THE BIOLOGY OF THE HYMENOPTEROUS INSECTS OF THE FAMILY CHALCIDIDÆ.*

BY

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The parasitic Hymenoptera as a whole may be classed among the entozoic parasites, yet their life is entozoic through only one stage of the existence of the individual. In the adult stage they are active creatures of an especially high degree of organization, and exhibit no trace of the degradational features characteristic of the epizoic parasites, nor yet of those entozoic forms whose whole life round is parasitic. Nor are their larvæ especially degraded beyond those of the non-parasitic families of the same order.

The phenomena of parasitism among the *Chalcididæ* do not differ in any marked degree from those characteristic of the three other great families of parasitic Hymenoptera—the *Ichneumonidæ*, *Braconidæ*, and *Proctotrypidæ*. In all four we normally have the eggs laid by the female on or beneath the skin of the host-insect, and the parasitic larva, on hatching, lives in the majority of the cases within the body of its host. It often happens that parasites, even of the same genus, are external feeders when parasitic upon endophytous insects, and internal when parasitic upon outside feeders. Some few species, however, are external upon external feeders.

Resembling, then, the other families in these general habits, the following pages will indicate of the *Chalcididæ* our knowledge of their particular modes of life and their relations to other insects and to each other—in fact their general economy.†

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*SIR: I take pleasure in recommending for publication in the Proceedings of the Museum the accompanying paper by Mr. L. O. Howard, on the "Biology of the *Chalcididæ*." This paper is based very largely on the collections of the Museum, as the material in this family has been specially studied and arranged by Mr. Howard.

Respectfully yours,

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† In preparing this paper I have had the very rich collection of the National Museum constantly before me, and with Prof. Riley's generous permission have freely used his own unpublished notes and those of the Division of Entomology.

THE INSECTS AND STAGES OF INSECTS INFESTED BY CHALCIDIDS.

Representatives of all of the original Linnæan orders of insects are parasitized in one or another of their stages by species of this family. Of the fifteen orders of Brauer, forms of but seven are infested by chalcidids, and these are the seven Linnæan orders in their restricted sense. Neither *Thysanura*, *Ephemeroptera*, *Odonata*, *Plecoptera*, *Platyptera*, *Dermaptera*, *Thysanoptera*, nor *Mecoptera* have ever been proven to be parasitized, largely from the fact that the larger number are aquatic in their early stages,* while most of the land forms are excessively minute, but, of course, the vast majority of insects belong to the older and more important orders. The most extensively parasitized orders are Lepidoptera, Hymenoptera and Hemiptera-Homoptera.

Lepidopterous insects in all stages are infested. The minute chalcidids of the genus *Trichogramma*, apparently few in number of species, but enormously abundant in individuals, attack the eggs of Rhopalocera, bombycids, noctuids, geometrids, and tortricids, and probably of members of other families. So numerous are these tiny creatures at times that hundreds of thousands of eggs of injurious noctuids are destroyed by them, and so small are they that twenty will develop in a single egg of *Papilio turnus*, the entire contents of which will not exceed 1.5 cubic millimeters. Reverting again to the numbers of individuals, Hubbard found in 1880 that *Trichogramma pretiosa*, alone and unaided, almost annihilated the fifth brood of the cotton worm (*Aletia xylina*) in Florida, fully 90 per cent of the eggs of this most abundant and prolific noctuid having been infested. (Fourth Report U. S. Ent. Com., p. 103.) It is interesting to note that these little egg-parasites, although so very abundant in this country, seem comparatively rare in Europe, although the family and its different genera were originally founded on European material. They seldom occur in the European lists, and a few years ago Dr. Gustav Mayr wrote me asking for a specimen of *Trichogramma*, saying that he had never seen one!

The eggs of some of the larger Lepidoptera are also parasitized by species of the genus *Eupelmus*. Prof. Riley, for instance, has reared species of this genus from eggs of *Antheræa pernyi*, *Telea polyphemus*, *Saturnia io*, *Datana ministra*, and of a sphingid on cherry, probably *Smerinthus myops*.

The larvæ of Lepidoptera are more extensively parasitized than perhaps any other group of insects. Among the Chalcididæ representatives of eleven of the twenty subfamilies affect lepidopterous larvæ. Certain forms attack them when young, others when half grown, and

*Hymenopterous parasites of aquatic insects are excessively rare. *Agriotypus armatus*, an ichneumonid, has been proven by Westwood to be a parasite of the caddis-fly, *Aspatherium picicorne*, and one of the Ephydras of our alkaline western lakes is attacked by a chalcid, possibly, however, after the puparia are washed up upon the banks. Moreover, in Europe the eggs of *Agrion*, one of the dragon-flies, are said to be parasited by a species of the mymarid genus *Polynema*.

others when full grown and just about to transform to pupæ. Those of the latter class, mainly pteromalines, issue from the pupæ of the host-insect, while the others destroy the host-larva before its transformation.

