiae; legs pale yellow shaded with light gray or brown above on femora and tibiae, and with prominent dark brown spot at tip of tarsi within. Pterothorax darker yellow than rest of body, with row of irregular dusky spots on each side close to middle, curving outwardly at both ends.

Abdomen quite long, cylindrical, widening somewhat at first two segments and tapering from eight to tip; eight to ten sharply conical. Spines on nine and ten short and weak, but dark-colored and quite conspicuous; other spines on abdomen small, pale, and indistinct. Abdomen pale yellow; segments one to seven slightly dusky on top, segment ten shading to dark brown at tip.

Redescribed from six long-winged and four short-winged females. Male unknown.

Food plants.—*Poa pratensis* and *Phleum pratense*.

I have also found genuine "silver top" upon the following list of grasses at Amherst, Massachusetts, but I can not positively connect this species with all the injury: *Poa serotina*, *P. nemoralis*, *P. compressa*, *P. arachnifera*, *P. fletcheri*, *P. aquatica*, *P. trivialis*, *P. cæsia*, *Agrostis alba*, *A. canina*, *A. stolonifera*, *A. vulgaris*, *Festuca olcoll*, *F. heterophylla*, *F. datur*, *F. ovina*, *F. duriuscola*, *F. rubra*, *Panicum crus-galli*, *P. sanguinale*, *Elymus striatus*, *E. virginicus*, *Bromus erectus*, *B. inermis*, *Arcuiflavescens-vera*, *Agropyrum caninum*, *Arrhenatherum avenaceum*, *Lolium perenne*.

Habitat.—Illinois, Iowa, Maine, Massachusetts, New York, Ohio, Ontario.

I have sought in vain for the males of this species, for although I have mounted over a thousand specimens, and have bred many more in bottles in the laboratory, and have taken and examined large numbers of them in the field, I have never seen any that I even suspected were males. A series of experiments begun in the laboratory in July and continued into December showed that no males are developed in the autumn generations. Experiments were begun the following season by obtaining hibernating females before the weather was warm enough for them to move out of doors and confining them in bottles in the laboratory. These became active and deposited eggs, from which succeeding generations developed without the appearance of any males. I conclude, therefore, that this species is parthenogenetic, and reproduces without the intervention of males, at least for a series of generations, in this locality.

The following descriptions are of the early stages:

Eggs.—The eggs are reniform, and vary in length from 0.265 mm. to 0.33 mm. and in width from 0.085 mm. to 0.145 mm. The average dimensions taken from twenty-five eggs are: Length, 0.288 mm.; width, 0.11 mm. The color is a translucent white. By transmitted light the eggs are seen to be filled with a mass of yolk globules which vary considerably in size.

Larva.—As the larva emerges from the egg it is very soft, shiny, and nearly white. The eyes are purplish red in color; the appendages are folded closely against the ventral side of the body. The length soon after emergence is about 0.3 mm. and the width is about 0.1 mm. Body tapers from eighth segment to tip; head is nearly as wide as the thorax. Antennæ are comparatively large, approximate at base, and composed of seven segments, of which the last four are closely joined and appear almost like a single conical segment; fourth segment is larger than any other, and distinctly ringed with whorls of minute hairs; the second and third are indistinctly ringed; basal segment bears one small spine on inner side; two has four spines which are directed forward and one very long spine which is directed backward toward the head; the third bears five short spines, and the terminal part of the fourth and each of the following segments a number of spines, which are quite long and stout. Legs are stout; tarsi one segmented and terminated by two claws. The bladder-like expansion is present. Abdomen much compressed longitudinally and, except the tenth segment, marked with six longitudinal rows of setæ, three pairs to each segment. The four dorsal rows also extend forward along the thorax and head; tenth segment bears six very long setæ—two dorsal, two lateral, and two ventral.

The full-grown larva is fusiform, about 1.2 mm. in length and about 0.3 mm. in breadth, while the width of head is about 0.1 mm. Antennæ

seven segmented, somewhat separated at their base and rather thick for their length; color darker than that of the body, often nearly black; segmentation beyond fourth segment more distinct than in immature larva; first four segments subequal in thickness, and third and fourth nearly equal in length, and each as long as the first and second segments together; last three segments much smaller; fifth shortest. Spines arranged much as in younger stage; third segment distinctly ringed and without setæ. Each segment, except last two, bears short spines which are slightly thickened at their extremities, and arranged as in the young larva; spines on last two segments long and acute. Integument of body roughened by transverse rows of clearly defined ridges. Body marked by dorsal and lateral longitudinal stripes of yellow which are most distinct upon thorax; dorsal stripe widest.

Pupa.—Its general form resembles that of the larva; color of legs, wing pads, and antennæ clear white; thorax and abdomen very light yellow; eyes bright red. When the pupal stage is first entered the antennæ are apparently three or four segmented, much shortened, and directed forward as in the larva; but after a few hours they are laid back upon the head and thorax. Wing sheaths short and developed outside of the body; legs thick and clumsy. Upon dorsal side of ninth segment, near posterior margin, are four prominent, stout, recurved, hook-like processes; abdominal setæ slender and acute. Wing sheaths finally extend to the sixth segment and fore pair bear a few small spines.

Life history.—About 98 per cent of the adults which hibernate are of the short-winged form, while from 90 to 95 per cent of the first generation in the spring develop long wings, and this form predominates until late summer, when the proportion declines, and in October only a small number of winged adults can be found. The females continue to deposit eggs and the young larvæ develop and may be taken from the grass upon warm fall days till snow covers the ground; but so far as I can find, only the adults survive the winter. Hibernating females do not appear to suffer from exposure to a temperature of -21° F., and they may be brought in at any time during the winter by pulling a few handfuls of grass from infested fields and bringing it into a warm room, where the little animals will very soon become lively and begin to crawl. Accidentally it was found that they could survive for several days though completely submerged in a weak solution of potassium hydrate, and they have been found to revive after being frozen solid in a 2 per cent solution of the same; but so far as my experiments went, freezing in pure water killed them. The females become active very early in the spring and the development of eggs begins. As many as eight apparently fully developed eggs have been seen at one time in the body of one of these hibernated females. Ovipos-

sition soon begins, and lasts for from four to six weeks in many cases. They seem to oviposit as readily at night as in daylight. The deposition of an egg requires about one and one-half minutes. The eggs may be readily seen in the leaf by holding it before a light, when they appear as small, lighter spots; they may be easily separated from the leaf by stripping off the epidermis. The length of the egg stage varies from ten to fifteen days for the first generation to from four to seven days during the heat of summer.

The length of the larval stage varies from two weeks in early spring to about four days in midsummer. The mature larvæ select secluded places in which to transform and are hard to find in the field, but it appears that they usually go down to the basal leaves near the root or into the sheaths higher up the stem. The pupal stage is longer for the long-winged females than for the short, in the former requiring four or five days in early spring, whereas the short-winged form requires only from two to three days at the same season. As the weather becomes warmer they transform more rapidly. The appearance of a number of winged adults early in May marks the maturity of the first generation, but as the length of the period of oviposition exceeds the length of time required for the early stages, there is no distinct line between the generations out of doors after this time. The length of the life cycle is from about twelve to thirty days.

Common name.—Since Professor Comstock's first mention of the injury done by this species of Thrips to June grass and timothy, several economic entomologists have referred to the most conspicuous effects of its work, the dead tops of these grasses, as "Silver top" or "White top." Many have questioned the agency of Thrips in producing this injury and have ascribed it to some other suctorial insect, but the majority of writers are now inclined to credit Thrips with a large part, if not all, of this damage. As they had no means of identifying the little pest, they have usually referred to it as the "Grass Thrips." This name has been very generally used for this species and for no other, so far as we can learn. It therefore appears to be the generally accepted common name.

Economic notes.—Extensive injuries to grass have been reported from the New England States, New York, southern Canada, Ohio, northern Illinois, and Iowa. Without doubt the insect causing this damage infests a larger territory than this, for it is so small that it easily escapes observation, and the damage done by it is often attributed to other agencies. In southern Maine, Professor Fernald reported (253) that by haying time one-fourth of the June grass (*Poa pratensis*) in the fields was dead and worthless. In 1887 it produced great injury around Emmet, Ohio, where 30 per cent of the grass was killed (272). In 1888 and 1889 widespread injury was reported from New York (291) and Ontario (322), where it appeared to work most

upon lawns and meadows. In Massachusetts, especially in dry seasons, its injuries are severe, it having been stated by Prof. W. P. Brooks that this tiny foe does more damage to grasses here than any other single insect.

Genus APTINOTHRIPS Haliday.

Body slender, almost naked. Head longer than wide, extending forward in a blunt projection between the eyes. Eyes small; ocelli wanting. Antennæ eight segmented (six segmented in *A. rufus* var. *connatticornis*). Maxillary palpi three segmented. Prothorax shorter than the head and somewhat broadened posteriorly, without long spines at angles. Legs short; femora plainly thickened; tibiæ very slender at the base, the remainder unusually broad; tarsi equally broad. Wings entirely absent. Hairs at end of abdomen short and very slender.

Males with two spines in middle of ninth segment above.

Species of this genus move slowly and have no power of springing.

I have found only the species *rufus* and its variety, *connatticornis*, belonging to this genus.

APTINOTHRIPS RUFUS (Gmelin).

Plate V, figs. 52-54.

"*Der rothe Blasenfuss*" v. GLEICHEN, das Neueste aus dem Reiche d. Pflanzen, 1764, pl. XVI, figs. 6 and 7.

Thrips rufa GMELIN, Caroli a Linné Systema Nat., 1788, p. 2224.

Thrips rufa NICHOLSON, Journ. Nat. Phil., 179-, pl. VIII, fig. 1.

Thrips (Aptinothrips) rufa HALIDAY, Entom. Mag., 1836, p. 445.

Thrips (Aptinothrips) rufa HALIDAY-WALKER, Homopt. Ins. of Brit. Mus., 1852, p. 1103, pl. v, figs. 5-11.

Aptinothrips rufa LINDEMAN, Bull. Soc. Imp. d. Natur. d. Moscow, 1886, pp. 319-320, fig. 11.

Aptinothrips stylifera TRYBOM, Entom. Tidskrift, Årg. 15, Häft. 1-2, 1894, pp. 41-58.

Aptinothrips rufa UZEL, Mon. der Ord. Thysanoptera, 1895, pp. 152-154, pl. II, fig. 17; pl. VI, figs 78, 79.

Aptinothrips rufa TRYBOM, Ofv. Ak. Forh., 1896, p. 613.

Aptinothrips rufa REUTER, Über die Weissähigkeit der Wiesengräser in Finland, 1900. Scattered references, especially pp. 92-120.

Aptinothrips rufa TUMPEL, Die Geradflügler Mitteleuropas, 1901, p. 290.

Female.—Length 1.22 mm. (1.06 to 1.30 mm.); width of mesothorax about 0.18 mm. (0.16 to 0.20 mm.). General color, entire body and legs clear, pale yellow; outer part of antennæ, mouth parts, and tip of abdomen shaded with brown. Body slender and smoothly fusiform.

Head considerably longer than broad, rounded in front; cheeks straight and parallel. Eyes small, black, oval, composed of few facets, situated at anterior angles, protruding very slightly; ocelli always absent. Mouth cone moderately long, not sharply pointed, tipped with brown-black; maxillary palpi three segmented. Antennæ

only one and three-sevenths times as long as the head, approximate at base, composed in the typical form of eight segments of following relative lengths:

1	2	3	4	5	6	7	8
5.5	7.7	7.5	6.1	6.1	11	3	3.3

Segment one is broadly rounded; two has an unusually constricted basal stalk, though it is broader than that of three; three to five bear each one quite slender sense cone on outer angle, and six has one on inner side beyond the middle; spines and sense cones upon all segments pale and inconspicuous. Antennæ concolorous with head at base, but shading outwardly gradually to brown-black at tip.

Prothorax slightly shorter than head and a little broader than long; smooth and without spines. Pterothorax a little broader than prothorax, without spines or traces of wings. Legs short and thick, all nearly equal in length, concolorous with body; tarsi tipped with brown within.

Abdomen unusually long and slender, nearly three and one-half times as long as its greatest diameter, about twice as wide as head, nearly cylindrical to eighth segment, then tapering to a point at tip. No spines upon abdomen except around segments nine and ten; these are quite short and slender and stand out nearly perpendicularly to the surface upon which they are borne. Extreme tip of ten shaded very dark brown.

Redescribed from three specimens.

Males unknown to me. According to Haliday, they are clear yellow, and the saffron-yellow spermaries show through the abdominal walls. The ninth abdominal segment bears two spines in the middle above, not far from the hind edge.

Var. connaticornis Uzel.—This variety agrees very closely with the typical form except that the antennæ have only six segments; the relative lengths of segments are as follows:

1	2	3	4	5	6
5	7	7	6.5	6	16.3

The sixth, seventh, and eighth segments are grown together into one compact sixth segment of an elongated conical form. The abdomen may be a little shorter in proportion and broader.

No males have been taken.

This species appears to be surely *Apt. rufus* Gmelin, but it is larger and differs in some other respects.

Food plants.—Various grasses and in turf.

Habitat.—England (Haliday), Russia (Lindeman), Sweden (Trybom), Bohemia, Germany, Helgoland (Uzel), Finland (Reuter), United States: Amherst, Massachusetts.

Life history unknown.

Genus HELIOTHrips Haliday.

Body, especially the head and prothorax, with a deeply reticulated structure. Head broader than long, uneven, somewhat broadened behind, and with a sharp hump between the eyes in front. Cheeks not arched, contracted into saddle-shape in the middle. Eyes prominent but not protruding. Ocelli present. Antennæ eight segmented; second segment of style very much longer than the first and provided with a short, slender hair at the tip. Maxillary palpi sometimes two, sometimes three segmented. Prothorax shorter than the head, without long spines at angles. Legs unarmed. Wings present, not reticulated. Fore wing broad at base, with two longitudinal veins, though the fore vein runs very near to and sometimes fuses with the costa; veins set with slender spines; fore fringe, in some species, very weak and sparse, and when this is the case the costal spines are very strongly developed. Anal spines weak and light.

The characters of this genus have been extended to include these species

SYNOPSIS OF SPECIES.

1	{ All tibiae yellow	2
	{ Middle and hind tibiae brown	3
2	{ Antennæ nearly three times as long as head	<i>femorialis</i> (p. 172)
	{ Antennæ only about twice as long as head	<i>haemorrhoidalis</i> (p. 168)
3	{ Antennæ two and one-half times as long as head; segments three and four modioliform. Maxillary palpi three segmented	<i>fasciatus</i> (p. 174)
	{ Antennæ twice as long as head; segments three and four fusiform. Maxillary palpi two segmented	<i>fasciapennis</i> (p. 171)

HELIOTHrips HAEMORRHOIDALIS (Bouché).

Thrips haemorrhoidalis BOUCHÉ, Schäd. Garten-Insecten, 1833, p. 42.

Heliethrips adonidum HALIDAY, Entom. Mag., III, 1836, p. 443.

Heliethrips haemorrhoidalis BURMEISTER, Handb. d. Entomologie, II, 1838, p. 412.

Heliethrips haemorrhoidalis BURMEISTER, Genera Insectorum, colored illustration, 1838.

Heliethrips haemorrhoidalis AMYOT and SERVILLE, Ins. Hemipt., 1843, p. 641.

Heliethrips haemorrhoidalis HALIDAY, Walker, Homopt. Ins. Brit. Mus., 1852, p. 1002, pl. vi, fig. 13.

Heliethrips haemorrhoidalis HEEGER, Fünfte Fortsetzung. Sitzungsber. Kais. akad. Wiss., Wien, IX, 1852, p. 473, pl. xvii; separate, Wien, Gerold, 1852, VIII, pp. 3-4.

Thrips haemorrhoidalis BREMI, Stett. Ent. Zeit., 1855, pp. 313-315. Reprinted from Abhandl. d. Zurich Gartenbau-Gesell., III, pp. 260-261.

Heliethrips haemorrhoidalis LÖW, Verhandl. d. k. k. zool.-bot. Gesellsch., Wien, XVII, 1867, p. 747.

Heliethrips haemorrhoidalis BOISDUVAL, Ent. Hortie., 1867, pp. 233-235, fig. 32.

Heliethrips haemorrhoidalis PACKARD, 17th Ann. Rept. Mass. Bd. Agr., 1870, p. 263, pl. 1, fig. 2; Injurious Ins. new and little known, p. 31.

Thrips adonidum COOK, 3d Ann. Rept. Pom. Soc. Mich., 1873-74, 1874, p. 501.

Heliethrips haemorrhoidalis PACKARD, Half Hours with Ins., 1881, pp. 118-119, fig. 86.

- Heliothrips haemorrhoidalis* PERGANDE, Psyche, III, 1882, p. 381.
Heliothrips LEFEVRE, Ent., XV, 1882, p. 240.
Thrips haemorrhoidalis FRIČ, Přírodopis živočišstva, 1882, p. 113.
Heliothrips haemorrhoidalis LINTNER, 2d Rept. Ins. N. Y., 1885, pp. 29, 31, 38, 56.
Heliothrips haemorrhoidalis ———, Bull. Soc. Ent. Belgique, XXIX, 1885, p. LXX.
Heliothrips adonidum CAMERON, Trans. Nat. Hist. Soc. Glasgow (new ser.), 1, 1886, p. 301.
Heliothrips haemorrhoidalis TARGIONI-TOZZETTI, Cronaca entomologica dell'anno, 1887, (1888), p. 5 (7).
Heliothrips haemorrhoidalis JORDAN, Zeit. f. Wissens. Zool., XLVII, 1888, pp. 541-620, pls. XXXVI-XXXVIII.
Heliothrips haemorrhoidalis REUTER, Meddal. af. Soc. Fauna Flora Fenn., XVII, 1891, pp. 164-165.
Heliothrips haemorrhoidalis UZEL, Mon. d. Ord. Thysanopt., 1895, pp. 168-170, pl. VI, figs. 90-92.
Thrips (Heliothrips) haemorrhoidalis FRANK, Die tierparasitären Krankheiten der Pflanzen, 1896, p. 134.
Heliothrips haemorrhoidalis BUFFA, Riv. Patol. Veget., VII, No. 1-4, pp. 94-108; continued, VII, Nos. 5-8, 1898, pp. 129-135, 136-142.
Heliothrips haemorrhoidalis TÜMPEL, Die Geradflügler Mitteleuropas, 1901, p. 290.

Female.—Length 1.23 mm. (1.12 to 1.39 mm.); width of mesothorax 0.30 mm. (0.25 to 0.35 mm.). Color of head and thorax dark brown; abdomen yellowish brown, fading at tip to brownish yellow. Entire body and legs showing reticulating chitinous thickenings, which are heaviest upon the head, thorax, and anterior sides of abdomen. Head one-fourth wider than long, outline very irregular and rough; cheeks slightly concaved, narrowed abruptly near posterior edge into a short neck; anterior margin strongly arcuate; dorsal surface of head bears a few small spines, the bases of which appear like small air bubbles in the angles of reticulations; frons reticulated. Eyes protruding considerably, strongly pustulated; three ocelli situated on sides of an elevation between the eyes, separated considerably from margins of eyes, pale yellowish, very faintly or not at all margined inwardly by crescentic pigmentation. Mouth cone short, blunt, not reticulated; maxillary palpi three segmented, second segment longest; labial palpi short. Antennæ twice as long as head; relative lengths of segments as follows:

$\frac{1}{5}$	$\frac{2}{10.3}$	$\frac{3}{17.7}$	$\frac{4}{13}$	$\frac{5}{11}$	$\frac{6}{9.7}$	$\frac{7}{4}$	$\frac{8}{15.5}$
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Second segment thickest, others very slender, especially peduncle and basal half of three; seven is nearly cylindrical, narrow, no thicker than bases of four and five; eight is very slender, tapering slightly, and bearing a single very slender bristle at its tip. Color of one and two light brownish yellow; three, four, and five clear pale yellowish; six abruptly brown, yellowish in basal third; seven and eight gray. Spines upon antennal segments pale and inconspicuous, three especially long ones being situated one each upon the outer angles of three and

four and the inner angle of six; segments three to five faintly annulated.

Prothorax transverse, only about three-fourths as long as head, but nearly twice as wide as long, rounded at the angles; sides slightly concave, bearing a few small spines, of which only the bright bases are usually visible; reticulation heavy, but interrupted across the middle. Mesothorax one and one-fourth times as wide as the prothorax; reticulation upon mesonotum quite heavy, regular upon anterior half, upon posterior half elongated toward a deep incision in the hind margin of the plate, the longitudinal thickening becoming weaker. Metanotum prominent, triangular, strongly reticulated. Wings very slender; not nearly reaching to tip of abdomen, broadened abruptly at base to more than twice their diameter at middle; only one distinct longitudinal vein, and this sends off a short oblique branch to costal vein. Anterior fringe very short and sparse; posterior quite long and heavy; no prominent spines upon veins. Legs rather short and thick; pale yellowish, except coxæ brownish; first and second pairs about equally long; hind pair a little longer; all legs reticulated.

Abdomen elongate-ovate, pointed at tip; dorsum reticulated; segments two to eight with irregular transverse brown line near front edge of each. Spines upon abdomen mostly small and indistinct; most prominent ones situated upon middle of dorsum of segments two to eight, close to median line; these gradually increase in size posteriorly; anal spines short and weak. Color of abdomen varies from brownish yellow to dark brown; last two segments usually much lighter but less variable in color than rest of abdomen, being regularly brownish yellow tipped with dark brown.

Redescribed from eight females.

Male unknown.

In Germany this species is called "Black Fly."

Food plants.—*Aspidium*, azaleas, *Croton*, dahlias, ferns, Liliaceæ, *Pellea hastata*, *Phlox*, pinks, verbenas, vines, etc.

Habitat.—England (Walker, Cameron), Germany (Bouché, Burmeister, Bremi, Jordan, Bohls), Vienna (Heeger, Löw), Finland (Reuter), United States: District of Columbia, Iowa, Massachusetts, Michigan.

Life history unknown.

In his original description Bouché states that he believes the native land of this species is America. In both countries, however, it has been found almost entirely confined to greenhouses and feeding upon greenhouse plants.

It has been very injurious in some places. Packard calls it "one of our greatest pests in hothouses," and Cook records it as "one of the worst pests around Detroit, at Adrian, and in the southern counties" of Michigan.

HELIOTHRIPS FASCIAPENNIS, new species.

Plate VI, figs. 58-61.