The pupa itself is seldom attacked, yet certain of the pteromalines which preferably oviposit in larvæ about to transform will also lay their eggs in just-formed pupæ. The same is the case with certain members of the genus *Chalcis*, particularly those parasitic upon diurnal Lepidoptera, and I am not sure that *C. flavipes* does not oviposit by preference on the fresh chrysalids of *Chlorippe clyton* and *Agraulis vanillæ*.

The adult lepidopteron is not parasitized. I have recorded (Proc. Entom. Soc. Washn., I, 95) the rearing by Scudder of *Ichneumon instabilis* from the adult of *Chionobas semidea*, the egg of the parasite having evidently been laid upon the chrysalis of the butterfly, but a similar instance has never to my knowledge been observed with a chalcidid.

Representatives of all families of Lepidoptera are attacked, the micros more abundantly than the macros, while among the latter the *Noctuidæ* (except in the egg state) seem to be most exempt, doubtless from the nocturnal habit of the larvæ and from the fact that so many of them burrow under ground during the day. The average chalcidid is essentially a creature of sunshine and of air and is most active in the middle of the day in the warm light of the sun.

Among the Hymenoptera the *Tenthredinidæ* are parasitized in the egg state by *Trichogramma*, as shown by Lintner in the case of *Nematus ventricosus*, while their larvæ are infested by species of the subfamilies *Pteromalinæ*, *Eurytominæ*, *Torymina*, *Eulophinæ*, and *Entedoninæ*, and a species of *Perilampus* is reported by Girand as parasitizing the European sawfly, *Athalia spinarum*. From the galls of *Cynipidæ* are reared very many chalcidids, those belonging to the subfamilies *Torymina* and *Eurytominæ* taking first rank in point of numbers. So abundantly do species of these two subfamilies attack our commoner oak galls that it is frequently a matter of great difficulty to rear the original gall maker. Then there are also several species of the subfamilies *Eupelminæ*, *Pteromalinæ*, *Encyrtinæ*, *Tetrastichinæ*, and *Eulophinæ* (genus *Olinx*). The great number of widely differing forms reared from these galls and the fact that their transformations are all undergone in secret in the interior of the gall make their interrelationships a matter of great confusion. The *Torymina* and *Eurytominæ* are primary parasites, although Wachtl has thrown doubt upon one of the former and Westwood upon one of the latter, as I shall show in a further paragraph. Nearly all of the others I am inclined to think are secondary, but only the most carefully isolated rearings coupled with dissections of the galls at successive stages will enable us to settle this question. *Olinx* is considered by Mayr to be primary, but representatives of all of the other subfamilies we know to be occasionally hyperparasitic.

Upon the families of the Hymenoptera Parasitica many chalcidids are parasitic. I know no case in which a chalcidid is a parasite of a proctotrypid, but the instances in which they parasitize ichneumonids, braconids, and even members of their own family are very numerous. Even the highest subfamily, *Chalcidinæ*, contains some hyperparasites. Thus Riley has recorded a species of *Spilochalcis* reared from the cocoons of the braconid parasite (*Meteorus hyphantriæ*) of the fall webworm (*Hyphantria cunea*) (Bull. 10, Div. of Ent., 2d. ed., p. 57), while Walsh reared *S. albifrons* from the cocoons of *Pezomachus minimus*, supposed to be parasitic on the army worm (*Leucania unipuncta*). In the *Eurytominæ*, *Eurytoma* has been reared from *Cryptus* and from Microgaster cocoons. In the *Eupelminæ*, *Eupelmus* has been reared from *Isosoma*, *Apanteles*, and *Meteorus* and is probably frequently hyperparasitic in galls. In the *Encyrtinæ*, *Encyrtus artaceæ* was reared from an ichneumonized cocoon of *Artace punctistriga*. Many pteromalines are hyperparasites, while the tetrastichines nearly all have this habit. With the *Elasminæ*, certain species of *Elasmus* have been reared from the cocoons of *Limneria* and *Apanteles*, although the majority are probably primary parasites, while with the *Elachistinæ* there is no doubt that *Cirrospilus* is usually, if not always, hyperparasitic. Certain of the entedonines are also secondary parasites, as, for instance, the forms so commonly reared from the naked pupæ of *Cratotechus*. The tetrastichine genus *Melittobia* is also parasitic upon *Monodontomerus* and *Leucospis* in the cells of bees and wasps, although it also feeds upon the aculeate larvæ.*

The aculeate hymenoptera are also attacked by chalcidids. *Leucospis* is reared from the cells of *Osmia* and *Chalicodoma*. Species of the torymine genus *Monodontomerus* infest the pupæ of *Anthophora* and are reared from the cells of *Chalicodoma* and *Osmia* in Europe, while in this country they are reared from cells of *Melissodes* and *Anthophora*, as shown by the notes of the Division of Entomology, and from *Osmia*, as proven by Rev. J. L. Zabriskie. A species of the allied genus *Diomorus* is reared from the cells of *Crabro* and *Stigmus*. With the *Eurytominæ*, one species is reared from the cells of *Prosopis* and other pith-digging forms. An *Encyrtus* has been reared from *Eumenes* and there is an old record by De Geer of the rearing of *Pteromalus* from some aculeate. The latter, however, may be a mistake and the ease with which such an error can be made is shown by the fact that specimens of the common *Pteromalus puparum* were recently received by Dr. Riley as having been reared from the cells of a mud-wasp. In those cells, however, must have been stored lepidopterous larvæ which were the true hosts of the pteromali. Rearings from the cells of fossorial Hymenoptera are, therefore, apt to be uncertain. The abnormal tetrastichine genus