Female.—Length 0.92 mm. (0.90 to 0.94 mm.); width of mesothorax 0.22 mm. (0.22 and 0.23 mm.). General color yellowish brown or dark brown. Head, thorax, and legs distinctly but not deeply reticulated.

Head about one and one-third times as wide as long; form rather rectangular; front margin depressed at insertion of antennæ; cheeks nearly straight. Eyes dark, quite large, prominent but hardly protruding, margins lighter; ocelli present, approximate, pale yellow with dark crescentic margins, well removed from eyes. Maxillary palpi small, two segmented. Antennæ eight segmented, twice as long as head; relative lengths of segments:

$$\frac{1}{4} \quad \frac{2}{8} \quad \frac{3}{11} \quad \frac{4}{10} \quad \frac{5}{9} \quad \frac{6}{5.5} \quad \frac{7}{3.5} \quad \frac{8}{8}$$

Segment one much narrower than two and almost spherical; two is thickest segment and but little longer than thick; three and four fusiform; five clavate; six and seven together of same form as five only inverted; eight very slender and terminated by an equally long hair. Segments one and two, outer half of five, six, seven, and eight brown; three, four, and basal half of five pale yellow. Spines on three, four, and five long, dark, and prominent; color around bases of those on three and four brownish.

Prothorax as long as head and less than twice as wide as long; sides rounded slightly and diverging somewhat posteriorly; without prominent spines at angles; concolorous with head and reticulation of about same depth. Mesothorax somewhat wider than prothorax; anterior edge about straight and angles nearly right angular; membrane yellow; plates brown. Wings long, overreaching the abdomen; fore wing quite slender beyond basal fourth at which point the hind longitudinal vein branches from the fore vein; width in middle about one-fifteenth its length; both veins run close to edges of the wing, the fore one becoming fused with the costa while the hind one remains distinct. Internal veins set with few short spines; costa set with stout spines but without fringe except for slight vestiges along the middle; hind fringe long, dark, and wavy. Wing dark brown crossed with three bands of white as follows: At one-fifth, three-fifths, and four-fifths its length; outer part of scale also white; the brown area at the tip is confined to edge on border around last fifth, the middle here being grayish and in continuation of the last white band. Legs fairly stout but not thickened, weakly reticulated; femora yellowish brown to dark brown; front pair lightest and yellow at tips; fore tibiæ yellow shaded with brown around middle; the other tibiæ brown, yellow at

tips; all tarsi pale yellow with brown shading at bases of bladders; spines weak and light colored; hind coxæ large, approximate, and about twice as long as wide.

Abdomen elongated ovoid, about twice as long as wide; width of segments gradually increasing up to the fourth, then decreasing gradually to tip; greatest width equal to about twice that of head; dark line across segments one to eight irregular, conspicuous only on the lighter specimen; that on segment one curving forward greatly in middle. Surface of abdomen very faintly reticulated, but this is not visible on darker specimen; spines on last two segments short and fine; color yellowish brown to dark brown, lightest along middle.

Described from two females.

Cotype.—Cat. No. 6330, U.S.N.M

Male unknown.

Food plants.—Taken on grass.

Habitat.—Amherst, Massachusetts.

HELIOTHRIPS FEMORALIS Reuter.

Plate V, figs. 55, 56; Plate VI, fig. 57.

Heliothrips femoralis REUTER, Meddel. af. Societas pro Fauna et Flora Fennica, XVII, 1891, p. 166.

Heliothrips cestri PERGANDE, Ins. Life, VII, No. 5, 1895, pp. 390-391.

Heliothrips femoralis UZEL, Mon. d. ord. Thysanoptera, 1895, p. 170.

Heliothrips femoralis BERGROTH, Ann. Soc. Ent. Belgique, XL, 1896, Pt. 2, p. 67.

Female.—Length 1.3 mm. (1.12 to 1.5 mm.); width of mesothorax about one-fourth the body length. General color dark brown to yellowish brown, lighter at extremities. Entire surface of body weakly but plainly reticulated.

Head two-thirds as long as broad, widest in front; anterior margin depressed at insertion of antennæ; vertex carinated; bases of antennæ separated by a prominence as high and nearly as wide as the first antennal segment; two transverse wrinkles near back of head more prominent than the others; behind the anterior one of these two the longitudinal parts of the reticulations become very faint; spines upon head scattering and small. Eyes quite large, protruding anteriorly, coarsely granulated; eyes and margins of ocelli bright, dark red by reflected light; ocelli placed on sides and front of a distinct elevation on top of head between eyes. Head light brown with light yellowish longitudinal stripe on each side between eye and ocelli. Maxillary palpi three segmented, short, small; labial palpi minute. Antennæ eight segmented, slender, nearly three times as long as head; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
5	8.8	16.6	12.2	11	8.6	4.3	10.5

Segment one cylindrical, three-fourths as broad as two, which is

barrel-shaped and annulated; remaining segments narrower than these two and more elongated; three and four fusiform; seven and eight nearly cylindrical; eight very slender; one, two, and three nearly concolorous, light yellow with tinge of gray or brown on one and two; four and five light yellow in basal half, shading to light brown on apical half; six, seven, and eight uniformly chocolate brown; segments two to five annulated; spines slender, light colored.

Prothorax transverse, about one-fifth wider than the head, twice as wide as long and shorter than the head; sides rounded; without conspicuously large spines. Mesothorax about one and two-thirds times as wide as the head; anterior angles prominent; mesonotum with deep incision on posterior margin; metanotum with four spines standing in a square near its center. Wings present, long, about one sixteenth as broad as long; fore wings broadened at base, with two longitudinal veins, the second branching from the first not far from the base of the wing. Spines upon veins of fore wing stout, dark colored, and set at uniform distances; costa bears seventeen to twenty, fore vein fourteen to seventeen, hind vein ten to thirteen, scale three to five besides pair at its tip; spines on basal fourth of wing are light colored, smaller and much less conspicuous; anterior fringe on both wings fairly long and stout; posterior fringe long, slender, and dark colored. Wings grayish brown to dark gray, lighter between the longitudinal veins; three nearly white cross bands; one across base before branching of veins, another at three-fourths the length of wing and the third across the tip. Legs: All tibiae, tarsi, and fore femora yellow; middle and hind femora dark brown, yellow only at ends; spines upon legs small and inconspicuous except ten to twelve on inner side of hind tibiae.

Abdomen broadly ovoid, conical at tip, twice as wide as head; ovipositor long and slender; tenth segment split open above; segments two to eight with dark cross line near anterior edge. Two or three spines on sides of each segment from two to eight, not conspicuous; anal spines weak. Color of abdomen yellowish brown to dark brown; last two segments much more yellow, but shading to brown at posterior edges.

This species has the power of springing.

No males found.

Food plants.—*Amarillis* sp., *Aralia*, *Arum*, *Cestrum nocturnum*, *Chrysanthemum*, *Crinum*, cucumber, *Dracaena* spp., *Eucharis grandiflora*, *Ficus elastica*, *F. grandiflora*, *Gardenia*, *Gossypium*, *Hydrangea*, *Mina lobata*, moonflower, *Pandanus*, *Phoenix*, *Richardia aethiopica*, tomato, *Vitis*.

Habitat.—Helsingfors, Finland (Reuter), United States: District of Columbia; Amherst, Massachusetts.

Life history unknown.

HELIOTHRIPS FASCIATUS Pergande.

Heliotrips fasciata PERGANDE, Ins. Life, VII, No. 5, 1895, pp. 391-392.

Female.—Length 1 mm.; width of mesothorax 0.29 mm. Body faintly reticulated. General color dark brown.

Head about two-thirds as long as wide; cheeks straight; anterior margin depressed at insertion of antennæ; color uniformly brown. Eyes small, black, not protruding; ocelli pale yellowish margined with reddish. Mouth cone moderately long; maxillary palpi slender, three segmented. Antennæ two and one-half times as long as head, eight segmented; bases separated by low elevation; relative lengths of segments:

1	2	3	4	5	6	7	8
4.5	9	13	11	9.25	6.5	3.5	7.5

Segment one rounded, wider than long; two is broadest, constricted abruptly at base, broad at outer end; three and four are of similar shape; modioliform (uniformly constricted at each end with median enlargement regular); outer end of five is quite broadly cut off; six is abruptly constricted at base, outer half tapering gradually; seven nearly cylindrical; eight tapers gradually and bears one very long, slender hair at tip nearly as long as segment itself. One and two uniformly brown, concolorous with head; three and four with light brownish ring around middle of enlargements; remainder pale yellowish, as is also basal half of five; rest of antenna brown; spines around middle of segments three and four and near end of five are long, dark, and conspicuous.

Prothorax fully twice as wide as long, slightly wider at posterior edge than at anterior, without conspicuous spines, colored like head. Mesothorax widest at posterior edge; sides curving gradually inward to anterior edge. Metathorax as wide at front edge as mesothorax is at hind edge, and its sides curve gradually to base of abdomen, so pterothorax appears smoothly rounded. Wings present, extending to tip of abdomen, slender except where broadened at base; two longitudinal veins, the second branching from the first near the broadened base; the fore vein then inclines toward the costal and runs contiguous with it to tip of wing; the hind vein runs close to hind edge, but is distinct. Costal spines twenty in number, very large and stout, much longer than the very weak fringe; fore vein bears four stout spines at basal third and two not far from tip; hind vein bears five moderately long spines; posterior fringes dark, heavy, and wavy. Wings grayish brown, darkest over veins; fore wings at base and a rather broad band at three-fourths their length transparently white, darkest brown around the outer shaded portion. Legs of medium length; femora and tibiae dark brown except around outer ends of femora, and both

extremities of tibiae pale yellowish; tarsi also yellowish, brownish around tips; legs bearing quite a number of inconspicuous spines; hind tibiae alone bearing stout spines at their tips.

Abdomen broadly ovate, pointed at tip, wider than thorax. Color dark brown, somewhat lighter on last two segments. Anal spines weak, especially on last two segments; the few spines on sides of segments two to eight are inconspicuous.

Redescribed from one specimen at U. S. Department of Agriculture, Division of Entomology.

Male not known.

Food plants.—Orange leaf infested with *Aspidiotus aurantii*. (Probably not feeding on scale.)

Habitat.—Yuba County, California.

Life history unknown.

Genus PARTHENOTHRIPS Uzel.

The body, principally the head and prothorax, with deeply reticulated structure. Head broader than long, with a hump in front between the eyes; cheeks swollen, constricted into a short neck at hind edge. Eyes protruding; ocelli present. Antennae seven segmented, very slender except the first two segments; style one segmented, hair-like, as long as the sixth segment and bearing a slender hair of equal length at the tip. Upon the third to the sixth segments, separated from each other, there are always two sense cones. Maxillary palpi two segmented, the second segment being distinctly longer than the first. Prothorax plainly shorter than the head, uneven, broadened posteriorly, with one long spine upon each hind angle. Legs unarmed. Wings very broad and long, so that they reach beyond the end of the abdomen. The fore wings have the form of a "cake-knife;" their surface is reticulated and there appears to be only one longitudinal vein and a very strongly developed ring vein. The vein arising from the base of the wing bends forward at the first fourth of the length of the wing and unites with the unusually strong ring vein from that point, while the hind vein, branching from the main vein at this point, bends toward the hind edge of the wing and runs parallel to it, but remains distinct. The fore fringe has disappeared and its place is taken by the stout costal spines. The hind vein is set with stout spines at regular intervals. Beyond the first fourth the wing is somewhat narrower than at the basal fourth. The front edge is nearly straight and the hind edge bending forward unites with it to form a sharp point. The last two abdominal segments are distinctly narrowed in the females. The spines at the end of the abdomen are weak and light. The species belonging here have the power of springing.

I have found only the species *dracaenæ* of this genus.

PARTHENOTHRIPS DRACÆNÆ (Heeger).

Plate VI, figs. 62-65.

Heliotrips dracænæ HEEGER, Sitzungsab. d. math.-naturw. Classed. kais. Akad. d. Wissensch., Wien, XIV, December, 1854., p. 365. Separata. Beiträge zur Naturgeschichte d. Insecten Oesterreichs, pp. 3-7.

Thrips dracænæ REGEL, Bull. phys.-mathem. Acad. Sciences, St. Petersburg, XVI, 1858, pp. 333-336; Melang biolog., II, 6, pp. 628-633.

Heliotrips dracænæ v. FRAUENFELD, Verhandl. d. k. k. zool.-bot. Gesellsch., XVII, Zool. Miscellen, XIII, 1867, pp. 793-801.

Heliotrips dracænæ PERGANDE, Psyche, III, 1882, p. 381.

Parthenothrips dracænæ JORDAN, Zeit. f. Wiss. Zool., XLVII, 1888, pp. 541-620 (Biological part).

Parthenothrips dracænæ REUTER, Meddel af. Soc. Fauna et Flora Fennica, XVII, 1891, p. 166.

Heliotrips dracænæ TRYBOM, Entom. Tidskrift, 15 Årg., Häft 1-2, 1893, pp. 56-58.

Parthenothrips dracænæ UZEL, Mon. d. Ord. Thysanopt., 1895, pp. 171-173, pl. II, figs. 12-14; pl. VI, fig. 93.

Parthenothrips dracænæ TÜMPEL, Die Geradflügler Mitteleuropas, 1901, p. 291.

Female.—Length about 1.15 mm.; width of mesothorax about 0.28 mm. General color dusky yellow, more or less strongly shaded with brown, especially upon the abdomen. Head, thorax, and wings covered with more or less clearly defined reticulating ridges.

Head widest in front through the eyes, four-fifths as wide as length; general shape quadrangular above, though front margin is somewhat elevated in middle; heavily reticulated; cheeks straight, but abruptly constricted at hind edge, neck-like; color quite uniform brownish yellow. Eyes black, very strongly protruding at fore angles; a slight depression surrounds each eye; ocelli small, approximate, with dark red margins contiguous, situated upon a slight elevation between the eyes and well removed from them. Maxillary palpi two segmented, the second segment being longer and more slender than the first. Antennæ seven segmented, very slender beyond second segment, about two and one-half times as long as the head; relative lengths of segments:

$\frac{1}{5}$	$\frac{2}{9.7}$	$\frac{3}{20.5}$	$\frac{4}{17}$	$\frac{5}{16.5}$	$\frac{6}{14.3}$	$\frac{7}{13.5}$
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Segment one nearly spherical, fully as long as broad, narrower than two, which is thickest; three to six subequal in thickness and about one-half the diameter of two, faintly ringed; seven very slender and bearing at its tip a still more slender spine, which may be nearly as long as the segment. Segments one and two slightly more dusky yellow than three to five; five is shaded with brown at its tip; six and seven brown or gray-brown.

Prothorax transverse, fully twice as wide as long and about two-thirds as long as the head, wider behind than in front; sides somewhat

rounded; surface reticulated like head and concolorous with it; one stout spine at each hind angle. Pterothorax on dorsal line only two-thirds as long as wide, one and one-fourth times as wide as prothorax; metathorax nearly as wide as mesothorax; color of pterothorax somewhat more yellow than head and prothorax; mesonotal plate deeply incised in middle behind; reticulations converging to anterior end of this incision. Wings very long and about one-tenth as broad, overreaching the abdomen considerably; form and venation unique; fore wings somewhat longer and about one and one-half times as broad as the hind wings; their front edge runs straight clear to the tip; the hind edge runs nearly parallel to it till near the end, where it curves forward to join the fore edge at the tip; the entire wing is bounded by one very heavy ring vein. There appears to be only one longitudinal vein; this at about basal fourth of wing curves forward to the costal vein, which it joins;^a then it curves backward and runs parallel with and quite close to the hind edge till it joins the ring vein before the tip. The costa bears no fringe, but is set with numerous stout spines as is also the longitudinal vein; hind edge bears a double fringe of long hairs; surface of fore wing shows faint reticulation. There are three rather faint brown spots on fore edge, the darkest being where the fore vein joins the costa, and one longer spot on hind edge; spines standing in these spots are much darker than the others. Legs concolorous with body, finely reticulated; hind coxæ approximate; fore femora brownish yellow, the others brown, yellowish at extremities; tibiæ and tarsi concolorous with second segment of antennæ; tarsi tipped with dark brown; spines very weak and light colored.

Abdomen distinctly wider than thorax and broadly joined to it; about twice as long as broad, ovoid, pointed at tip; general color brown or yellowish brown; last three segments yellow; sometimes the sides of each segment are much more yellow than its brown central area; anterior edge of segment one is curved forward very abruptly in the middle forming a rounded apex to the dorsal plate; prominent dark stripe on anterior edges of three to seven; anal spines weak and light.

Redescribed from five females taken in Amherst, Massachusetts, on *Kentia* and *Ficus*. I have no male, but Heeger says:

Male.—The abdomen in males is distinctly more slender than in females; is yellow-brown, thinly chitinized; about twice as long as the meso and metathorax together; almost cylindrical, with tapering anal extremity; naked, set with some long bristles only at the hinder edge of the last three abdominal segments.

Food plants.—*Dracæna*, *Ficus elastica*, *Kentia balmorina*.

^aI believe that the fore vein coincides with the costal from the spot where they join, the cross vein being more apparent than real, and that the vein which runs parallel with and close to the hind edge is really the hind vein.

Habitat.—Vienna (Heeger, v. Frauenfeld), Finland (Reuter), St. Petersburg (Regel), Germany (Jordan, Bohls), Bohemia (Uzel), United States: Washington, District of Columbia; Amherst, Massachusetts.

The early stages are described as follows:

Egg.—The eggs are nearly membranous, greenish white, elongate-ovate, $1\frac{1}{5}'''$ long, half as broad.

Larva.—Larvæ are milky white, nearly cylindrical; only the last three abdominal segments taper gradually to a blunt point; they are about $1\frac{1}{2}'''$ long, $\frac{1}{4}$ as thick. The head is inverted conical, a little more slender but noticeably longer than the breadth of the abdomen; mouth parts are thin, horny, yellowish, pointed, snout-like. Eyes are on the sides of the head, circular, not raised; relatively large and clear red. The antennæ are thread-like, white with gray points, five segmented, somewhat longer than the head; first three segments small, cup-shaped, of equal size; fourth, spindle-shaped, about as long as first three together; fifth is gray, conical, very pointed, somewhat longer than the fourth.

The thorax is somewhat longer than the antennæ, swollen, flat beneath; prothorax is rounded-triangular, somewhat shorter than the pterothorax, the segments of which are grown together, and are elongated-rectangular and rounded. The legs are close together, with very large coxæ; nearly as long as the antennæ; middle pair noticeably shortest, hind pair longest; femora shorter and thicker than tibiæ, which are cylindrical; tarsi very short, indistinctly two segmented.

Abdomen spindle-shaped, nearly as broad and somewhat more than twice as long as the entire thorax; the nine segments are hardly perceptibly marked, equally long and set at sides with single, knobbed hairs.

Nymph or pupa.—The nymphs in the last days before their transformation are whitish, fusiform; their eyes are raised, round, and red; antennæ indistinctly eight segmented, laid back over the head near one another; wing sheaths lying at the sides of the abdomen, slender, bottle-shaped, reaching to the fore edge of the sixth segment and set with many transparent, white hairs, as is also the spindle-shaped abdomen; the hind edge of the next to the last and the end of the last segment set with single, knobbed hairs.

Genus THRIPS Linnæus.

Ocelli present. Antennæ seven segmented (style one segmented). Maxillary palpi three segmented. Prothorax regularly somewhat longer than the head; two long spines always present upon its posterior angles. Fore legs usually unarmed. Wings usually present, moderately broad, with fore fringe developed and veins set with short spines.

The species belonging here have the power of springing.

Although this is the largest genus of the order, I have here found but two species which I can place in it. These two may be easily distinguished by their colors.

Head brown, thorax reddish brown, abdomen yellow or gray-brown. *perplexus* (p. 184). Color uniformly light yellowish varying to brownish yellow. *tabaci* (p. 179).

THRIPS TABACI Lindeman.

ONION THRIPS.

Plate VII, figs. 69-71.

? *Limothrips tritici* PACKARD, 2d Ann. Rept. Ins. of Mass., 1872, pp. 5-8, 2 figs.; 19th Ann. Rept. Secy. Mass. Bd. Agr. for 1871, pp. 333-336, 2 figs.; reprinted in 9th Ann. Rept. U. S. Geol. Geog. Surv. Territories for 1875, pp. 742-744, pl. LXVII, figs. 3-5.

Thrips on onion plants, SHIPLEY, Bull. 10, Miscell. Information Roy. Gardens, 1887, p. 18.

Thrips tabaci LINDEMAN, Die schädlichsten Insekten des Tabak in Bessarabien, 1888, p. 15, 61-75.

Thrips sp. THAXTER, Ann. Rept. Conn. Exp. Sta. for 1889, 1889, p. 180.

Thrips sp. RILEY-HOWARD, Insect Life, III, 1891, p. 301.

Thrips tabaci RITZEMA BOS, Tierische Schädlinge und Nützlinge, 1891, pp. 577, 578.

Thrips tabaci TARGIONI-TOZZETTI, Animali ed Insetti del Tabacco in Erbal del Tabacco Secco, 1891, pp. 222-224.

Thrips sp. LINTNER, Count. Gent., LVII, Oct. 27, 1892, p. 809; Abstract in 9th Rept. Ins. N. Y., p. 445.

Limothrips sp. BAKER, Amer. Florist, VII, 1892, p. 168, fig.

Thrips striata? GILLETTE, Ann. Rept. Col. Exp. Sta. for 1892, 1892, p. 36.

Thrips on onions, WEBSTER, Ins. Life, V, 1892, p. 127.

Thrips striatus GILLETTE, Bull. 24, Col. Exp. Sta., 1893, pp. 13-15, figs. 11, 12.

Thrips striatus RILEY-HOWARD, Ins. Life, VI, 1893, pp. 4-5, 343.

Thrips striatus? GILLETTE, 5th Ann. Rept. Col. Agr. Exp. Sta. for 1892, 1893, p. 36; 6th Ann. Rept. Col. Agr. Exp. Sta. for 1893, p. 55.

Onion Thrips, SMITH, Ann. Rept. N. J. Agr. Col. Exp. Sta. for 1893, 1894, p. 441.

Limothrips tritici WEBSTER, Ins. Life, VII, 1894, p. 206.

Thrips allii SIRRINE and LOWE, Bull. 83, N. S., N. Y. Agr. Exp. Sta., 1894, pp. 680-683, pl. II.

Thrips allii WEBSTER, Ohio Farmer, Aug. 2, 1894, p. 97; Aug. 23, 1894, p. 157; Nov. 7, 1894, p. 373.

Thrips allii SIRRINE and LOWE, 13th Ann. Rept. N. Y. Exp. Sta. for 1894, 1895, pp. 758-760, pl.

Thrips allii OSBORN-MALLY, Bull. 27, Iowa Agr. Exp. Sta., 1895, pp. 139-142.

Thrips tabaci PERGANDE, Ins. Life, VII, 1895, pp. 392-395.

Limothrips tritici WEBSTER, Bull. 58, Ohio Agr. Exp. Sta., 1895, pp. xxxiii-xxxiv, fig. 3; also in Ins. Life, VII, 1895, p. 206.

Thrips communis UZEL, Mon. d. Ord. Thysanoptera, 1895, pp. 176-179, pl. VI, fig. 100.

Thrips tabaci UZEL, Mon. d. Ord. Thysanoptera, 1895, p. 447.

Thrips tabaci SLINGERLAND, Rural New Yorker, LV, 1896, p. 561.

Thrips tabaci FRANK, Die tierparasitären Krankheiten der Pflanzen, 1896, p. 134.

? *Thrips* sp. near *tabaci* DAVIS, Special Bull. 2, Mich. Agr. Exp. Sta., 1896, p. 13.

- ? Thrips on cabbages, SMITH, Economic Ent., 1896, p. 102.
 ? Thrips on cucumber, BRITTON, 20th Rept. Conn. Exp. Sta. for 1896, 1897.
Thrips tabaci SIRRINE, 15th Ann. Rept. N. Y. St. Exp. Sta. for 1896, 1897, pp. 612-613.
 Onion Thrips, SIRRINE, Bull. 115, N. Y. Exp. Sta., 1897, p. 70.
 Onion Thrips, SLINGERLAND, Rural New Yorker, May 8, 1897, p. 309.
Thrips tabaci LINTNER, 51st Ann. Rept. N. Y. St. Mus. Nat. Hist., 1898, p. 363.
 Separata, 13th Rept. Inj. Ins. N. Y., 1898, p. 333.
Thrips striatus GILLETTE, Bull. 47, Col. Exp. Sta., 1898, p. 44.
Thrips tabaci QUAINANCE, Bull. 46, Fla. Agr. Exp. Sta., 1898, pp. 103-114, figs. 10-12.
Thrips tabaci HOWARD, Yearbook, U. S. Dept. Agr. for 1898, 1899, pp. 142, 143, fig. 27.
Thrips tabaci PETTIT, Bull. 175, Mich. Exp. Sta., 1899, pp. 343-345, figs. 1, 2.
Thrips tabaci QUAINANCE, Bull. 20, N. S., U. S. Dept. Agr., p. 59. Remedies, various authors, 1899, p. 60.
Thrips tabaci WEBSTER-MALLY, Bull. 20, N. S., U. S. Dept. Agr., 1899, pp. 67-70.
 Thrips in Greenhouses, FERNALD-HINDS, Bull. 67, Mass. Exp. Sta., 1900, pp. 9-12.
Thrips communis TÜMPEL, Die Geradflügler Mitteleuropas, 1901, p. 293.
Thrips tabaci GARMAN, Bull. 91, Kentucky Exp. Sta., 1901, pp. 42-45.
Thrips tabaci WEBSTER, Journ. Columbus Hort. Soc., XVI, 1901, No. 3, 7 pp., 4 figs.
Thrips tabaci HINDS, Proc. 17th Ann. Conv. Soc. Amer. Florists, 1901, pp. 90-92.

Female.—Length about 1.1 mm.; width about one-fourth the length. Color quite uniformly light yellowish varying to brownish yellow.

Head one-fifth wider than long; cheeks slightly arched behind the eyes; frons slightly arcuate between them; occiput indistinctly transversely striated; hairs upon the head few and minute; eyes not protruding, coarsely granulated, very dark red by reflected light, black by transmitted light, sparsely pilose; ocelli subapproximate, standing well back to the line of the hinder edge of the eyes but posterior ocelli not contiguous with margins of eyes; color light yellow, margined inwardly with light brown crescents. Maxillary palpi three segmented; first and third segments equally long, second shorter. Antennæ seven segmented; relative lengths of segments as follows:

1	2	3	4	5	6	7
4.4	8.7	11.1	10	8.6	10.6	4

Segment one short and globose; two barrel-shaped; three to five pedunculate, elongated ovoid; five joined by moderately broad surface to base of six which tapers somewhat from its middle to its apical end; seven tapering slightly, blunt at apex. Segment one lightest in color, clear light yellow; two, six, and seven uniformly light grayish brown; three light brownish yellow; four and five colored like three at their bases but apices nearly as dark as six.

Prothorax as long as head, one-half wider than long; pronotum, indistinctly transversely striated and sparsely clothed with small spines; each hind angle bears a pair of very stout, conspicuous spines.

and between these pairs, along the hind edge of pronotum, stands a row of three smaller spines on each side. Metathorax one-third wider than prothorax; metanotal plate bears a few small spines. Wings about one-fourteenth as broad as long, slightly colored with light yellow; costal fringe of fore wings composed of short, stout bristles intermixed with a row of shorter spines. Fore longitudinal vein bears from ten to twelve spines arranged in three groups, as follows: Two groups upon the basal half of vein, the first of three or four spines, the second group of three, and beyond the middle of the wing four to six spines scattered at considerable distances along the vein to its tip; when only four are present in last group they stand at nearly equal distances apart; hind vein bears from fourteen to seventeen spines. Occasionally one or two cross veins may be seen between the fore vein and the costal at about one and two-thirds its length, but usually they are not present; hind vein arises from fore vein at about the middle of second group of spines. Hairs composing posterior fringes on both wings are long, slender, wavy, and light colored. Legs concolorous with body or somewhat lighter, quite long and slender; second segments of tarsi much longer than first; spines on inner side of hind tibiae weak, except the pair at its extremity; legs sparsely clothed with fine hairs.

Abdomen as wide, or slightly wider, than the mesothorax, about twice as long as wide; each dorsal plate of segments two to eight marked near its anterior edge with a narrow, transverse line of dark chestnut-brown color, widest at its middle and tapering gradually toward the sides, disappearing at the upper edge of the groups of three to five short spines which stand upon these segments just above the pleural plates. Posterior edge of ninth segment bears a circle of eight long, stout spines, most prominent dorsally; terminal segment bears six spines which are nearly as long as the preceding; besides these long spines both of these segments bear a few finer spines.

Redescribed from many specimens.

Male.—"Head and abdomen yellowish white; thorax yellow. The first two antennal segments white, the third at the end very weakly, the fourth and fifth more strongly shaded with gray; the sixth is gray, at the base or even to the middle white; the seventh segment entirely gray. Wings present."—Uzel.

Food plants.—Apple, aster (cultivated), blanket flower, blue grass, cabbage, candytuft, catnip, cauliflower, celery, chickweed, cinquefoil, clover, coneflower, crab-grass, cucumber, dandelion, *Erechtites*, *Erigeron canadensis*, four-o'clock, garden leek, goldenrod, heal-all, honeysuckle, Jamestown weed, jimson, kale, melons, mignonette, mullein, nasturtium, onion, parsley, pink, plum, pumpkin, *Rubus* several species, shepherd's purse, *Speicillaria*, squash, stonecrop, sweet clover, timothy, tobacco, tomato, turnip, wheat.

Habitat.—Russia (Lindeman), England (Shipley), Italy (Fargioni-Tozzetti), Bohemia, Helgoland (Uzel), Bermuda, United States: Massachusetts, Connecticut, New York, Long Island, Pennsylvania, New Jersey, District of Columbia, Virginia, Florida, Kentucky, Ohio, Indiana, Illinois, Iowa, Michigan, southern Canada, Colorado, California.

The early stages are described by Quaintance^a as follows:

Egg.—Length 0.26 mm.; width 0.12 mm.; in shape the egg is elliptical and curved. Fresh eggs are clear white. In eggs with advanced embryos, the reddish eyes are distinctly visible.

Larva, first stage.—(About one-half hour after hatching). Length, 0.38 mm.; width of thorax, 0.14 mm.; somewhat fusiform in shape; gradually tapering caudad from fourth or fifth abdominal segment; body, legs, and antennæ clear white; eyes reddish. Head in dorsal aspect about as broad as long; the eyes are situated at the cephalic lateral margins; no ocelli. In cephalic aspect the head is seen to be considerably produced—ventrad and caudad; suboval in outline. The four jointed antennæ are borne upon the vertex, and are approximate at base. Basal joint short, cylindrical, about half the length of second; second segment subpyriform, slightly longer than wide; third subspherical, about as long as second; fourth joint as long as the proximal three together, club-shaped, thickest near the basal third, tapering distally to a point. Joints three and four ringed; in the distal part of four these are much more pronounced, dividing it into what might be taken for short, indistinct segments. The antennæ bear setæ, which are much more numerous on fourth joint. Legs stout; coxa and trochanter short; femur about as long as tibia and tarsus together. The tarsus appears to be composed of but one joint, which terminates distally in two diverging claw-like processes; the bladder-like expansion on tip of tarsus does not seem to be present in this stage. Abdomen composed of ten segments; on the dorsum are four longitudinal acute setæ, and a row on each lateral margin. On the tenth segment these setæ are quite large, being from two to four times longer than the others.

Mature larva (second stage).—Length 0.94 mm.; width of mesothorax 0.22 mm. Body elongate; abdomen tapering caudad from about fifth segment. Head slightly longer than wide. Color greenish yellow, varying to greenish white. Legs and antennæ lighter; eyes reddish brown; ocelli wanting. Setæ practically as in stage 1. Antennæ four-jointed;^b basal joint short, cylindrical; second, sub-cylindrical, about twice as long as first. Third joint a fourth longer

^aQuaintance, Bull. 46, Fla. Agr. Exp. Sta.

^b“Lindeman regards the antennæ as six jointed, but to me joint four has not appeared to allow of being considered as made up of three joints, although there are four more or less well-defined parts, as determined by the rings, which, if considered as joints, would make seven in all, instead of six.”

than second; subpyriform, united to second by narrow "neck," rather closely ringed. Fourth, about as long as proximal three together, club-shaped, ringed as in stage 1. Antennae bearing setae much more numerous on fourth joint. Tarsi without the pronounced claw-like structures of the first stage. In other respects essentially as in preceding stage.

Nymph (about two days old).—Length about 0.7 mm.; width of mesothorax about 0.15 mm.; color yellowish, varying to almost colorless; eyes reddish. Pupa-skin somewhat separated from the body proper, being particularly noticeable in the caudal end of the abdomen, wing-pads, legs, and antennae. In these two latter the joints are very obscure, the pupa-skin covering them as a sheath. The wing-pads reach to about the eighth abdominal segment. There are numerous setae on the body, antennae, legs, and wing-pads. On the abdomen they have practically the same position as in the adult larva. The dorsal setae of the last segment in the nymphs are very stout, almost hook-like, curving cephalad.

Life history.—Dr. Lindeman's conclusions, quoted by Dr. Lintner, are so different from those which have been reached by workers upon the same species in this country that we are led to suspect that he has confused the early stages of very different species.

In Massachusetts, using specimens found infesting a cucumber house in January and February, I have found that the egg stage varies from four to seven days. Pupation takes place in seven or eight days and lasts for nearly a week, when the adults emerge and after a few days lay their eggs. The whole life cycle in a greenhouse thus occupies from three to four weeks.

In Florida Quaintance found that the egg stage lasts in summer from three and a half to four days; the larval stage from seven to nine days, during which time the larva molted twice; the nymph stage four days, the total life cycle thus requiring about sixteen days. There appeared to be no distinct broods at any season.

In Ohio Professor Webster has found that this species hibernates in larval, pupal, and adult stages, the first predominating, being found in matted grass or refuse tops left in the onion fields, and that they safely passed through winters when the temperature fell to -23 to -25 degrees F.

Economic considerations.—Dr. A. S. Packard, in 1872, was the first to record the ravages of the "Onion Thrips," which he called *Limothrips tritici* Fitch, believing it to be identical with the "Wheat Thrips." While Dr. Packard's description is unidentifiable, it is sufficient to show that the insect was not *Thrips tritici* Fitch, nor did it belong to the genus *Limothrips*. Furthermore, Packard states that the antenna consists of eight segments, which would separate it from *Thrips tabaci*, which has only seven. Still the injury recorded is so like that which is known to have been committed by *Thrips tabaci* at

various times that I have included a reference to it under this species, though its correctness is questionable.

Dr. Packard found that this insect has been observed attacking onions for fifteen years previously, but the damage in 1872 was unusually severe in Essex County, Massachusetts, amounting that year to at least one-tenth of the crop, and having a money value in that one county of at least \$10,000.

In 1889, Dr. Thaxter found the Onion Thrips generally distributed and very injurious to onions in Connecticut, the injury produced being known as "White Blast."

The next report of very serious injury was made by Prof. C. P. Gillette from Colorado, where for several seasons it had been noticed as very abundant and doing considerable harm. It has also been found a serious pest all through the Middle States and in several of the Atlantic coast States as well as on the Pacific coast. This shows its very wide general distribution, and since its attacks seem to be most severe upon onions and cabbages—two important garden crops—it must be considered as, perhaps, the most injurious species of the order.

THRIPS PERPLEXUS (Beach).

Plate VI, figs. 66-68.

Seicotrips? perplexa BEACH, Proc. Iowa Acad. Sciences, 1895, III, (1896), pp. 216-218.

Female.—Length 0.935 mm. (0.80 to 1.0 mm.); width of mesothorax 0.197 mm. (0.18 to 0.21 mm.). General color: head brown and thorax reddish orange-brown, very much darker than the pale yellow or gray-brown abdomen; body slender.

Head very large, somewhat pentagonal, approximately as long as broad or but slightly shorter, almost as large as prothorax, within which it is slightly withdrawn; cheeks nearly straight and parallel; anterior margin broadly elevated; without special prominences between bases of antennæ; occiput transversely wrinkled; without conspicuous spines. Eyes black, not protruding, together occupying about one-half the width of the head, margins lighter colored; ocelli conspicuous, large and well separated, placed far forward, all three being in front of the middle of the eyes, reddish yellow with maroon inward margins; ocellar bristles moderately long. Maxillary palpi three segmented. Antennæ fully twice as long as head, subapproximate; relative lengths of segments:

$$\begin{array}{ccccccc} \frac{1}{5.5} & \frac{2}{7.6} & \frac{3}{10.4} & \frac{4}{12} & \frac{5}{8.8} & \frac{6}{13} & \frac{7}{6.1} \end{array}$$

Segment one broader than two which is intermediate in thickness between one and three; three and four thickest at about their middle then tapering gradually to the ends; seven bluntly conical. Spines

long and slender, but not very conspicuous; those on three to five nearer the middle than usual. Color of one, two, five, six, and seven brown like head; three and four pale yellowish or gray; four shaded slightly with brown, increasing toward tip; basal constriction of five yellowish.

Prothorax not longer and but very slightly wider than the head, nearly square, without stout spines upon fore angles but with two long spines at each hind angle. Mesothorax about one and one-half times as wide as head, slightly wider than metathorax; greatest width at hind edge; color reddish or orange-brown. Wings reaching usually beyond the tip of abdomen, about one-seventeenth as broad as long; fore wing with two longitudinal veins; the origin of the hind vein indistinct; neither vein heavy; costa set with about twenty quite long spines besides the fringe hairs; fore vein bears ten to twelve rather weak spines and the hind vein about thirteen similar spines. Legs rather short; fore femora slightly thickened; yellow to gray-brown, bases of bladders dark brown; spines small except row of eight or nine on inner side of hind tibiae.

Abdomen nearly cylindrical and long, two and two-thirds times as long as wide; but very slightly wider than mesothorax; last three segments very short and tapering very abruptly to the acute apex. Color pale yellowish or grayish brown, very much lighter than thorax and head; ninth and tenth segments shading to brown-black; intersegmental membranes pale yellowish or gray. Segments not overlapping; receptaculum seminis placed far back beneath eighth dorsal plate, very conspicuous, bright orange-red; ovipositor indistinct, vestigial; tenth segment split open above and sides nearly meeting beneath; anal spines long, slender, not very dark.

Redescribed from seven females taken on grass at Amherst, Massachusetts.

Male unknown.

Food plants.—*Cyperus* sp., corn and grass (Iowa), *Dactylis glomerata*, *Panicum sanguinale*, and various other grasses (Massachusetts).

Habitat.—Ames, Iowa; Amherst, Massachusetts.

These specimens have been compared with Miss Beach's types and are identical. The vestigial condition of the ovipositor, however, misled her into thinking her specimens all males, whereas they are really all females.

This species is exceptional among the Terebrantia in lacking a functional ovipositor, but it is surely vestigial in this case. The eggs are very large, while the ovipositor is disproportionately short and weak, and it seems that it must be impossible for this species to deposit its eggs in the plant tissue. In this respect they thus show a divergence toward the Tubulifera, which lay their eggs wholly exter-

nally. It also seems probable that the so-called "rod" of the Tubuliferan female is but the vestige of a former ovipositor. The wing venation also indicates that the Eolothripidæ come nearest the primitive form and that Phlæothripidæ have diverged farthest from the type, with the Thripidæ somewhere in between. This species is therefore of considerable interest as possibly being one of the guide-posts to the phylogeny of the order Thysanoptera.

CHARACTERS OF TUBULIFERA (PLÆOTHIRIPIDÆ).

The members of this suborder agree so closely in general characters that they have all been included in the single family Phlæothripidæ. They are, as a rule, considerably larger and more powerfully formed than the Terebrantia, some of them being the giants of the order.

In the insects belonging to this suborder the head is always as long as broad, and may be two or three times as long. In most of those species which have comparatively short heads the front is smoothly rounded, but in those having very much elongated heads the vertex is considerably elevated, in some cases even forming a very prominent conical projection of the vertex beyond the bases of the antennæ. The eyes vary widely in size and number of facets. Ocelli are generally present. The cheeks are usually nearly straight and parallel, and in some species set with more or less numerous spine-bearing warts. Nearly every species has a pair of well-developed spines standing immediately behind the eyes, and therefore called post-ocular spines. The antennæ are invariably eight segmented in the adult stage and the sense cones on the intermediate segments are always simple. The mouth cone varies in form, being in some species short and blunt, and none of the external parts are acute at the tips; in others the labrum is abruptly constricted beyond the middle, its end forming a sharp spine-like process, which reaches beyond the broadly rounded labium; in still others the entire mouth cone, labium and all, is elongated and tapers to a quite slender tip, which, however, is not spine-like. These different forms of mouth cone have been thought to possess a generic value in classification, but my studies thus far have led me to the conclusion that too high a value has been placed upon this single character. The maxillary palpi have always two segments, of which the basal is very short, and the labial palpi are also two segmented, though frequently they are short and indistinct.

The prothorax has, in most cases, a trapezoidal form, and this is especially noticeable in those species in which the fore femora are much enlarged. The regularity of the outline of this trapezoid is, however, more apparent than real, as will be seen by reference to Plates VIII, IX, and X. The projecting fore coxæ fill in the hind angles so smoothly that in many cases careful focusing is necessary to show that the outline is not entirely that of the prothorax alone. The pro-

notum usually bears around its outer portion a number of conspicuous, long spines. The fore femora are frequently greatly enlarged, and when this is the case there will be found upon the fore tarsus a more or less stout tooth or hook. In most species the femora and tarsal teeth are larger in the males than in the females. The pterothorax is very compact and nearly rectangular in outline. The wings, which are usually present, are all very similar in form, venation, etc. They are either quite slender throughout or somewhat constricted near the middle, and are rounded at the tips. They have almost no veins, there being no ring or cross veins, and only one partially developed median vein in each wing. Along the margins of each wing there is borne a long, slender fringe, which is single except near the outer end of the hind margin of the fore wing, where it is double for a short distance. The membrane of each wing lacks microscopic spines such as are found upon the wings of Terebrantia. When brought to rest the wings are laid back closely upon the middle of the abdomen, so that they overlap in their second halves. They are here held in place, and the long, slender fringes confined by the rows of inwardly curved spines which stand upon each side of the second to seventh segments. In some species the wings are reduced to short, rounded pads, while in others even these are wanting.

The abdomen is very similar in both sexes, except that in the male it is usually more slender, especially through the sixth, seventh, and eighth segments. The female has no ovipositor. The sexual opening is between the ninth and tenth segments in both males and females. The last segment is a simple tube in both sexes and at its base, beneath, are found the distinctive sexual characters. The female is distinguished by a short, strongly chitinized rod upon the ninth segment near the base of the tube which is regular and entire. The male is distinguished by a semicircular notch in the base of the underside of the tube, providing an opening for the protrusion of the copulatory apparatus which is wholly retracted into the ninth segment. In many species the abdomen is somewhat flattened dorso-ventrally so that a cross section is elliptical in outline.

Tubuliferans live usually in secluded places, as between the parts of composite flowers, under the bark of trees, on the underside of foliage, in galls, moss, turf, fungi, etc. Their movements are very deliberate and they never run or spring.

SYNOPSIS OF PHLEOTHRIPIDÆ.

1	{	Body slender, head more than one and one-half times as long as wide	8
		Body more or less thickened, head less than one and one-half times as long as wide	2
2	{	Breadth of abdomen of female nearly or quite one-half its length	3
		Breadth of abdomen of female not nearly equal to one-half its length	4
3	{	Head broadly rounded in front, cheeks without warts..... <i>Trichothrips</i> (p. 191)	
		Head narrowed in front	<i>Eurythrips</i> (p. 202)

4	{	Wings always present, usually inhabiting flowers	5
	{	Wings usually reduced, usually inhabiting bark or turf	7
5	{	Checks without spine-bearing warts.....	<i>Anthothrips</i> (p. 188)
	{	Checks with spine-bearing warts	6
6	{	Fore femora with teeth at tip within, intermediate antennal segments usually long and slender.....	<i>Acanthothrips</i> (p. 198)
	{	Fore femora without teeth in female and usually in male, intermediate antennal segments not elongated.....	<i>Phlocothrips</i> (p. 195)
7	{	Head very large, rounded in front.....	<i>Cephalothrips</i> (p. 194)
	{	Head small, narrowed in front.....	<i>Malacothrips</i> (p. 200)
8	{	Head more than twice as long as wide	<i>Idolothrips</i> (p. 206)
	{	Head less than twice as long as wide	<i>Cryptothrips</i> (p. 205)

Genus ANTHOTHRIPS Uzel.

Head but little longer than wide, rounded in front; cheeks nearly parallel, without warts. Antennæ nearly twice as long as the head. Ocelli and wings always present in both sexes. Wings narrowed in the middle. Mouth cone not longer than the breadth at its base; labrum narrowed toward tip but not sharply pointed. Fore tarsi armed with a tiny tooth which is somewhat larger in males than in females. Males without a scale at base of tube.

The two species belonging here may be easily separated by the presence or absence of spines upon the head. In *A. niger* (p. 188) the cheeks are smooth, without spines, and there are no post-ocular spines, while in *A. verbasei* (p. 189) the cheeks bear small spines not standing on warts and the post-ocular spines are well developed.

ANTHOTHRIPS NIGER (Osborn).

Plate VII, figs. 72-75.

Phlocothrips nigra OSBORN, Canad. Entom., XV, 1883, p. 154; Rept. U. S. Dept. Agr. for 1887, (1888), pp. 163, 164; Ins. Life, I, 1888, pp. 137-142; Ins. Life, V, 1892, pp. 112-113.—DAVIS, Bull. 116, Mich. Agr. Exp. Sta., 1894, pp. 62, 63.

Anthothrips nigra UZEL, Mon. d. Ord. Thysanoptera, 1895, p. 242.

Female.—Length 1.5 mm. (1.1 to 1.8 mm.); width of mesothorax 0.34 mm. (0.3 to 0.4 mm.). General color more or less dark reddish brown.

Head approximately as long as broad, longer than prothorax, smoothly rounded in front; cheeks straight, parallel, and without warts. Eyes small, finely faceted; ocelli quite large and well separated, posterior ocelli almost contiguous with margins of eyes; no post-ocular bristles. Mouth cone shorter than its breadth at base and blunt at tip. Antennæ subapproximate, as long as width of mesothorax; segments quite short and stout; fourth thickest and most rounded; relative lengths of segments as follows:

$\frac{1}{6}$	$\frac{2}{10.3}$	$\frac{3}{12.3}$	$\frac{4}{12.9}$	$\frac{5}{11.5}$	$\frac{6}{10.7}$	$\frac{7}{10.6}$	$\frac{8}{7.4}$
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Color nearly uniform brown; three and base of four yellowish brown; spines short and weak; sense cones short and blunt.

Prothorax one-half as long as breadth to outer angles of coxæ; front and hind edges nearly parallel, gently curved; one short spine at each posterior angle and one nearly halfway between this and middle of hind edge. Mesothorax somewhat wider than prothorax but usually less than twice as wide as the head; sides of pterothorax nearly straight, shorter than its breadth. Legs short and moderately stout; fore femora but slightly thickened; fore tarsi armed with a tiny tooth near tip within; middle and hind tibiae with one prominent spine externally at tip. Legs brown; middle and hind tarsi slightly yellowish, sometimes brown; fore tarsi and tip of tibiae yellow. Wings always present, narrower in middle than at ends, shaded with brown only at base, where fore wing bears three erect spines. Wings and fringes nearly equal; fringes single, except on hind border of fore wing near tip, where for seven or eight hairs they are double.

Abdomen about twice as broad as head, averaging about two and one-half times as long as wide; segments overlapping somewhat; sides nearly parallel to middle, then tapering gradually to base of tube. Tube about four-fifths as long as head, only slightly tapering; sides straight; terminal spines shorter than tube. All spines on abdomen short, weak, and not conspicuous.

Redescribed from seven specimens.

Male unknown.

Food plants.—*Achillea millefolium*, ox-eye daisy, red clover, white clover, various grasses.

Habitat.—Iowa, Michigan, Massachusetts.

ANTHOTHIRIPS VERBASI (Osborn).

Plate VII, figs. 76-78.

— OSBORN, *Ins. Life*, I, 1888, pp. 137-142.

Phleothrips verbasi OSBORN, *Proc. Iowa Acad. Sc.*, III, 1896, p. 228.

Female.—Length 1.8 mm. (1.42 to 2.12 mm.); width of mesothorax 0.38 mm. (0.32 to 0.44 mm.). General color dark brown.

Head but slightly, if any, longer than wide; cheeks nearly straight and parallel, set with few minute spines; post-ocular bristles prominent; hind margin of head not covered by front margin of prothorax. Eyes finely and closely faceted, rounded, not protruding; ocelli widely separated, posterior ones contiguous with the light margins of eyes; front ocellus placed at extreme vertex. Mouth cone about as long as it is broad at base, pointed. Antennæ approximate, almost twice as long as head; relative lengths of segments:

1	2	3	4	5	6	7	8
9	12	15	15	15	14	12.6	10.6

Segment three clavate; four fusiform; five and six becoming more slender and less fusiform; seven cylindrical; eight sharply conical. Segment one and base of two dark brown; tip of two, seven, and eight yellowish brown; intermediate segments pale yellow. Spines pale and weak; sense cones short and blunt.

Prothorax short, only about three-fourths as long as head; fore and hind margins nearly parallel and curving backward; one stout spine at each angle, one in middle of sides, and one on each side between those at the angle and the median line on both fore and hind margins; hind angles appear to entirely cover the fore coxæ as a rule; each fore coxa bears one stout spine. All these stout spines are blunt but not knobbed. Sides of pterothorax full and smooth; fore angles oblique; color of thorax uniform dark brown or yellowish brown, more or less irregularly mottled with dark red. Wings present, narrowed in middle, transparent except at base, where the fore wing bears three long spines upon the remnant of the single median vein. Fringes long, single, except near end of hind fringe of fore wing where it is double for ten or twelve hairs. Legs moderately long and slender; fore femora only slightly thickened; fore tarsus one segmented and armed with a tiny tooth. All femora and middle and hind tibiæ dark brown; middle and hind tarsi slightly yellowish or grayish brown; fore tibiæ and tarsi bright yellow like middle of antennæ; fore tibiæ shaded a little with brown toward their bases outside. One long slender spine near base of each fore femur below; each fore coxa with one long spine.

Abdomen broadly joined to metathorax and but slightly wider, widest at base but less than twice as wide as head; segments more or less imbricate, tapering gradually to tube. Tube about four-fifths as long as head, tapering slightly, not swollen at base, bearing a circle of spines at tip which are shorter than the tube. All spines on abdominal segments slender and rather faint; color of abdomen quite uniform yellowish brown to dark brown. In the lightest colored specimens the irregular dark mottlings show up most prominently.

Redescribed from eight females.

Male.—The male agrees quite closely with the foregoing description; it is usually somewhat smaller throughout; relative lengths of antennal segments are as follows:

1	2	3	4	5	6	7	8
8.5	11.5	13.5	14.5	14	12.8	12	10

Fore tarsi are armed with a medium-sized tooth, which is larger than that in the female. Of the four spines standing near the hind edge of the ninth segment, the outer pair is very short, stout, and acute; the abdomen seems to be somewhat more slender than in female.

Described from four males.

Food plant.—Mullein.

Habitat.—Ames, Iowa; Amherst, Massachusetts.

Genus TRICHOTHRIPS Uzel.

Head about as broad as long, broadly rounded in front. Eyes small. Ocelli present in both these species, but often wanting. Mouth cone not longer than its breadth at base; labrum pointed at tip. Fore femora somewhat enlarged and tarsi armed with a tooth. Wings usually wanting, but present in both these species, slender throughout. Abdomen very broad and heavy; tube very slender in proportion to width of abdomen; no scale at base of tube in the male.

The two species which I have placed in this genus may be distinguished by the following characters:

- Tube fully as long as the head *beachi* (p. 192)
- Tube two-thirds as long as the head *ambitus* (p. 191)

TRICHOTHRIPS AMBITUS, new species.

Plate VIII, figs. 81, 82.

Female.—Length 2 mm.; width of mesothorax 0.45 mm. General color brownish yellow shading to brown or reddish brown.

Head slightly longer than wide, widest just behind the eyes, rounded in front; cheeks straight and converging posteriorly; at hind edge only six-sevenths the diameter at widest part; frons slightly elevated between bases of antennae; post-ocular bristles present; a few scattering small spines upon head not raised upon warts; surface faintly reticulated. Anterior half of head light brown flecked with reddish, posterior half fading to yellow at the neck. Eyes small, finely granulated, compact, not pilose, purplish by transmitted light, reddish orange by reflected light; ocelli present, subapproximate, pale yellow margined inwardly with reddish brown crescents. Mouth cone reaching nearly to posterior edge of prosternum; maxillary palpi two segmented; labial palpi short and thick; labium broad and rounded; maxillae converging abruptly below the palpi and short. Antennae one and three-fourths times as long as the head, eight segmented, though the joint between seven and eight is very indistinct; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
12	18	28	26	21	20	15	8

Segment one truncate, conical; two constricted toward base into a broad stalk, cut off squarely at end; three to seven slenderly stalked at bases; three to six clavate; seven cylindrical-ovate, very closely united by full width of end to eight which is conical. Color of one pale brownish yellow; two and three clear yellow; four yellow at base

shading to light brown at end; remaining segments dark brown. Sense cones on segments three to six very long and slender; transparent spines upon each segment also long and slender.

Prothorax three-fourths as long as head and three-fifths as long as wide; fore coxæ project considerably beyond posterior angles. One medium length spine on each side of middle and near anterior edge, one near each anterior angle, one at middle of each side and one longer one at each posterior angle. Mesothorax equal in width to prothorax and concolorous with it; mesonotum bears one long spine close to base of each fore wing. Metathorax equal in width to mesothorax, narrowed but very slightly posteriorly, pale yellow in middle, shaded on sides, splashed with red. Each fore coxa bears a single long spine on outer side; fore femora somewhat enlarged; each femur bears a single long, erect spine on the outer side near its extremity; tarsi short and thick, fore pair armed with a stout tooth. Femora gray-brown, fore pair yellowish brown; fore tibiæ and tarsi pale yellow; middle and hind tibiæ and tarsi almost white. Wings reaching to tip of abdomen; both pairs equal in size, edges parallel, heavily fringed; fore wings bearing a costal group of three long slender spines between the fringe and base of wing. Color of wings clear, transparent, except a slightly clouded band across fore wings at about one-third their length.

Abdomen broad and heavy; last three segments tapering abruptly; at sixth segment one and one-sixth times as broad as thorax. Tube two-thirds as long as head and at middle one-seventh as broad as the fourth abdominal segment; terminal spines about as long as tube. A stout bristle projects anteriorly from each side angle of first segment; each following segment, except tube, bears on each side one spine; these are short upon first segment and increase in length and size posteriorly. Color brownish yellow in middle, shaded with dark reddish brown on sides; tube bright brownish yellow tipped abruptly with gray-brown.

Described from one female.

Male unknown.

Food plant.—Grass.

Habitat.—Amherst, Massachusetts.

TRICHOTHRIPS BEACHI, new species.

Plate VII, fig. 79; Plate VIII, fig. 80.

Female.—Length 1.84 mm. (abdominal segments one-third telescoped); width of mesothorax 0.48 mm. General color yellow-brown.

Head as broad as long, rounded in front; cheeks slightly converging behind the middle, set with scattered, small, stout spines borne upon small warts; post-ocular bristles quite long and acute. Eyes small, finely faceted, rounded; ocelli large, distant, posterior two almost

contiguous with light yellowish margins around eyes, color reddish yellow. Antennæ more than twice as long as the head; length and breadth of segments increase gradually from base to middle, then decrease to tip of antenna; relative lengths of segments as follows:

$\frac{1}{9}$	$\frac{2}{15}$	$\frac{3}{22}$	$\frac{4}{22}$	$\frac{5}{19}$	$\frac{6}{17}$	$\frac{7}{14.5}$	$\frac{8}{13}$
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Color dark brown; bases of three to five yellowish; spines of medium length, but not very conspicuous; sense cones about one-third of the length of the segment bearing them.

Prothorax about five-sixths as long as head, and nearly twice as broad as long, broadly rounded at hind edge; spines upon fore edge much smaller and weaker than the mid-lateral and those on hind edge; all these spines are acute. Mesothorax about one and one-half times as wide as prothorax, uniting closely and evenly with metathorax so that sides of pterothorax are nearly straight. Wings present, long and powerful; fringes long, double for from nine to eleven hairs in hind fringe of fore wing near tip. Legs of medium size and length; fore femora a little thickened and tarsi armed with a very tiny tooth; middle legs much the smallest. All femora chestnut brown; tibiae at base brown, fading to yellowish at tips; fore tibiae lightest; tarsi yellow. Fore coxæ project a little beyond sides of prothorax and each bears one long spine; each femur bears one long slender spine on under side near base; three or four long slender spines stand around tips of middle and hind tibiae.

Abdomen large and heavy, somewhat broader than thorax, slightly more than twice as broad as head; segments overlapping about one-third; sides nearly parallel up to eighth segment, then tapering very abruptly. Tube slender in middle, about one-eighth the breadth of the abdomen, fully as long as the head, tapering but slightly; terminal circlet of spines shorter than tube; spines on abdomen light colored.

Color of whole body generally yellowish brown, lightest along middle of back of thorax and abdomen; abdomen darkest where segments overlap; thorax and abdomen show some irregular dark red hypodermal pigmentation. All spines acute.

Described from one female taken under quince bark in early spring, together with many bright-red larvæ around it.

Male unknown.

Food plant.—Taken under quince bark.

Habitat.—Amherst, Massachusetts.

I take pleasure in naming this species for Miss Alice M. Beach in recognition of her work upon the Thripidae of Iowa.

Genus CEPHALOTHRIPS Uzel.

Head considerably longer than its breadth or the length of the prothorax, broadly rounded in front and larger than in most species in proportion to the other segments. Eyes small; ocelli present. Antennae about one and one-half times the length of the head. Mouth cone shorter than its breadth at base; labrum not narrowed in the middle and ending in a blunt point. Fore femora slightly thickened and tarsi with a tiny tooth. Wings usually reduced or wanting entirely. Male without a scale at base of the tube.

I place here only one species, *yuccæ*.

CEPHALOTHRIPS YUCCÆ, new species.

Plate VIII, figs. 83, 84.

Female.—Length 1.48 mm. (1.40 to 1.56 mm.); width of mesothorax 0.29 mm. (0.28 to 0.30 mm.). General color yellowish brown, irregularly mottled with dark-red hypodermal pigmentation.

Head broad and large, about one and two-fifths times as long as wide; cheeks slightly arched and smoothly joined to eyes, converging slightly toward neck; front smoothly rounded; post-ocular bristles present, but rather small and not prominent; cheeks smooth. Eyes small, each being less than one-fourth the breadth of the head through them, triangular above and surface even with that of head, very dark red in color; ocelli small, situated far forward, quite widely separated, with very dark red inner margins. Mouth cone short and rather blunt. Antennae nearly one and one-half times as long as head, considerably separated at bases with but slight elevation between them; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
6.5	11.6	12.5	12.5	11.8	11.3	11.2	8.25

Segments three to five subequal in breadth and similar in shape. Antennae yellow, segments one and two shaded with brownish. Sense cones quite long and slender; spines shorter and light colored, so inconspicuous.

Prothorax two-thirds as long as head and across outer angles of coxæ about one and two-fifths times as wide as head; sides of thorax really considerably indented above fore coxæ. Anterior marginal and mid-lateral spines wanting; those at angles present, but weak and inconspicuous. Pterothorax as broad as prothorax through coxæ, equal to about one-fifth the length of the body; its sides straight and parallel; about four-fifths as broad as abdomen. Wings usually reduced to mere pads, but when occasionally present they are of moderate length, though not very powerful. (Winged specimens have the

pterothorax nearly as wide as the abdomen.) Legs rather short and thick; fore coxae project somewhat beyond thorax; fore femora slightly thickened and the tarsi armed with a tiny tooth; tibia of each leg slightly shorter than its femur; all tarsi short and thick. All femora and middle and hind tibiae brown; all tarsi and fore tibiae, except at base outside, pale yellow; a prominent brown spot at tip of tarsi within.

Abdomen about three-fifths the length of the body; about one and one-fourth times as broad as the mesothorax; nearly cylindrical to seventh segment, then sides curve smoothly to base of tube. Tube less than one-half as long as head and at middle only about one-ninth the breadth at middle of abdomen. Spines on abdomen of moderate length, slender, acute, light colored, and not prominent. The abdomen is darkest at sides and tip; on each side of segments two to eight, slightly outside the line of wing-confining spines, there is a rounded or elliptical clear yellow spot. The body lacks any striking coloration.

Described from ten wingless and two winged females.

Cotype.—Cat. No. 6331, U.S.N.M.

Male.—The males are about five-sixths as large as females. Their antennae are about one and two-fifths times as long as the head; there appears to be less difference in the length of antennal segments than in female; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
6	10	11	10.25	10	9.75	9.75	7.4

Abdomen about one and one-fifth times as broad as mesothorax; tube about one-half as long as head and at middle about two-fifteenths as broad as middle of abdomen.

Described from nine males, all short winged. All of my males were taken in September, and it may be that winged specimens occur earlier in the season.

Cotype.—Cat. No. 6331, U.S.N.M.

Food plants.—*Yucca filamentosa*, goldenrod.

Habitat.—Amherst, Massachusetts; Washington, District of Columbia.

Genus PHLÆOTHRIPS Haliday.

Head somewhat longer than wide; cheeks with small warts, each bearing a tiny spine. Intermediate antennal segments not particularly elongated; the whole antenna less than twice as long as head. Mouth cone as long or longer than its breadth at base and narrowed; labrum sharply pointed at tip. Fore femur enlarged and tarsus armed with a tooth. Wings not narrowed in middle, present in both sexes. No scale at base of tube in male.

I place two species in this genus. They may be separated by the following characters:

All femora dark brown; tibiae and tarsi bright yellow.....*uzeli* (p. 196).
 Legs gray-brown; tarsi somewhat lighter; fore tibiae yellowish...*pergandeii* (p. 197).

The female of the species *uzeli* comes within the definition of the genus *Phleothrips*, but the male of this species has the teeth at the tip of the fore femora, which is the principal character upon which Uzel has separated his genus *Acanthothrips*. This species, therefore, appears to unite the characters of these two genera, and as more emphasis is placed upon the description of the female than upon that of the male, I have preferred to include this species in the established genus *Phleothrips* rather than to erect a new genus for it.

PHLEOTHRIPS UZELI, new species.

Plate VIII, figs. 87-90; Plate IX, figs. 91, 92.

Female.—Length 1.76 mm. (1.72 to 1.86 mm.); width of mesothorax 0.39 mm. (0.38 to 0.40 mm.). General color dark brown with yellow tibiae and tarsi.

Head about one and one-fourth times as long as wide, rounded in front; cheeks nearly straight and parallel, set with several short, stout spines borne upon small warts; post-ocular bristles quite long and knobbed. Eyes moderately large, rounded, finely faceted; ocelli prominent, distant, reddish yellow, posterior ones contiguous with light borders of eyes. Mouth cone long and pointed, reaching to posterior edge of prosternum. Antennae about one and three-fourths times as long as the head, slightly more than twice as long as width of head; relative lengths of segments as follows:

$\frac{1}{9.7}$	$\frac{2}{12.3}$	$\frac{3}{18}$	$\frac{4}{18.3}$	$\frac{5}{16}$	$\frac{6}{14.3}$	$\frac{7}{13.3}$	$\frac{8}{8.5}$
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Segments one and two dark brown; three brownish yellow, lightest at base; four to six light brown, pale yellow at base; seven and eight light brown; spines long but not very dark colored; sense cones over one-third the length of the segment bearing them.

Prothorax two-thirds as long as head, and to angles of coxæ twice as wide as long; usual anterior marginal, posterior marginal and mid-lateral spines present, knobbed. Mesothorax slightly wider than prothorax; sides of pterothorax straight and converging a little to base of abdomen. Wings long and powerful. Legs of medium length and quite stout; fore femora somewhat thickened and the tarsi armed with a small tooth; middle of outer surface of each fore tibia and femur supports one long slender spine near the base on under side. All femora dark brown; all tibiae and tarsi bright yellow, the middle and hind ones being slightly shaded with brown.

Abdomen large and stout, about four times as long as head, as wide as mesothorax; sides nearly parallel to seventh segment, from there tapering roundly to base of tube; segments overlapping about one-third. Tube four-fifths as long as head; sides straight and converging slightly; breadth in middle one-seventh that in middle of abdomen; terminal circle of hairs about the length of the tube, very slender. Spines on sides of abdomen blunt; abdomen quite uniformly yellowish brown (dark brown where segments overlap).

Described from three females.

Cotype.—Cat. No. 6332, U.S.N.M.

Male.—Males about six-sevenths as large as females. Cheeks slightly fuller; relative lengths of antennal segments as follows:

1	2	3	4	5	6	7	8
8	11	15.6	15.9	13.9	12.4	11	7.9

Fore femora larger than in female and terminating in two teeth at tip within; fore tibiae have each a small tooth near base within; teeth on fore tarsi large. (The teeth upon femora and tibiae are not found at all in the female of this species.) Tube at middle about one-sixth the width at middle of abdomen; abdomen tapering slightly.

Described from five males.

Cotype.—Cat. No. 6332, U.S.N.M.

Food plants.—Taken on various grasses, clover, and *Ulmus montana* var. *pendula*.

Habitat.—Amherst, Massachusetts.

This species is named for Dr. Henry Uzel, of Königgrätz, Bohemia, whose Monograph of the Order Thysanoptera is by far the best work that has been published upon this order.

PHLÆOTHRIPS PERGANDEI, new species.

Plate VIII, figs. 85, 86.

Female.—Length 1.68 mm. (abdominal segments overlapping for about one-fourth their length); width of mesothorax 0.42 mm. General color yellowish brown, with considerable irregular red hypodermal pigmentation.

Head about one-sixth longer than wide, widest close behind the eyes, rounded in front; cheeks slightly curved and bulging behind eyes, converging slightly posteriorly, set with a number of short, stout spines borne upon quite prominent warts; post-ocular bristles long and knobbed. Eyes about medium in size, slightly elongated, finely faceted; ocelli quite large, distinct, subapproximate, reddish yellow with dark red crescentic margins, situated well forward upon vertex, which is slightly elevated. Mouth cone quite long, reaching to back of prosternum; labrum sharply pointed and overreaching the

labium. Antennae twice as long as width of head; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
$\frac{1}{10}$	14	22	21	17	14	13	8.5

Color of antennae brown with bases of three, four, five, and six decreasing in area and intensity of yellowishness; sense cones about one-third the length of segment three; spines quite long, dark, and conspicuous.

Prothorax only five-sevenths as long as head, and to outer angles of fore coxae slightly more than twice as wide as long; usual prothoracic spines present, quite long and knobbed. Mesothorax as wide as width across fore coxae, closely joined with prothorax; pterothorax very compact, sides converging slightly to base of abdomen. Wings long and powerful. Legs quite strong; fore femora much thickened, over one-half as broad as head; fore tarsi armed with a small tooth. Color of legs uniformly gray-brown; tarsi somewhat lighter; fore tibiae yellowish, shaded with brown at bases and on top.

Abdomen less than twice as broad as head, equal in width to mesothorax, nearly cylindrical to eighth segment; eighth and ninth tapering abruptly to base of tube. Tube only two-thirds as long as head; sides straight, tapering somewhat; breadth in middle about one-eighth that of middle of abdomen; terminal hairs a little longer than tube. All large spines on body, except those on hind edge of nine and at tip of tube are short and knobbed; those on nine and tube are acute. Color of abdomen pale brownish yellow, lightest in middle; blood-red pigmented tissue confined mostly to sides of abdomen in this specimen.

Described from one female.

Male unknown.

Food plant.—Taken on grass.

Habitat.—Amherst, Massachusetts.

I name this species for Mr. Theodore Pergande, by whom several of our native species have been described.

Genus ACANTHOTHIRIPS Uzel.

Head somewhat longer than wide; cheeks with spine-bearing warts. Antennae very nearly twice as long as head; intermediate segments elongated and bearing very long sense cones. Mouth cone considerably longer than its breadth at base and quite slender. Fore femora enlarged in both sexes and with one or two teeth at tip within; tarsus armed with a stout tooth (Uzel says the tooth is weaker in the male than in the female). Wings present in both sexes. No scale at base of tube in the male.

I have placed the single species *magnafemoralis* in this genus, though I do not know the female. The characters of the fore femora and antennæ are sufficient to separate it generically from *Phleothrips*.

ACANTHOTHRIIPS MAGNAFEMORALIS, new species.

Plate IX, figs. 93, 94.

Male.—Length 2.16 mm.; width of mesothorax 0.42 mm. General color yellowish brown with antennæ, legs, and eighth and ninth abdominal segments banded with nearly transparent or yellowish white.

Head nearly one and one-fourth times as long as wide; cheeks bulging abruptly and greatly behind the eyes, then converging to the neck, which is as wide as the diameter through the eyes; cheeks, especially anterior parts, set with short spines borne upon very prominent tubercles; front between eyes very narrow, carinated. Eyes large, finely faceted, reniform above, inner edges parallel; ocelli small, approximate, and placed between the middle of the eyes. Proboscis long, slender, pointed; labrum sharply pointed. Antennæ scarcely twice as long as the head and very slender; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
10	12	29	26	23	15	15	9

Segments one to five subequal in thickness; three to five similar in shape, elongated, urn-shaped; eight sharply conical. Segments one, two, seven, and eight quite uniformly dark brown; bases of three to five and tips of three and four pale yellowish, nearly white on three; six entirely pale yellow, with slight brownish tinge on outer half; antennæ appear annulated with pale yellow and dark brown. Spines and sense cones long, slender, and light colored; the cones on three to five fully one-third the length of segment three and on six about three-fifths its length.

Prothorax about two-thirds as long as head; width to outer angles of coxæ nearly twice its length; transverse margin nearly straight; the usual stout spines on thorax and abdomen, except those at tip of tube, are extremely short and blunt. Mesothorax slightly wider than the abdomen; middle of pterothorax concaved slightly. Wings long and rather slender. Legs moderately long; fore femora extremely thick and large, almost as wide as length of fore tibiæ; fore femora armed with a stout tooth at the tip within; fore tibiæ bent outward at base; fore tarsi one segmented, armed with a very stout tooth; middle and hind tibiæ rather short and swollen in the middle, their tibiæ quite slender and their tarsi two segmented. Fore femora yellowish brown; fore tibiæ and tarsi pale yellowish, tibiæ alone shaded with brown on middle of outside; middle and hind femora almost transparent white at base, outer half shaded with brown and having a

roundish, light yellowish spot on side of dark area; middle and hind tibiae pale yellowish at base and tip, banded with dark brown around the middle, these tarsi pale yellow, brown at tips; surface of all legs rough, being thickly set with minute warts, each bearing a small spine.

Abdomen about two-thirds the length of the body, tapering gradually from second segment to tip; width at second segment but slightly less than that of mesothorax. Tube slightly more than three-fourths as long as head; diameter at middle of tube about one-sixth that at middle of abdomen. Sides of metathorax and surface of abdomen, up to about the seventh or eighth segment, peculiarly roughened with closely set small warts, many of which bear small spines. The tube is nearly cylindrical, without a scale at its base, and at the tip bears a circle of eight extremely long, slender, acute hairs, which are nearly three times as long as tube. The basal third of tube is very pale yellowish white; the outer two-thirds is abruptly brown-black; segments eight and nine pale yellow; three to seven appear irregularly striped with pale yellow and dark brown; dorsal stripe pale yellow and about the width of the wings; a subdorsal row of dark-brown, semicircular spots, which stand one in the middle on each side of these segments with the straight side toward the dorsal line, gives the appearance of a subdorsal stripe; then follows on each side an irregular, pale yellow stripe, and the middle of the sides of the segments is shaded with brown. Spines on sides of abdominal segments and the back of eighth and ninth are extremely short and blunt.

Described from one specimen.

Female unknown.

Food plant.—?

Habitat.—Miami, Florida.

MALACOTHRIPS, new genus.

Head plainly longer than wide and narrowed in front. Cheeks full and with spine-bearing warts; vertex elevated. Antennae nearly twice as long as head. Mouth cone as long as its breadth at base, reaching the hind edge of the prosternum; labrum quite sharply pointed at tip. Prothorax two-thirds as long as head. Pterothorax somewhat constricted in middle. Fore tarsi with a tiny tooth. Wings usually reduced to pads. Abdomen large and full in the female. A closely lying scale at base of tube in the male.

This genus contains only one species, *zonatus*.

(μαλακος, soft; θρυσ.)

MALACOTHRIPS ZONATUS, new species.

Plate IX, figs. 95-98.

Female.—Length 1.62 mm. (1.50 to 1.68 mm.); width of pterothorax 0.30 mm. (0.27 to 0.34 mm.). General color pale bright yellow on

thorax and segments one, three, four, and five of the abdomen; head and other abdominal segments brown. Body apparently weakly chitinized.

Head nearly one and one-third times as long as wide, narrowed in front; cheeks moderately full and set with a few small spines borne upon small warts; head appears constricted close behind the eyes, and slightly so at neck; post-ocular bristles well developed; front of head between eyes developed into a prominence bearing the antennæ; vertex produced into a sort of hump, which, however, does not overreach the insertion of the antennæ. Eyes small, finely faceted, dark purplish red, surrounded by pale yellow margins; ocelli present, subapproximate, borne well forward upon the hump, the front ocellus being upon its vertex; pigmentation around ocelli bright red. Mouth cone moderately long and slender; labrum abruptly constricted and sharply pointed at tip. Antennæ approximate at base, almost twice as long as head; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
9.8	13.5	18.4	16.5	15.8	13.9	12.4	11.4

Basal segments large, truncate-conical, placed divergently; three clavate; from three to eight the segments become gradually more narrow. Antennæ nearly uniformly brown, except three, which is yellowish brown; spines and sense cones quite long, but slender and light colored, so inconspicuous.

Prothorax about two-thirds as long as head and across outer angles of coxæ about twice as wide as long. All the usual prominent prothoracic spines well developed, but light colored; hind margin not sharply defined. Pterothorax in middle slightly narrower than width across fore coxæ; mesothorax short, slightly narrower than metathorax and slightly brownish yellow in color. Wings reduced to very small pads, each fore pad bearing three quite long, blunt spines. Legs of medium length and middle and hind pairs quite slender; fore coxæ projecting considerably beyond thorax; fore femora slightly thickened and tarsi armed with a small tooth. All legs pale yellow or pale brownish yellow with prominent brown spot within tip of tarsus.

Abdomen about one and two-fifths times as broad as metathorax, quite stout to eighth segment, then sides converging to base of tube. Tube about three-fourths as long as head and one-third as wide at middle as long; sides straight, tapering slightly; terminal spines about as long as tube; spines on sides of abdomen pale, but quite prominent in reduced light. Segment one is concolorous with metathorax; three to five are clear, bright yellow; two, six, seven, and eight are yellowish brown, darkest on sides; nine and tube are darkest brown.

Described from four females.

Cotype.—Cat. No. 6333, U.S.N.M.

Male. Length about five-sixths that of female; head and prothorax nearly as long as in female; relative lengths of antennal segments as follows:

1	2	3	4	5	6	7	8
10	11	16	14	13.8	11.8	10.5	9.5

Abdomen only about four-fifths as long or as broad as in female and tapering more uniformly from base to tip.

Described from two specimens.

Cotype.—Cat. No. 6333, U.S.N.M.

Food plant.—Taken in turf.

Habitat.—Amherst, Massachusetts.

EURYTHRIPS, new genus.

Head as long or somewhat longer than wide, narrowed in front. Eyes small and vertex between them elevated. Antennæ fully twice as long as the head and thicker than in most species. Prothorax about two-thirds the length of the head. Fore tarsi with a small tooth, which is larger in the male than in the female. Wings usually reduced to short pads. Abdomen unusually large and heavy in proportion to the rest of the body. Males with a closely lying scale at the base of the tube.

The species *ampliventralis* is the type of this genus.

(*εὐρύς*, broad; *θρῦψ*.)

The two species belonging to this genus may be separated by the breadth of the abdomen, which in *ampliventralis* (p. 202) is about one and two-thirds times as wide as the pterothorax, while in *osborni* (p. 203) it is only about one and one-fourth times as wide as the pterothorax.

EURYTHRIPS AMPLIVENTRALIS, new species.

Plate IX, figs. 99-101.

Female.—Length 1.08 mm. (1 to 1.20 mm.); width at middle of pterothorax 0.24 mm. (0.22 to 0.25 mm.). General color of head and legs clear yellow to brownish yellow; body shading posteriorly to dark brown beyond middle of abdomen.

Head slightly longer than wide, slightly narrowed in front, broadest at neck; cheeks diverging gradually behind the eyes; vertex drawn out into a hump between and in front of the eyes; post-ocular bristles quite long; head clear, brownish yellow with some red hypodermal pigment on vertex. Eyes extremely small and composed of but very few large facets, slightly protruding, oval in outline, black; ocelli wanting. Mouth cone short and blunt; labrum not constricted beyond middle. Antennæ approximate, large, and heavy, fully twice the length of the head, with peculiar, semicircular, shelf-like support visible on under side at base; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
9.2	10.4	14.8	13.5	12.8	11.9	9.5	6.4

Segment one is broadest, cylindrical, and following segments decrease gradually in diameter; three is clavate, four to seven each barrel-shaped, with a short stalk. Antennal segments shade gradually from concolorous with head at base to very dark brown at tip; spines and sense cones very long, slender, and quite prominent.

Prothorax quite variable in length, but averaging slightly more than two-thirds as long as head; width also unusually variable, but averaging twice its length and equal to width of pterothorax. Anterior marginal spines wanting; others present, moderately long, blunt, but not knobbed. Pterothorax very small, rather shorter than prothorax and usually slightly narrower. Wings reduced to mere pads. Fore and middle legs rather short and thick, but hind legs quite long and slender; fore femora but slightly thickened and tarsi armed with a tiny tooth. Legs concolorous with head; femora shaded somewhat with brown, but without hypodermal pigment.

Abdomen exceedingly large and heavy, about one and two-thirds times as broad as pterothorax; posterior half rounding up to base of tube. Tube fully two-thirds as long as head and almost one-half as broad at middle as it is long; sides straight and tapering evenly; terminal hairs slightly shorter than tube; spines on sides of abdomen quite long and prominent.

Prothorax concolorous with head, but much more suffused with irregular, bright red hypodermal pigmentation. (Seen by reflected light on white background.) Pterothorax and base of abdomen more shaded with brown, and the latter becoming darker toward tip, where it is dark brown or almost black. Pterothorax, and sides of abdomen especially, thickly marked with bright red hypodermal pigment.

Described from five females.

Cotype.—Cat. No. 6334, U.S.N.M.

Male unknown.

Food plant.—Taken in turf in fall.

Habitat.—Amherst, Massachusetts.

EURYTHRIPS OSBORNII, new species.

Plate X, figs. 102, 103.

Female.—Length 1.12 mm. (1 to 1.22 mm.); width of mesothorax 0.27 mm. (0.25 to 0.30 mm.). General color light yellowish brown to dark brown; head and legs yellow.

Head approximately as long as wide, narrowed in front; the antennæ standing upon a triangular projection between the eyes; head enlarged quite abruptly behind the eyes; cheeks not converging posteriorly. Eyes very small, depressed, finely faceted, almost oval in outline.

black; ocelli present, small, frequently more or less hidden by irregular dark-red local pigmentation, placed well forward upon an elevation between the eyes; postocular bristles quite long. Mouth cone short and blunt; labrum not constricted abruptly. Antennae very large and long, fully two and one-half times as long as head, with a semicircular, shelf-like support below bases; bases approximate; elevation between them extending half the height of first segments; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
8.3	10.5	15.3	14.2	14.2	11.9	10.	9.9

Segment one large and cylindrical; two cup-shaped; three very slender at base, clavate; four to seven also slender at bases, decreasing gradually in diameter and length of stalk; eight enlarging to one-third its length and then tapering to a sharp point. Color shading gradually from concolorous with head at base to dark brown at tip. Spines and sense cones long, slender, and quite conspicuous. Head clear, pale yellow to brownish yellow.

Prothorax and pterothorax (in short-winged specimens) along dorsal line, each approximately as long as head; width of prothorax across coxae nearly twice its length, its sides indented considerably above them. Anterior marginal spines wanting; others present as usual (at angles, mid-lateral and posterior marginal) long, slender, and blunt. Mesothorax approximately as broad as prothorax; in long-winged specimens about one-fourth longer than in short-winged, and also slightly fuller. Legs short and moderately stout; fore femora but slightly enlarged and tarsi armed with a small tooth; one long, erect, knobbed spine upon the back of each femur. Legs yellow; femora shaded with brown; in darker specimens femora more strongly shaded.

Abdomen large and heavy; fore angles abrupt; about one-half as wide as long; nearly cylindrical to seventh segment, then sides curve roundly to base of tube. Tube as long or slightly longer than head, about one-third as broad in middle as long, more slender in outer than in basal half; terminal spines only about two-thirds as long as tube; those on sides of abdomen quite long and prominent, knobbed.

Thorax and abdomen uniform in color, abruptly darker than head and legs, ranging from yellow-brown to dark brown, with considerable dark red, irregular, hypodermal pigmentation.

Described from ten females, eight long and two short winged.

Cotype.—Cat. No. 6335, U.S.N.M.

Male.—Males about six-sevenths as large as females. Relative lengths of antennal segments as follows:

1	2	3	4	5	6	7	8
8	10	12.6	12	12	10.2	8.6	8.6

The prothorax is a little wider than the mesothorax. Fore femora

considerably enlarged and tooth upon tarsus quite stout. Abdomen more slender than in females and tapering more gradually.

Described from five males, all short winged.

Cotype.—Cat. No. 6335, U.S.N.M.

Food plants.—Grasses.

Habitat.—Amherst, Massachusetts.

This species is named for Prof. Herbert Osborn, who has for many years shown considerable interest in the study of these tiny insects.

Genus CRYPTOTHRIPS Uzel,

Head cylindrical, fully one and one-half times as long as wide. Eyes large and prominent. Vertex strongly elevated and bearing the anterior ocellus at its extremity. Mouth cone about as long as its breadth at base and reaching about two-thirds across the prosternum; labrum blunt. Prothorax about as long as width of head. Legs slender; fore femora but slightly enlarged; fore tarsi unarmed. Wings present, slightly narrowed in middle. Male with a scale at base of tube.

I find only one species belonging to this genus, *aspersus*.

CRYPTOTHRIPS ASPERSUS, new species.

Plate X, figs. 104-106.

Female.—Length 1.68 mm. (1.45 to 2 mm.); width of mesothorax 0.32 mm. (0.28 to 0.36 mm.). General color yellowish brown to brown-black; body and legs considerably marked with irregular, dark-purplish, hypodermal pigmentation.

Head cylindrical, one and one-half times as long as wide, about as wide as length of prothorax; cheeks almost straight and nearly parallel, set with a few minute, slender spines; postocular bristles short; surface of head finely cross-striated. Eyes quite large, finely faceted, very slightly protruding, dark-purplish red with pale yellowish inner margins; ocelli present, small and inconspicuous, frequently concealed by local hypodermal pigmentation, situated far forward; posterior ocelli close to margins of eyes, front one on apex of prolonged vertex of the head. Mouth cone rather short, reaching only to middle of prosternum; maxillary palpi long and slender; sides of labrum straight, its point blunt. Antennæ inserted below vertex, approximate at base, slightly more than one and one-half times as long as the head, quite slender; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
7.5	13	18.2	17.8	13.6	12.1	11.6	8

Segments one and two concolorous with head; three pale yellow; rest of antenna shading gradually to dark brown at tip, except bases of four and five, which are pale yellow; spines and sense cones short and inconspicuous.

Prothorax small, scarcely two-thirds as long as head. One spine at each posterior angle alone prominent; those at fore angles smaller than the anterior marginals; all indistinct; midlaterals wanting; posterior marginals small and not visible except on lightest specimens with careful focusing. Pterothorax approximately as wide as abdomen; its sides nearly straight and parallel. Wings present; hind fringe of fore wing double for five or six hairs near tip. Legs long and slender; fore coxae projecting strongly; fore femora scarcely thickened and tarsi unarmed; one spine near base of each femur below much longer than others on legs and longest on fore femora; legs concolorous with body.

Abdomen long and slender, cylindrical to about seventh segment, about twice as wide as head, from seventh segment tapering quite gradually to tube. Tube short, only one half as long as head; its sides straight and converging slightly; width at middle about one-third width of head; terminal hairs about as long as tube. Spines at sides of abdomen slender, pale, and not very prominent; segments usually overlapping considerably; sides darkest in color.

Described from eight females.

Cotype.—Cat. No. 6336, U.S.N.M.

Male.—Male about five-sixths as large as female, though antennae are of about same size in both sexes; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
8	12	16.5	16	13	12.5	11	8

Abdomen much smaller than in female and tapering gradually from base to tip.

Described from one specimen.

Food plant.—Grape.

Habitat.—Amherst, Massachusetts.

Genus IDOLOTHRIPS Haliday.^a

Anterior ocellus remote from the base of the antennae. Proboscis reaching the base of the prosternum; labial palpi papiliform; vein one of the fore wings shortened by one-half or abbreviated. Head very long, rounded; abdomen hollowed out. Antennae slender, three or four times as long as the thorax; prothorax unequally tuberculated; metatarsi unarmed. Size large, marked with three or more lines.

In this genus I find only the species *coniferarum*.

IDOLOTHRIPS CONIFERARUM Pergande.

Plate X, figs. 107-110.

Idolothrips coniferarum PERGANDE, Entom. News, VII, 1896, pp. 63-64.

Idolothrips coniferarum TRYBOM, Festschrift für Lilljeborg, 1896, p. 218.

^aThis generic description is translated from Haliday's original description.

Female.—Length about 4 mm. (3.34 to 4.26 mm.); breadth of mesothorax 0.55 mm. (0.50 to 0.60 mm.). Color coal-black without markings.

Head long and cylindrical; proportional length more variable than in most species, but averaging about two and one-third times as long as wide; surface of head transversely finely striated; cheeks set with a number of short, stout spines; head broadened a trifle just before the neck-like constriction at the base; vertex produced into a very prominent, conical hump in front of the eyes and overreaching the insertion of the antennae. Eyes large, finely faceted, bulging slightly, extending as far around on under side of head as on upper; ocelli small, widely separated, the anterior one occupying the extreme vertex; the posterior ones, nearly on a line with the middle of the eyes and close to their margins, are often invisible, unless in favorable light, owing to the opacity of the head. Mouth cone short and rounded. Antennae approximate at base, inserted under the vertex, only about one and one-sixth times as long as the head, and slender; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
$\frac{1}{12}$	19	38	$\frac{4}{32}$	$\frac{5}{26}$	17.5	13.3	$\frac{8}{15}$

Segment one concealed at base; three to five clavate; six to eight fusiform. Three mostly yellow (two-thirds); four nearly one-half, and five about one-third yellow; rest of antenna brown-black. Spines and sense cones light and inconspicuous, but the cones especially are long, slender, and acute; three apparently bears only one sense cone, and that is on outer side; six has but one, which is on inner side; four and five have four each.

Prothorax small, only about two-fifths as long as head; only the one long spine on the outer angle of each fore coxa is at all conspicuous. Pterothorax appears nearly square; sides straight and parallel; more than twice as wide as head. Wings present, but short as compared with great length of abdomen, not reaching beyond fifth or sixth segment, heavily fringed; hind fringe of fore wing double for about 26 hairs near tip. Legs short as compared with length of body; fore femora but slightly thickened and tarsi armed with a tiny tooth; legs set with a number of quite long, slender, black spines. Legs black, except fore tibiae dark yellowish brown along middle of inside, and all tarsi dark brown.

Abdomen extremely long and slender, about two-thirds the length of the entire body and less than one-fourth as wide at base as it is long; tapers gradually from second segment to tube. Tube of female fully five-sixths as long as head and a little more than one-third the width of head; terminal hairs weak and only about two-thirds the length of the tube; spines on sides of abdomen short and weak.

Redescribed from four females.

Male.—Contrary to the usual rule, these two specimens are longer than the females, being 4.22 mm. (4.34 to 4.10 mm.). They are somewhat more slender, especially through the middle of abdomen. Heads about two and two-thirds times as long as wide; antennæ longer than in female, about one and one-fifth times as long as head; relative lengths of segments as follows:

1	2	3	4	5	6	7	8
$\frac{1}{14}$	$\frac{2}{20}$	$\frac{3}{42}$	$\frac{4}{34}$	$\frac{5}{29.5}$	$\frac{6}{21.5}$	$\frac{7}{14.5}$	$\frac{8}{15.5}$

Prothorax nearly one-half as long as the head; fore femora considerably thickened (almost as broad as the head) and each fore tarsus bearing an extremely stout tooth; fore tarsi and inside of tibiae yellow.

Abdomen at second segment only two-elevenths as broad as long; tube three-fourths as long as head and very slender.

Male newly described from two specimens.

Food plants.—*Pinus iops*, *Juniperus virginiana*, and *Abies* sp.

Found on either green or dry branches in spring and early fall and hibernating under bark.

Habitat.—Near Washington, District of Columbia; Amherst, Massachusetts.

UNCLASSIFIED DESCRIPTIONS.

LIMOTHRIPS TRITICI (Fitch) Packard.

“The females alone are winged, the males being wingless and closely resembling the larvæ. The body of the female is smooth and shining, uniformly greenish yellow, with no other markings; the legs are a little paler toward the articulations. The antennæ are eight-jointed, slightly longer than the head; the two basal joints are the largest; the three succeeding joints equal, regularly ovate, the sixth a little longer than the fifth; seventh and eighth minute, seventh a little shorter than eighth, each joint bearing four large bristles. This species differs from the European *L. cerealium* in having but eight joints, the seventh and eighth being minute, and with no intermediate short one, as described in the European insect.

“The prothorax is square, the scutellum short, crescent-shaped, and the abdomen is long and narrow, smooth and shining, ten-jointed. Length, four one-hundredths of an inch, or less than half a line.

“The larva (fig. 2) is entirely greenish yellow, the head and prothorax of the same color as the rest of the body. The eyes are reddish. The feet and antennæ are whitish, not annulated, as in *L. cerealium*. The feet (tarsi) consist of but a single joint ending in a point.

“The male differs from the larva in having two-jointed feet (tarsi) and seven-jointed antennæ, those of the larva being four-jointed. The second joint is exactly barrel-shaped, with two ridges or lines surrounding it, third and fourth joints long, ovate, the third being a lit-

the larger than the fourth, and with about twelve transverse lines, there being about eight on the fourth joint, from the end of which projects a remarkable tubercle, as seen in the figure. The fifth joint is square at the end, with about eleven transverse lines, and three or four stout hairs externally; sixth joint minute and spherical, while the seventh is three times as long as the sixth, and is finely striated, and with four unequal stout hairs. It is just twice the length of the female, measuring 0.08 inch."

THRIPS TRIFASCIATUS Ashmead.

"*Female*.—Length 0.8 mm. Light brown; eyes strongly faceted, purplish-brown in certain lights; three basal segments of the abdomen above, dark brown; segments 4, 5, and 6 white; apical segments light brown, the sutures dusky; legs, except hind femora toward tips, white; wings linear, strongly fringed, without nerves, the ground color brown or fuscous, with three transverse white bands, i. e., the front wings have a white band at base, another at about two-thirds their length, and with the apices white.

"*Habitat*.—Near Utica, Mississippi."

THRIPS SECTICORNIS Trybom.

I have been unable to see the description of this species which was published in Öfversigt af k. Vetenskaps-Akademiens. Förhandlingar, 1896, page 620.

PHLÆOTHRIPS MALI Fitch.

"This insect measures only six-hundredths of an inch in length and one-hundredth in width. It is polished and shining, and of a blackish purple color. Its antennæ, which are rather longer than the head and composed of eight nearly equal joints, have the third joint of a white color. The abdomen is concave on its upper side, and is furnished with a conical tube at its tip which has a few bristles projecting from its apex. The wings when folded are linear, silvery-white, and as long as the abdomen; they are pressed closely upon the back, spreading asunder at their bases, and appear like an elongated Y-shaped mark. Viewed from above, the head is of a square form, longer than wide. The first segment of the thorax is well separated from the second, is broadest at its base, and gradually tapers to its anterior end, where it is as wide as the head. The following segment is the broadest part of the body and square, with its length and breadth equal."

PHLÆOTHRIPS CARYÆ Fitch.

"This insect is 0.07 long, of a deep black color and highly polished. Its head is narrower than the thorax and nearly square. The third, fourth, and fifth joints of the antennæ are longer than the others, yellow, and slightly transparent; the last joint is shortest and but half as

thick as those which precede it. The abdomen is egg-shaped, with its tip drawn out into a tube thrice as long as it is thick, with four long bristles at its end, and the abdomen is furnished with bristles at each of its sutures. The wings do not reach the tip of the abdomen. They are white and slightly transparent and fringed with black hairs. In its larva state it has a more slender linear form with a dull greenish yellow head, a white thorax with a broad black band anteriorly, a pale red abdomen with a black band at its tip, and whitish legs."

FOSSIL THYSANOPTERA.

Tiny though they are, these insects are not unknown as fossils. The White River deposits are the only ones in this country from which they are yet known. Three species, representing as many genera, have been found there in Tertiary rocks, and have been described by Dr. S. H. Scudder (174, 336), whose descriptions of these insects follow. The last two genera are extinct. Of the genus *Melanothrips*, no living representative has as yet been found in this country, though a species of this genus is known in Europe.

MELANOTHRIPS EXTINCTA Scudder.

Melanothrips extincta SCUDDER, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, p. 221; Rept. U. S. Geol. Surv. Terr., XIII, 1890, p. 371.

"Head small, tapering; the only appendages visible are the antennæ; these are only sufficiently preserved to recognize that they are very long and slender, longer than the thorax. The thorax is rather small, quadrate; wings nearly as long as the body, fringed on the costal border as in *Pulvethrips fossilis*. The abdomen is composed of only eight joints, but is very long and very tapering, fusiform, the last joint produced, as usual in the Physapods; the third joint is the broadest; of the wings only the costal border and a part of one of the longitudinal veins can be seen; there are no remains of legs.

"Length of body, 2.2 mm.; of antennæ, 0.8 mm.; of head, 0.14 mm.; of thorax, 0.5 mm.; of abdomen, 1.56 mm.; greatest breadth of abdomen, 0.5 mm.

"Chagrin Valley, White River, Colorado. One specimen, W. Denton."

Genus LITHADOTHRIPS Scudder.

Lithadotrips SCUDDER, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, p. 221; Rept. U. S. Geol. Surv. Terr., XIII, 1890, p. 372.

"Allied to *Melanothrips* Haliday. The head is large, broad, globose; the eyes exceedingly large, globose, each occupying on a superior view fully one-third of the head; the antennæ very slender, equal, as long as the thorax, the joints eight or nine in number, cylindrical, equal, scarcely enlarging toward their tips. The prothorax is no

larger than the head, of equal breadth with it, the whole thorax shaped as in *Palæothrips*. Only fragments of the wings remain, sufficient to render it probable that they agree well with the character of the group to which *Melanothrips* and *Æolothrips* belong. The legs resemble those of *Palæothrips*, but are slender and appear to be rather profusely supplied with hairs. The abdomen differs considerably in the two specimens referred to this genus. In one it is very broadly fusiform, the tip a little produced, nine joints visible, the apical furnished with a few hairs, and bluntly rounded at the tip; the other has the sides equal, the apex not at all produced, but very broadly rounded, only seven or eight joints vaguely definable.

“A single species is known.”

LITHADOTHRIPS VETUSTA Scudder.

Lithadothrips vetusta SCUDDER, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, p. 222; Rept. U. S. Geol. Surv. Terr., XIII, 1890, p. 372.

“The specimens, both of which represent the upper surface of the body with fragments and vague impressions of the members, are too poorly preserved to add anything to the above description of their generic features, excepting the following measurements:

“*First specimen*.—Length of body 1.76 mm., of antennæ 0.6 mm., of thorax 0.6 mm., of abdomen 0.87 mm.; breadth of head 0.28 mm., of thorax 0.52 mm., of abdomen 0.56 mm.; length of fore femora, 0.37 mm. ?; breadth of same, 0.14 mm.; length of hind femora, 0.42 mm.; breadth of same, 0.13 mm.

“*Second specimen*.—Length of body 1.96 mm., of antennæ 0.76 mm., of thorax 0.56 mm., of abdomen 1.10 mm.; breadth of head 0.38 mm., of thorax 0.59 mm., of abdomen 0.59 mm.

“Fossil Canyon, White River, Utah. Two specimens, W. Denton.”

Genus PALÆOTHRIPS Scudder.

Palæothrips SCUDDER, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, p. 222.

“This genus is allied to *Æolothrips* Haliday. The head is small, globose; eyes rounded, much smaller than in *Lithadothrips*; antennæ slender, fully as long as the thorax, not more than seven jointed, the joints cylindrical, subequal. Prothorax considerably larger than the head, the thorax as a whole very large, stout, and tumid; fore femora very stout, scarcely more than twice as long as broad; fore tibiæ also stout, a little longer than the femora; the other legs are moderately stout, long, reaching beyond the tip of the abdomen, with a few scattered, rather short, spinous hairs: the hind tarsi three jointed, the last joint smaller than the others, and altogether two-sevenths the length of the tibiæ. Fore wings unusually broad, broadest apically, where their breadth more than equals one-fourth of their entire length, provided with two longitudinal veins, dividing the disk into three nearly

equal portions, connected in the middle by a cross vein, and with either border by other cross veins at about one-third and two-thirds of the distance from the base to the tip of the wing; the wing is heavily fringed, especially along the hind border. Hind wings veinless, nearly as long, and at the tip nearly as broad, as the fore wings. Abdomen nine jointed, half as long again as the thorax, rather tumid, scarcely or not at all produced apically."

PALÆOTHRIPS FOSSILIS Scudder.

Palæothrips fossilis SCUDDER, Bull. U. S. Geol. Geog. Surv. Terr., I, 1875, pp. 222-223.—ZITTEL, Handb. d. Palæontology, I, Pt. 2, 1885, p. 784, fig. 999; Rept. U. S. Geol. Surv. Terr., XIII, 1890, pp. 373-374.

"Head small, tapering a little in front, where, however, it is broadly rounded. The antennæ are certainly seven jointed, and none of the apical joints show any indication of being connate, the last joint being of the same length as the two preceding it, tapering, and bluntly pointed; none of the joints show any enlargement in the middle, but the middle joints are slightly larger at the distal extremity than at the base; they appear to be destitute of hairs. The prothorax is subquadrate, a little broader than long, with rounded sides; the fore femora are unusually stout, as long as the width of the prothorax. The longitudinal veins of the fore wings approach each other somewhat abruptly in the middle, where they are united by a cross vein, and at the tip of the wing they curve away from each other; the two cross veins on the lower third of the wing are, respectively, slightly farther from the base of the wing than the corresponding veins of the upper third; the fringe on the posterior border is largest near the tip of the wing, where the hairs are about three times as long as those on the costal border. The first hind tarsal joint is scarcely longer than broad, cylindrical; the second of about the same length, but decidedly broader at apex than at the base; the apical joint is nearly globular, smallest at base, as large in the middle as the base of the other joints. There are a few hairs at the tip of the abdomen and a few short ones on the hind tibiæ; the apical ones stouter than the others, resembling spines; but the insect appears to have been unusually destitute of hairs, excepting on the wings, where not only the edges but also all the veins are fringed.

"Length of body 1.6 to 1.8 mm.; of antennæ 0.58 mm.; of fore femora 0.32 mm.; breadth of same 0.14; length of fore tibiæ 0.32 mm.; of hind femora 0.38 mm.; breadth of same 0.11 mm.; length of hind tibiæ 0.42 mm.; of hind tarsi 0.12 mm.; of fore wings 1.4 mm.; of hind wings 1.27 mm.; greatest breadth of fore wings 0.37 mm.; length of prothorax 0.16 mm.; breadth of same 0.32 mm.; length of whole thorax 0.64 mm.; of abdomen 0.92 mm.; greatest breadth of the same 0.37 mm.

"Fossil Canyon, White River, Utah. W. Denton."

GENERAL CONSIDERATIONS.

As has been shown in Jordan's conclusion in regard to the systematic position of this group (see p. 82), Thysanoptera have branched off from the line of the Orthoptera-Hemiptera and resemble the Homoptera more closely than they do any other group.

Starting with a given form which we may call Prothysanopteron, I believe that changes in the degree of development of any of its organs must be correlated with changes in its habits and environment. What was Prothysanopteron like? Judging from its line of phyllogeny, it must certainly have been an active running and flying insect, having elongated mouthparts which were probably becoming suctorial in function and bearing near the other extremity of the body a saw-like ovipositor. Having these organs which would be concerned in the chief relations of its life to its environment—nutrition, locomotion, and reproduction—what can we infer as to the habits of that primitive insect? It fed externally upon the juicy parts of plants, probably puncturing them with its elongated mouthparts and sucking up the exuding juices. It flew from flower to flower or tree and ran about actively thereupon. In the tissue of its food plants it deposited its eggs, cutting the necessary slits for them with its saw-like ovipositor. Its legs, used chiefly in running or crawling, would present few, if any, modifications, while its wings, though surely slender, were probably broad as compared with those found in the order to-day, and the hairs which happened to stand along their edges had begun to elongate so as to compensate, in some degree, for the narrowness of the membranes. With such an insect and such habits as this hypothesis suggests, if we can name reasonable changes in habits which, acting in accordance with the laws of Nature as we know them to be acting to-day, will produce the various forms of insects which we now include in this order, we feel that our hypothesis can be as well sustained as any such hypothesis with reference to primitive forms is capable of being.

If some of the descendants of our external-feeding Prothysanopteron in their struggle for existence should, in the course of numerous generations, acquire a habit of feeding in some well-protected part of the plant, e. g., inside the closely rolled central leaves of *Yucca filamentosa*, where they would be comparatively safe from the attacks of their enemies (a change of habit easily produced by natural selection), then, this environment being favorable, they would no longer find as frequent or as urgent use for their wings and legs as had their ancestors, and they would be favored by remaining in a very restricted place. As a result, wings would degenerate from disuse, and the movements of the insects upon their feet would become slower. Wings might, and probably would, be a distinct disadvantage in such a restricted habitat, so that many influences would tend toward their reduction,

which, however, could not be complete without entailing a decided disadvantage to the species by hindering its spread to other food plants. Nature has established her line of equilibrium somewhere between the two extremes, and we have a majority of short-winged individuals favored by the absence of long wings, but yet in nearly every species will be preserved in some sex, generation, or individuals fully developed wings to assist in the spreading of the species. This line of "balance" will be affected by nearly every habit of the species, so that we may naturally expect to find it in different places in species having different habits, and such is indeed the case. (See p. 105.)

Such a change of habit from frequenting an exposed to a protected feeding ground would affect other organs than the wings. There would no longer be any need of embedding the eggs for protection, and should the atmosphere prove sufficiently moist, they would undoubtedly develop though laid upon the surface of the leaf or stem. This would save much of the energy of oviposition, and in the course of time the practice of embedding the eggs would cease altogether. Having now no use for the ovipositor, that, too, would degenerate from disuse till, at most, a mere vestige would remain of this originally well-developed organ. Some such course of development I believe to have taken place in the Phlæothripidae, and the chitinous rod now found on the underside of the ninth abdominal segment just in front of the sexual opening seems best explainable as the remaining vestige of the former ovipositor. (See Plate X, fig. 115.) As the ovipositor became weaker and weaker other changes correlated to this must have been in progress. The sheath which had contained the ovipositor, being no longer needed, would naturally become closed up. The ventral plates which had previously disappeared to provide room for the sheath would not again develop, but the edges of the dorsal plates closing around still further would meet on the ventral line forming the tube of the Tubulifera. At the same time the sexual opening seems to have moved backward till it reached the hind part of the ninth segment, where it is now found.

Other modifications of the Prothysanopteron, found in the Tubulifera (mainly), may logically be traced to this one change of habit. I refer to the trapezoidal form of the prothorax, the enlargement of the fore legs, and the development of a tooth upon the fore tarsus which thereby has lost one segment in a large number of forms, also the flattened character of the body, and possibly its elongation.

In regard to the modifications of the prothorax and the fore pair of legs, it is very evident that they may all be related to the one simple change of habit in regard to the place of feeding, which has been assumed. Naturally considerable effort would frequently, perhaps usually, be required to drag their bodies through such narrow places as those in which they lived. Any variation in the line of a more

powerful development of the muscles of the fore legs or of any modification of the tarsus which would tend to give a firmer hold in crawling, being favorable to the insect, would be preserved by natural selection, and thus in the course of many generations the tarsal tooth and the powerful, thickened femora of most Tubulifera would be developed. There would also be a correlative broadening and flattening of the prothorax, which would necessarily result in pushing farther apart the fore coxæ, which are attached to its hind angles. The logical result of these changes is the trapezoidal form of the prothorax always found in those species having such thickened femora and well-developed tarsal hooks.

The elongation and flattening of the body are doubtless referable in some degree to the same change in the conditions of external life, for such a changed form would certainly have been favorable to its possessors, and we are surely safe in assuming that the favorable changes are the ones which have been preserved, while the unfavorable ones have been eliminated. We do not presume to say that all the descendants of Prothysanopteron followed this suggested line of change; some of them certainly may have done so. Neither do we presume that all the descendants of those which did follow some such line of development would continue in an even similar environment till all the modifications which have been named had been accomplished. We have just as much reason to expect a change of environment anywhere along the phyllogenetic line as at its beginning, and such changes certainly must have taken place. What would be the result if this were the case? Different environments acting upon different subjects, or even upon like subjects, would favor entirely different variations. Structures which had become developed during the changes subsequent to Prothysanopteron might be lost, but those that had been lost could never again be developed in their original form; e. g., tarsal teeth and thickened femora might develop and then disappear, but an ovipositor of the original type would never again be found in the Tubulifera. We would expect then that the descendants of Protubuliferan would vary in habits, habitat, form, and life rather than in the tubular nature of the terminal segment of the body. Such is indeed the case, and so while there do take place great modifications of each organ, the presence of the tube is constant. We feel justified in concluding that the family Phlæothripidæ has now diverged far more widely from Prothysanopteron than has either of the families of the Terebrantia.

The two families constituting the suborder Terebrantia resemble each other quite closely in many respects. We find between them no such marked points of difference as we do between each of them and the Phlæothripidæ. The principal differences which do exist are mainly various modifications of the same organ, and the most impor-

tant structures which we must notice are the antennæ, wings, and ovipositor. What are the chief points of difference that we find in the structure of these organs? Only a modification in the structure of each organ has taken place. In *Æolothripidæ* we find always nine segmented antennæ, comparatively broad wings, which are rounded at their extremities, and have, in the fore wing, the fore fringe and the spines along its veins very weakly developed, a strong ring vein, two longitudinal veins, and four or five cross veins, and finally a strongly developed ovipositor, which curves upward toward the tip of the abdomen. In *Thripidæ* we find antennæ with from six to eight segments, wings which are nearly always slender and quite sharply pointed at their tips; that in the fore wing the fore fringe and numerous spines along its veins are nearly always well developed, two (sometimes only one) longitudinal veins are present, the ring vein is rarely strongly developed, cross veins are absent or but slight traces of them occasionally appear, the ovipositor is moderately well developed in most cases, but sometimes is small, weak, and functionless, though it is always plainly present and curves downward away from the tip of the abdomen.

Between these two families we shall find it much more difficult to decide just what influences may have favored the development of the differences noted. Certainly many influences were concerned, and they could not have been of such a nature as to favor such radical changes as have resulted in the development of the *Tubulifera*. Rather than attempt to outline these varied influences and their probable results, we prefer, in this case, to base our conclusions upon the general tendencies which now appear to be acting, and which we may reasonably assume to have been acting in the same way during much, perhaps all, of the past history of this suborder.

We have shown that *Phlæothripidæ* have diverged more widely from *Prothysanopteron* than have any other members of the order. A comparison of the antennæ in the three families will aid us in determining the order in which the families must be arranged. In the *Phlæothripidæ* these organs are always eight segmented. The intermediate segments are, as a rule, much thicker in the middle than at the ends, and are sometimes rounded. Stout spines are borne around the apical thirds of segments two to six, inclusive, and more slender spines are more generally distributed over the last two segments. A whorl of small spines stands also around the first third of each segment from three to six, inclusive, and simple, stout, specialized sense cones are borne at about the outer third of these segments in most cases. The antennæ of *Thripidæ* consist of from six to eight segments, of which the intermediate ones are always considerably thicker in the middle than at their ends. Stout spines are usually present around the apical ends of segments two to five inclusive. More slender spines

are generally distributed over segments six, seven, and eight, and from three to five whorls of small spines are often discernible around the middle half of each intermediate segment. Sense cones are found upon segments three to six, inclusive; in some cases these are all simple, though in the majority those upon segments three and four are double or crescentic in form. The antennæ of *Æolothripidæ* have always nine segments, of which the intermediate ones are always much elongated and regularly cylindrical in form. Stout spines are found only around segment two, while the remaining segments, except the basal, are thickly set with small spines, which are irregularly, but generally distributed. Of these last two types of antenna, that of *Thripidæ* unquestionably approaches more closely to that of *Phlæothripidæ*. Granting that the latter exhibits the extreme degree of divergence from the original type, we must place *Thripidæ* next, and this leaves the antenna of *Æolothripidæ* as resembling most closely that of *Prothysanopteron*.

If we examine the wings in like manner, we shall find that both pairs of those of *Phlæothripidæ* are similar in form, long, slender, and rounded at their ends. Ring vein and cross veins have entirely disappeared. Each wing has only one longitudinal vein, which is median and though quite strong at its base usually disappears before the middle of the wing. The fringes upon both margins are equally well developed and quite similar in all respects. The membrane of the wing is smooth and the veins are not set with spines except for about three, which usually stand near the base of the vein in the fore wing. *Thripidæ* have wings which differ in many regards from those of *Phlæothripidæ* just described. The fore and hind wings are dissimilar in many respects. They are both, however, long, very slender (except the fore wing of *Parthenothrips*), and sharply pointed at the tips. The fore wing is always somewhat stronger than the hind wing and has more veins and heavier fringes. There are usually present in it two fully developed longitudinal veins (sometimes only one), and these disappear before reaching the end of the wing. The ring vein, though very strong in the one species of *Parthenothrips*, is weakly developed in most species and in some is hardly distinguishable. Traces of cross veins can sometimes be seen, but they are never strongly developed except the one between the two longitudinal veins at the first third of the wing. While entirely absent (with the exception named as strongly developed) in most species, there may occasionally appear individuals having wings which show traces of cross veins, and it is very significant that these always occur at just the same positions in the wing as are occupied by the cross veins of *Æolothripidæ*, which will be more fully described in connection with that family. The hind wing has one longitudinal vein which is median, but no ring or cross veins are present. Fringes usually occur upon

both margins of both wings, but are different upon the two margins, the fore fringe being single, shorter, and usually stouter than the hind one. The veins of the fore wing alone bear more or less strongly developed spines which upon the costa may even take the place of the fringe. The membranes of both wings are thickly set with very minute, microscopic spines. In *Æolothripidæ* we find wings which are long, comparatively broad, and rounded at their extremities. Here also the fore and hind wings are dissimilar in many respects, the fore wing being stronger and far more heavily veined. The fore wing has always a strongly developed ring vein,^a two longitudinal veins which extend throughout the wing and unite with the ring vein on each side of the tip, and four or five well-developed cross veins situated as described on p. 129. The hind wings have no fully developed longitudinal vein and no trace of cross or ring veins. No fringe is developed on the front margin of the fore wing and only a very short, weak fringe is here present upon the hind wing. The veins of the fore wing bear only short spines and the membranes of both wings are thickly set with small spines which, though minute, are larger than the similar spines in *Thripidæ*.

Comparing now these three types of wing point by point, and balancing the weight of evidence, we are led to the conclusion that *Æolothripidæ* and *Phlæothripidæ* stand at the extremes in respect also to their wings, with *Thripidæ* somewhere between them but nearer to the former than to the latter group. The strong, constantly developed ring vein of *Æolothripidæ* has become much weaker or entirely disappeared among *Thripidæ*, while in the widely divergent *Phlæothripidæ* no trace of it is found. Cross veins are also disappearing in *Thripidæ*, and their occasional presence in much the same position in the wing as in *Æolothripidæ* suggests the idea that they are undergoing degeneration and that this process has gone farther in some species than in others. In *Æolothripidæ* the longitudinal veins join the ring vein near the tip, in *Thripidæ* they do not reach this point but taper out and disappear before the tip, while in *Phlæothripidæ* they rarely reach beyond the middle of the wing. The microscopic spines upon the membranes and the comparative development of the fore fringes both point to this same relation of the families. In only one character do the wings of the extreme groups closely resemble each other—this is in the broadly rounded tips. The *Phlæothripidæ* being, as we have seen, the most widely divergent group, we must conclude that, so far as wings are concerned, those of *Æolothripidæ* resemble most closely the wings of *Prothysanopteron*.

In regard to the ovipositor but little will need to be said. It is always found more strongly developed in *Æolothripidæ* than in *Thrip-*

^aThis heavy ring vein is a most remarkable character and, so far as the writer can learn, nothing like it is found in any other order of insects.

idæ, while in Phlæothripidæ it is entirely wanting. Moreover, there exists in Thripidæ a wide variation in the degree of its development, as has already been shown. So in this respect, also, we must place our three families in the same relation to each other, and if Prothysanopteron possessed an ovipositor, as we can not doubt from its phylogeny must have been the case, the well-developed organ found in Æolothripidæ must very probably approach most closely to the primitive form.

Summarizing the conclusions which we have now reached, we find, first, that the Tubulifera (Phlæothripidæ) have diverged more widely from Prothysanopteron than have either of the families of the Terebrantia. Second, a comparative consideration of antennæ, wings, and ovipositor shows that Æolothripidæ and Phlæothripidæ present the extreme types of these structures found in the order. Therefore we conclude that the Æolothripidæ most nearly preserve the characters present in the Prothysanopteron ancestor of this order. From this it appears that the descendants of Prothysanopteron early divided into two main groups, one of which diverged widely from the original form and has developed the Tubulifera of to-day. The other of these groups continued nearly along the original line, but in time it divided again and a group (Thripidæ) branched off, taking in some respects the direction of Phlæothripidæ, while in the majority of characters it followed a line of its own. The group which still continued most nearly in the original direction includes the insects which we now place in the family Æolothripidæ.

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EXPLANATION OF PLATES.

In the figures of wings of species of Terebrantia the hind fringes are not fully represented on account of their great length.

PLATE I.

- Fig. 1. *Eolothrips fasciatus* Linnaeus. Head, prothorax, antennæ, and fore legs of female. $\frac{62}{1}$.
2. *Eolothrips fasciatus*, left fore wing of female. $\frac{62}{1}$.
3. *Eolothrips fasciatus*, end of abdomen of female. $\frac{62}{1}$.
4. *Eolothrips bicolor*, new species. Head, prothorax antennæ, and fore legs of female. $\frac{62}{1}$.
5. *Eolothrips bicolor*, end of abdomen of female. $\frac{62}{1}$.

- Fig. 6. *Eolothrips bicolor*, anterior part of abdomen at junction with metathorax showing first abdominal segment of male. $\frac{85}{1}$.
7. *Eolothrips bicolor*, end of abdomen of male. $\frac{85}{1}$.
8. *Eolothrips bicolor*, left antenna of male. $\frac{62}{1}$.
9. Fore tarsal hook present in both sexes of *Eolothripidae*. $\frac{213}{1}$.
10. *Limothrips areva*, new species. End of abdomen of female. $\frac{85}{1}$.
11. *Limothrips areva*, end of abdomen of male. $\frac{85}{1}$.
12. *Limothrips areva*, right fore wing of female. $\frac{62}{1}$.

PLATE II.

- Fig. 13. *Limothrips areva*, new species. End of abdomen of female. $\frac{85}{1}$.
14. *Chirothrips manicatus* Haliday. Head, prothorax, antennae, and legs of female. $\frac{107}{1}$.
15. *Chirothrips manicatus*, end of abdomen of male. $\frac{107}{1}$.
16. *Chirothrips manicatus*, left fore wing of female. $\frac{62}{1}$.
17. *Chirothrips crassus*, new species. Head, prothorax, and antennae of female. $\frac{107}{1}$.
18. *Chirothrips crassus*, end of abdomen of female. $\frac{107}{1}$.
19. *Chirothrips crassus*, head, prothorax, antennae, and fore legs of male. $\frac{107}{1}$.
20. *Chirothrips crassus*, end of abdomen of male. $\frac{107}{1}$.
21. *Chirothrips obesus*, new species. Head, prothorax, antennae, and fore legs of female. $\frac{107}{1}$.
22. *Chirothrips obesus*, end of abdomen of female. $\frac{107}{1}$.
23. *Sericothrips variabilis* (Beach). Left fore wing of female. $\frac{107}{1}$.

PLATE III.

- Fig. 24. *Sericothrips variabilis* (Beach). Head, prothorax, and antennae of female. $\frac{107}{1}$.
25. *Sericothrips variabilis*, end of abdomen of female. $\frac{107}{1}$.
26. *Sericothrips variabilis*, end of abdomen of male. $\frac{107}{1}$.
27. *Sericothrips cingulatus*, new species. Head, prothorax, and antennae of female. $\frac{107}{1}$.

- Fig. 28. *Sericothrips cingulatus*, end of abdomen of female. $\frac{107}{1}$.
29. *Sericothrips cingulatus*, end of abdomen of male. $\frac{107}{1}$.
30. *Pseudothrips inequalis* (Beach). Head, prothorax, antennae, and fore legs of female. $\frac{107}{1}$.
31. *Pseudothrips inequalis*, end of abdomen of female. $\frac{107}{1}$.
32. *Pseudothrips inequalis*, right fore wing of female. $\frac{107}{1}$.
33. *Euthrips nervosus* (Uzel). Head, prothorax, antennae, and fore legs of female. $\frac{62}{1}$.
34. *Euthrips nervosus*, end of abdomen of female. $\frac{62}{1}$.

PLATE IV.

- Fig. 35. *Euthrips nervosus* (Uzel). Right fore wing of female. $\frac{62}{1}$.
36. *Euthrips tritici* (Fitch). Head, prothorax, antennae, and fore legs of female. $\frac{107}{1}$.
37. *Euthrips tritici*, end of abdomen of female. $\frac{107}{1}$.
38. *Euthrips tritici*, end of abdomen of male. $\frac{107}{1}$.
39. *Euthrips tritici*, left fore wing of female. $\frac{85}{1}$.
40. *Euthrips fuscus*, new species. Head, prothorax, antennae, and fore legs of female. $\frac{107}{1}$.
41. *Euthrips fuscus*, end of abdomen of female. $\frac{107}{1}$.
42. *Scolothrips 6-maculatus* (Pergande). Head, prothorax, antennae, and fore legs of female. $\frac{107}{1}$.
43. *Scolothrips 6-maculatus*, end of abdomen of female. $\frac{107}{1}$.
44. *Scolothrips 6-maculatus*, end of abdomen of male. $\frac{107}{1}$.
45. *Scolothrips 6-maculatus*, right fore wing of female. $\frac{107}{1}$.

PLATE V.

- Fig. 46. *Raphidothrips fuscipennis*, new species. Head, prothorax, antennae, and fore legs of female. $\frac{85}{1}$.
47. *Raphidothrips fuscipennis*, end of abdomen of female. $\frac{85}{1}$.
48. *Raphidothrips fuscipennis*, left fore wing of female. $\frac{85}{1}$.
49. *Anaphothrips striatus* (Osborn). Head, prothorax, and antennae of female. $\frac{85}{1}$.
50. *Anaphothrips striatus*, end of abdomen of female. $\frac{85}{1}$.

- Fig. 51. *Anaphothrips striatus*, right fore wing of female. $\frac{85}{1}$.
52. *Aptinothrips rufus* (Gmelin). Head, prothorax, and antennæ of female. $\frac{107}{1}$.
53. *Aptinothrips rufus*, end of abdomen of female. $\frac{107}{1}$.
54. *Aptinothrips rufus* var. *conutticornis* Uzel. Antennæ of female. $\frac{107}{1}$.
55. *Heliothrips femoralis* Reuter. Head, prothorax, antennæ, and fore legs of female. $\frac{62}{1}$.
56. *Heliothrips femoralis*, end of abdomen of female. $\frac{62}{1}$.

PLATE VI.

- Fig. 57. *Heliothrips femoralis* Reuter. Left fore wing of female. $\frac{62}{1}$.
58. *Heliothrips fasciapennis*, new species. Head, prothorax, and antennæ of female. $\frac{107}{1}$.
59. *Heliothrips fasciapennis*, end of abdomen of female. $\frac{107}{1}$.
60. *Heliothrips fasciapennis*, right antenna of female. $\frac{167}{1}$.
61. *Heliothrips fasciapennis*, right fore wing of female. $\frac{85}{1}$.
62. *Parthenothrips dracæna* (Heeger). Head, prothorax, antennæ, and fore legs of female. $\frac{62}{1}$.
63. *Parthenothrips dracæna*, end of abdomen of female. $\frac{62}{1}$.
64. *Parthenothrips dracæna*, portion of reticulation from head of female. $\frac{213}{1}$.
65. *Parthenothrips dracæna*, left fore wing of female. $\frac{62}{1}$.
66. *Thrips perplecus* (Beach). Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.
67. *Thrips perplecus*, end of abdomen of female. $\frac{107}{1}$.
68. *Thrips perplecus*, left fore wing of female. $\frac{107}{1}$.

PLATE VII.

- Fig. 69. *Thrips tabaci* Lindeman. Head, prothorax, antennæ, and fore legs of female. $\frac{107}{1}$.
70. *Thrips tabaci*, end of abdomen of female. $\frac{107}{1}$.
71. *Thrips tabaci*, left fore wing of female. $\frac{85}{1}$.
72. *Anthothrips niger* (Osborn). Head, prothorax, and fore legs of female. $\frac{62}{1}$.
73. *Anthothrips niger*, end of abdomen of female. $\frac{85}{1}$.
74. *Anthothrips niger*, left antenna of female. $\frac{85}{1}$.

- Fig. 75. *Anthothrips niger*, left fore wing of female. $\frac{62}{1}$.
76. *Anthothrips verbasci* (Osborn). Head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.
77. *Anthothrips verbasci*, end of abdomen of female. $\frac{50}{1}$.
78. *Anthothrips verbasci*, left antenna of female. $\frac{85}{1}$.
79. *Trichothrips beachi*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.

PLATE VIII.

- Fig. 80. *Trichothrips beachi*, new species. End of abdomen of female. $\frac{50}{1}$.
81. *Trichothrips ambitus*, new species. Head, prothorax, antennæ, and fore femora of female. $\frac{50}{1}$.
82. *Trichothrips ambitus*, end of abdomen of female. $\frac{50}{1}$.
83. *Cephalothrips guccæ*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.
84. *Cephalothrips guccæ*, end of abdomen of female. $\frac{50}{1}$.
85. *Phlæothrips pergandei*, new species. Head, antennæ, prothorax, and fore legs of female. $\frac{50}{1}$.
86. *Phlæothrips pergandei*, end of abdomen of female. $\frac{50}{1}$.
87. *Phlæothrips uzeli*, new species. Head, prothorax, antennæ, and fore legs of male. $\frac{50}{1}$.
88. *Phlæothrips uzeli*, end of abdomen of male. $\frac{50}{1}$.
89. *Phlæothrips uzeli*, under side of right fore leg of male. $\frac{85}{1}$.
90. *Phlæothrips uzeli*, upper side of left fore leg of male. $\frac{85}{1}$.

PLATE IX.

- Fig. 91. *Phlæothrips uzeli*, new species. Head, prothorax, antennæ, and fore legs of female. $\frac{50}{1}$.
92. *Phlæothrips uzeli*, end of abdomen of female. $\frac{62}{1}$.
93. *Acanthothrips magnafemoralis*, new species. Head, prothorax, antennæ, and fore legs of male. $\frac{50}{1}$.
94. *Acanthothrips magnafemoralis*, end of abdomen of male. $\frac{50}{1}$.
95. *Malacothrips zonatus*, new genus and new species. Head, prothorax, antennæ, and fore femora of male. $\frac{50}{1}$.
96. *Malacothrips zonatus*, end of abdomen of male. $\frac{50}{1}$.

- Fig. 97. *Malacothrips zonatus*, head, prothorax, antennae, and fore legs of female. $\frac{50}{1}$.
98. *Malacothrips zonatus*, end of abdomen of female. $\frac{50}{1}$.
99. *Eurythrips ampliventralis*, new genus and new species. Head, thorax, and fore legs of female. $\frac{62}{1}$.
100. *Eurythrips ampliventralis*, end of abdomen of female. $\frac{62}{1}$.
101. *Eurythrips ampliventralis*, left antenna of female. $\frac{85}{1}$.

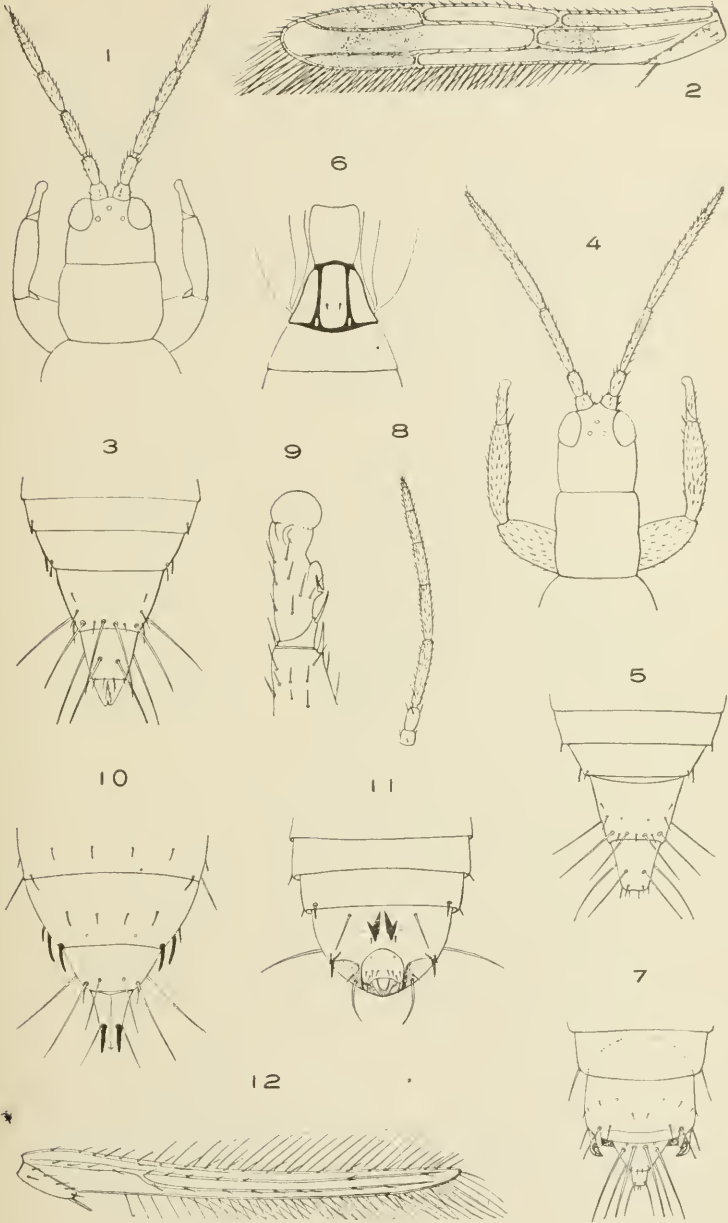
PLATE X.

- Fig. 102. *Eurythrips osborni*, new genus and new species. Head, prothorax, antennae, and fore legs of female. $\frac{62}{1}$.
103. *Eurythrips osborni*, end of abdomen of female. $\frac{62}{1}$.
104. *Cryptothrips aspersus*, new species. Head, prothorax, and fore legs of female. $\frac{50}{1}$.
105. *Cryptothrips aspersus*, end of abdomen of female. $\frac{50}{1}$.
106. *Cryptothrips aspersus*, right antenna of female. $\frac{85}{1}$.
107. *Idolothrips coniferarum* Pergande. Head, prothorax and fore legs of male. $\frac{33}{1}$.
108. *Idolothrips coniferarum*, end of abdomen of male. $\frac{50}{1}$.
109. *Idolothrips coniferarum*, head, prothorax, and fore legs of female. $\frac{33}{1}$.
110. *Idolothrips coniferarum*, right antenna of female. $\frac{50}{1}$.
111. *Thrips tabaci*, longitudinal-vertical section through anterior part of body showing form of head and thorax and position of nervous system and alimentary canal. $\frac{83}{1}$.
112. *Anaphothrips striatus*, surface view of stigma from first abdominal segment. $\frac{716}{1}$.
113. *Anaphothrips striatus*, cross section through stigma from first abdominal segment. $\frac{716}{1}$.
114. *Anthothrips verbasci*, under side of last two abdominal segments of male; A, notch in base of tube. $\frac{62}{1}$.
115. *Anthothrips verbasci*, under side of last two abdominal segments of female; A, chitinous rod. $\frac{62}{1}$.

PLATE XI.

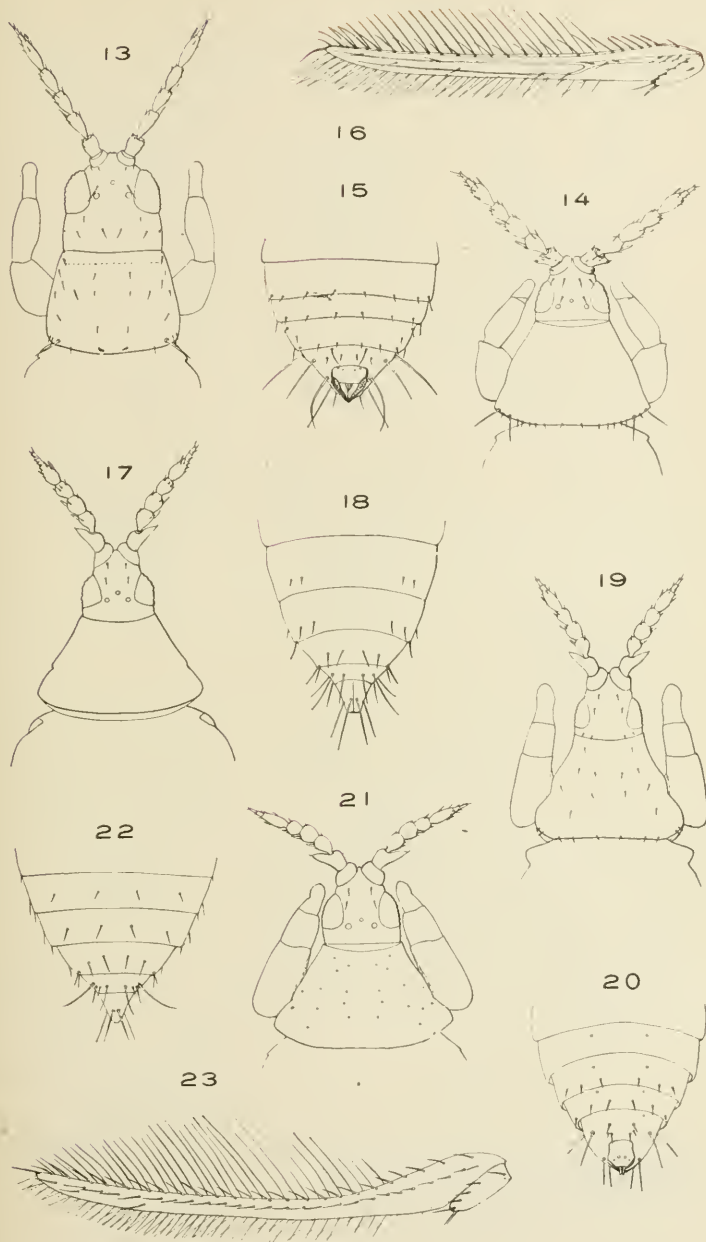
- Fig. 116. *Eolothrips fasciatus*, dorsal view of pterothorax of female. $\frac{62}{1}$. A1, first abdominal tergite; A2, second abdominal tergite; M1, mesoscutum; M2, metascutum; M3, metascutellum.

- Fig. 117. *Eolothrips fasciatus*, ventral view of pterothorax of female. $\frac{62}{1}$. C, coxa; ET, endothoracic invaginations; MS, mesosternum; MT, metasternum; S1, first abdominal sternite; S2, second abdominal sternite; T, trochanter.
118. *Heliothrips femoralis*, dorsal view of pterothorax of female. $\frac{62}{1}$. A1, first abdominal tergite; A2, second abdominal tergite; M1, mesoscutum; M2, metascutum; M3, metascutellum.
119. *Heliothrips femoralis*, ventral view of pterothorax of female. $\frac{62}{1}$. ET, endothoracic invaginations; MS, mesosternum; MT, metasternum.
120. *Anaphothrips striatus*, face of female. $\frac{115}{1}$. EC, endocranial thickening at base of mouth cone; LI, labium; LP, labial palpi; LR, labrum; MD, mandible; ML, internal piercing lobe of maxilla; MP, maxillary palpi; MN, maxilla.
121. *Anaphothrips striatus*, side view of end of abdomen of female; ovipositor lowered into position for use. $\frac{107}{1}$.
122. *Eolothrips bicolor*, under side of antennal segments two to five. $\frac{213}{1}$. SA, sense areas.
123. *Thrips perplexus*, upper side of antennal segments two to seven. $\frac{213}{1}$. SC, sense cones.
124. *Trichothrips ambitus*, upper side of antennal segments two to seven. $\frac{130}{1}$. SC, sense cones.
125. *Limothrips arcuæ*, dorsal view of pterothorax of wingless male. $\frac{107}{1}$. A1, first abdominal tergite; A2, second abdominal tergite; M1, mesoscutum; M2, metascutum.
126. *Anthothrips verbasci*, dorsal view of head and thorax of female. $\frac{62}{1}$. A1, first abdominal tergite; A2, second abdominal tergite; M1, mesoscutum; M2, metascutum; M3, metascutellum.
127. *Anthothrips verbasci*, ventral view of head and thorax of female. $\frac{62}{1}$. ET, endothoracic invaginations; MS, mesosternum; MT, metasternum; S1, first abdominal sternite; S2, second abdominal sternite.



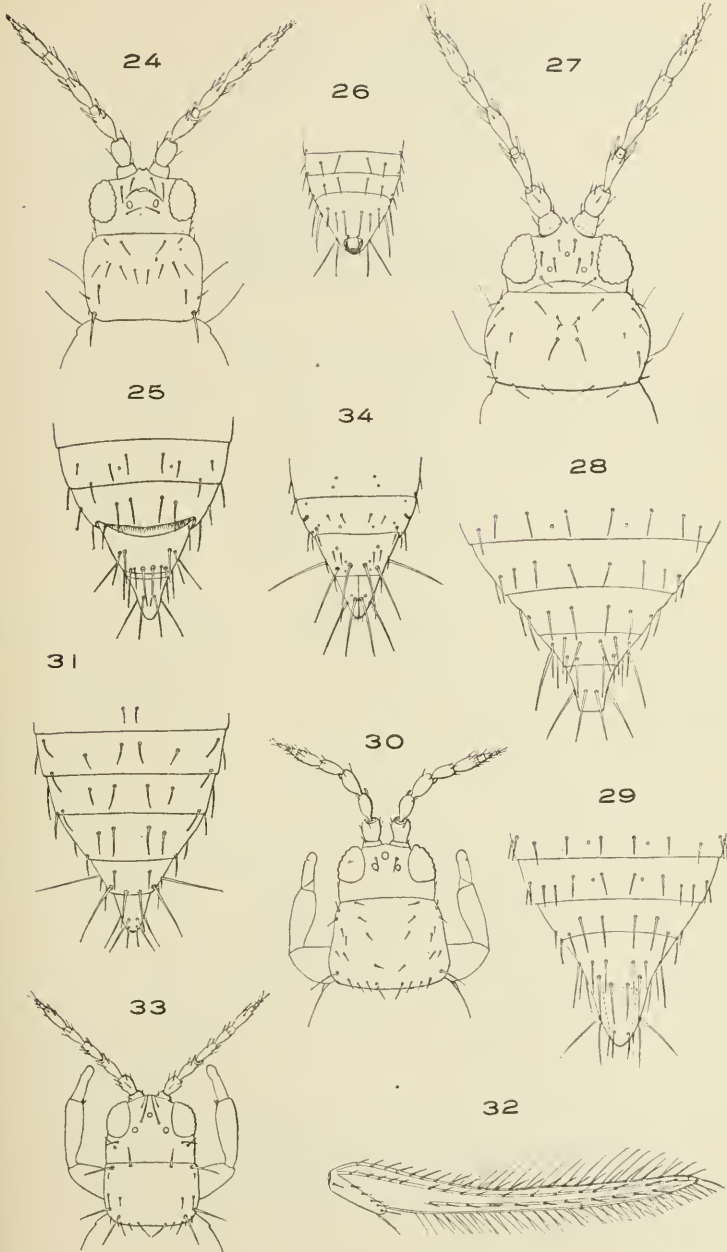
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FOR EXPLANATION OF PLATE SEE PAGE 237.



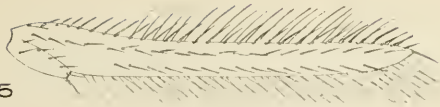
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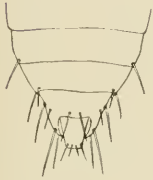
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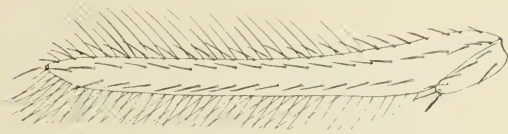
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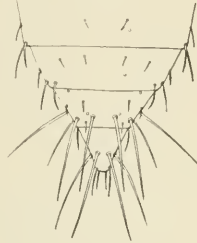
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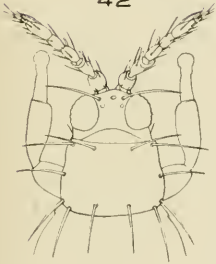
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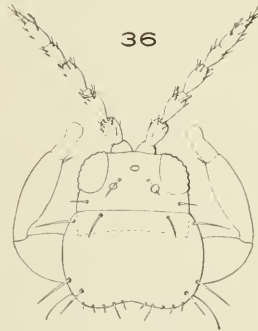
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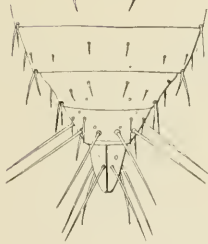
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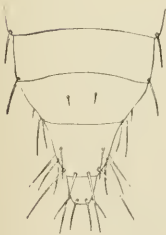
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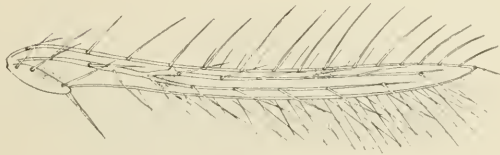
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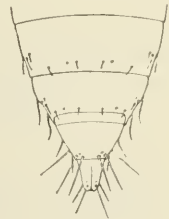
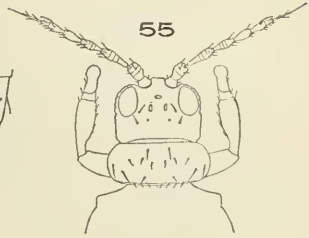
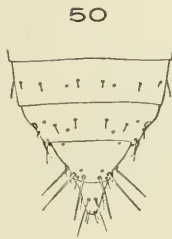
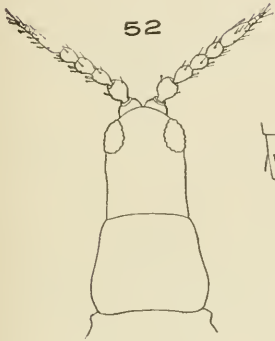
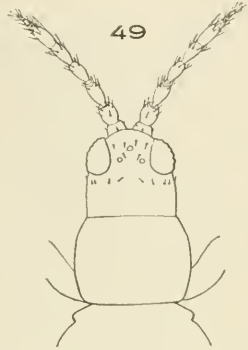
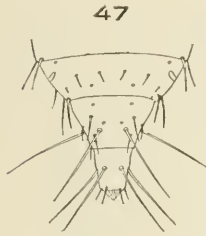
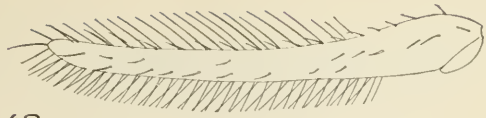
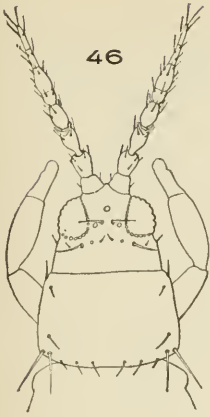


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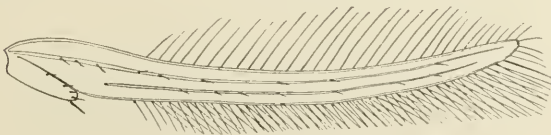


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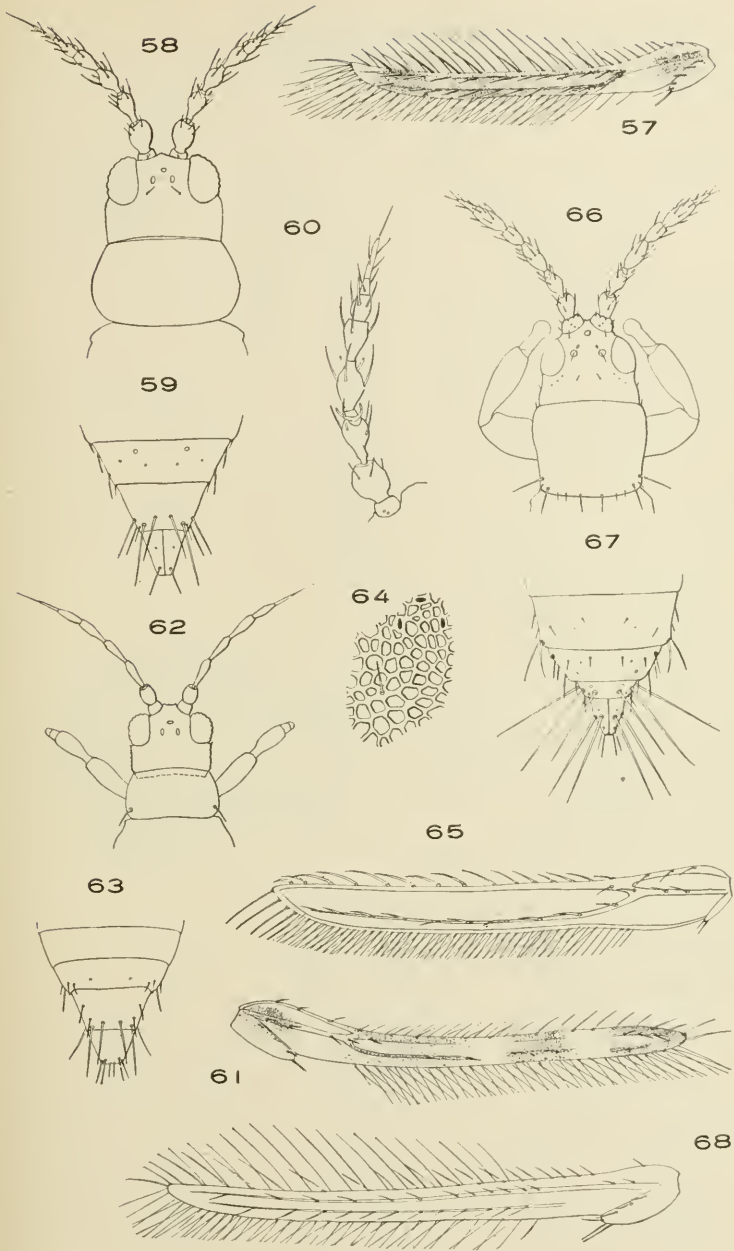


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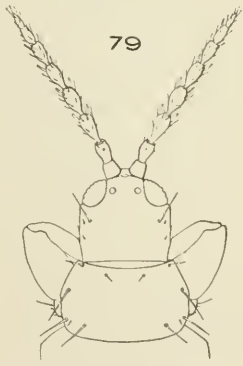
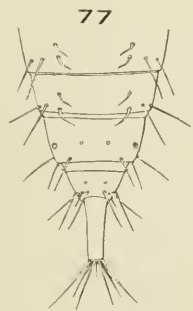
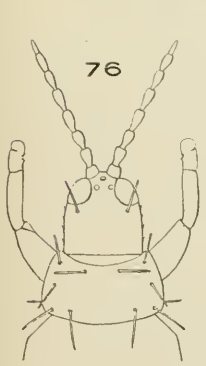
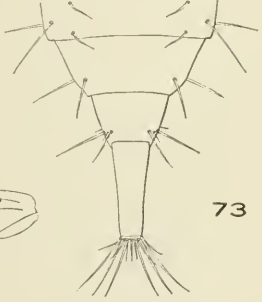
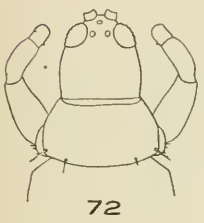
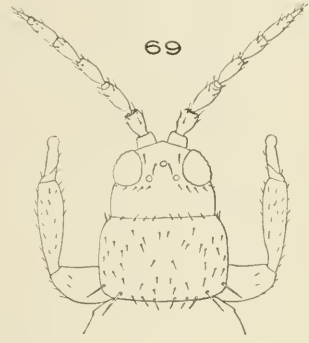
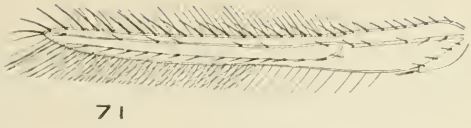
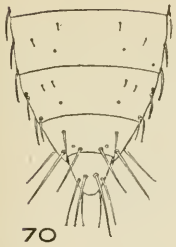
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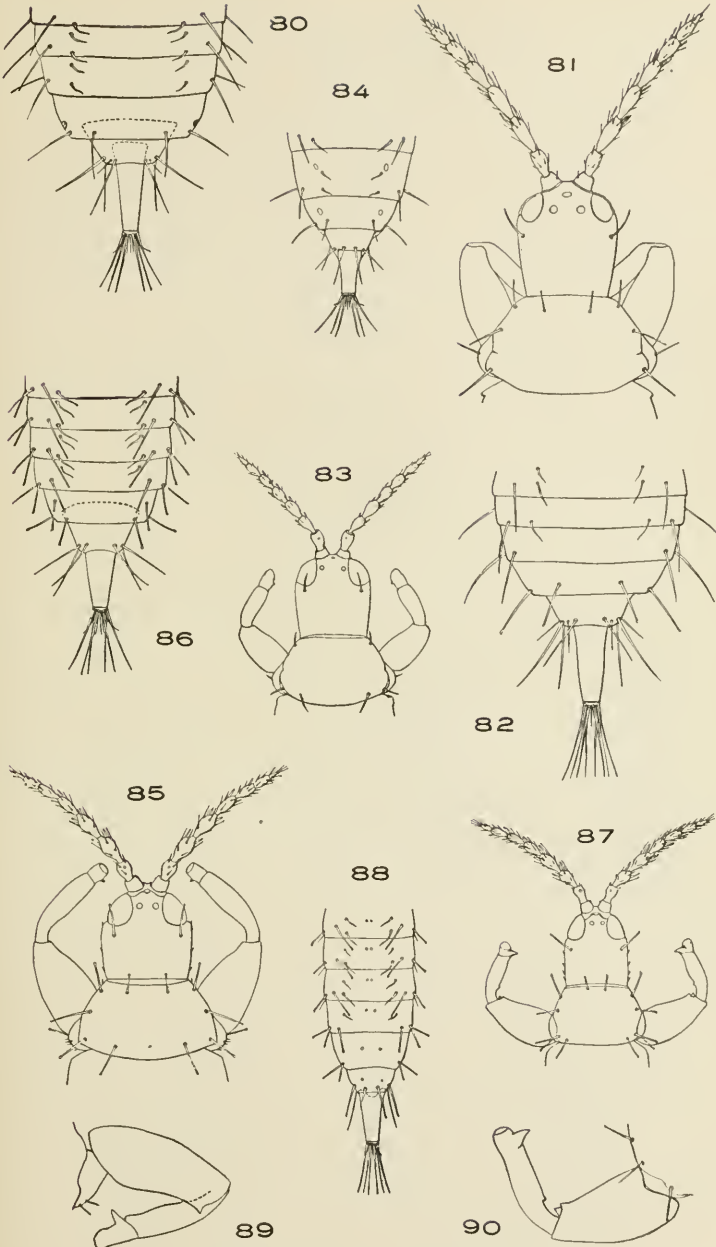
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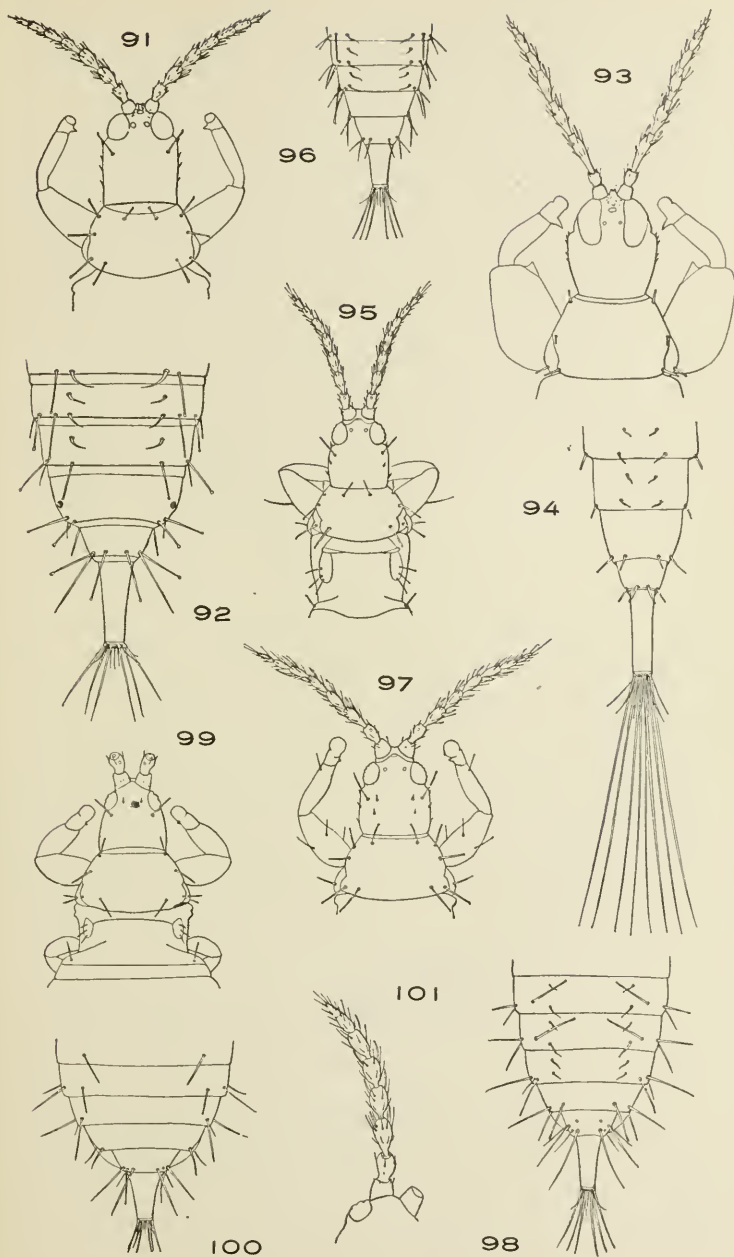
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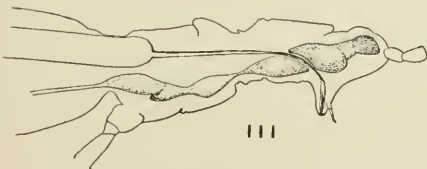
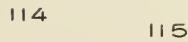
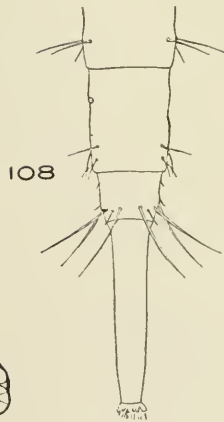
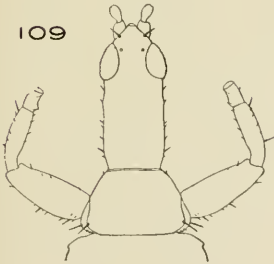
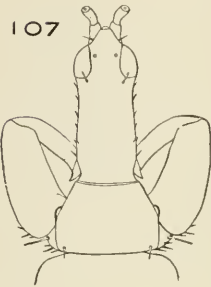
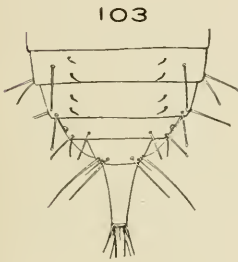
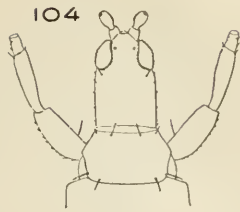
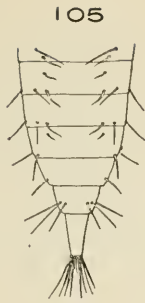
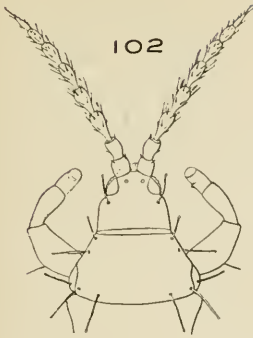
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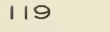
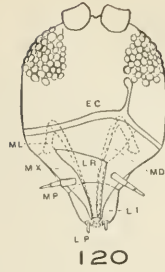
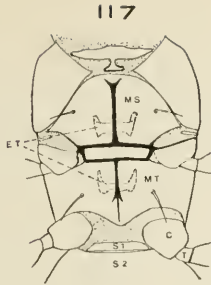
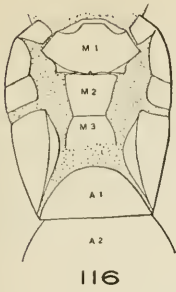
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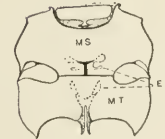
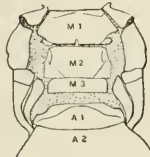
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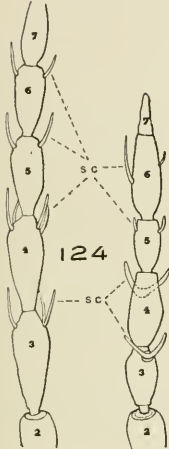
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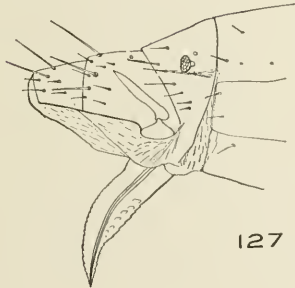
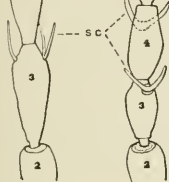


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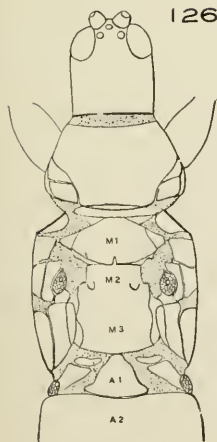
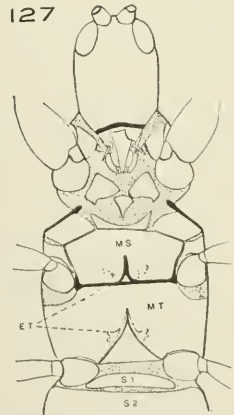
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FOR EXPLANATION OF PLATE SEE PAGES 241, 242.