* Since this was written specimens of a *Melittobia* have been received from Mr. A. N. Caudell, Oklahoma, reared from a dipterous puparium found in a mud-dauber's cell. The puparium itself was also sent by Mr. Caudell, so there can be no doubt as to the accuracy of the observation, which is one of extreme interest.

Melittobia is reared in Europe from the cells of *Odynerus*, *Trypoxylon*, *Osmia*, *Stelis*, *Chalicodoma*, and other bee genera, but is also a hyperparasite, preying upon larvæ of *Leucospis* and *Monodontomerus*. Species of this genus are found in this country parasitic in the nests of *Megachile*, *Ceratina*, *Anthophora*, and *Pelopæus*.

Chalcidid parasites of the Hemiptera-Heteroptera are very rare, the only ones being the eupelmines which infest the eggs of these insects, and a few species of *Encyrtus* which have the same habit. Even these are not so abundant, however, as the proctotrypid parasites of the same eggs. With the Hemiptera-Homoptera, however, they are very numerous, although the insects of the homopterous families *Cicadidæ*, *Fulgoridæ*, *Membracidæ*, *Cercopidæ*, and *Jassidæ* are singularly free from the attacks of hymenopterous parasites. Some of them are preyed upon by the externally attached larvæ of the proctotrypid subfamily *Dryininæ*, but the only chalcidids which I know to attack members of this section are a trichogrammine, forming a new genus, which infests the eggs of the buffalo tree-hopper (*Ceresa bubalus*), in the United States, and a species of *Eupelmus* which is said to inhabit the eggs of *Cicada* in Europe. The gall-making *Psyllidæ* are attacked by several species of *Encyrtus*, while the *Aleyrodidæ* are attacked by the encyrtine genus *Thysanus*, the aphelinine genus *Encarsia* and the tetrastichine genus *Gyrolasia*. The most abundant parasites of the latter insects, however, are the exceedingly minute species of the family *Mymaridæ*. When we come to the family *Coccidæ* we find that its species are infested almost exclusively by chalcidids. The species of one entire subfamily, the *Aphelininæ*, are bark-louse parasites with the exception of a very few species which attack aphidids and aleyrodids. They seem to be confined mainly to the true scale-bearers (*Diaspinæ*), but a few infest the naked bark lice. The latter, however, are most extensively parasitized by members of the subfamily *Encyrtinæ*. Hardly a species of scale insect can be found which does not have its formidable parasite in some species of one of these two subfamilies, while many of them are also attacked by species of *Mymaridæ* which I take, from their minute size to be egg parasites in many if not most instances. Outside of these three groups almost no parasites of *Coccidæ* are known, the species of the genera *Dilophogaster* and *Ophelosia*, provisionally placed in the subfamily *Pirenina*, forming the principal exceptions. It is true that an occasional *Pteromalus* or *Tetrastichus* is reared from barklice and one or two other genera are mentioned in the European lists, but I think it quite likely that most of these forms are hyperparasitic and that they have really developed upon some primary encyrtine.

The most important of the parasites of the *Aphidida* or plant lice are the braconids of the subfamily *Aphidiinæ*, but the plant lice have many proctotrypid parasites (all belonging to the subfamily *Ceraphronina*) as well as many among the *Chalcidida*. Besides the few aphelinines there are a number of species of the subfamily *Pteromalinæ*, particularly those

of the genus *Isocratus*, which are commonly reared from these insects. The chalcidids which are perhaps most abundantly reared from plant lice belong to the pteromaline genus *Pachyneuron*. The closely allied genus *Pachycrepis* is, I feel sure, hyperparasitic, attacking primarily the aphidiid parasites of plant lice, and the suspicion is growing in my mind that the same may be the case with *Pachyneuron*. If this be so the apparently anomalous host-habits of these insects which I have pointed out (Proc. Entom. Soc. Washington, Vol. II, pp. 105–109) are readily explainable.

Only a few families of Coleoptera are parasitized by chalcidids. So far as I know none have been reared from beetles of the adephagous, or lamellicorn series.* In the clavicorn series the species of the family *Coccinellidæ* are frequently parasitized in larva state by the several species of the encyrtine genus *Homalotylus*. Hubbard has reared these parasites from full grown larvæ of *Hippodamia convergens*, while Mr. F. H. Chittenden has shown me specimens which he has reared from larvæ of *Coccinella novemnotata*, *Mysia pullata*, and *Psyllobora vigintimaculata*.

In the serricorn series the wood-boring species of the families *Buprestidæ* and *Ptinidæ*—the subfamily *Bostrichinæ* of the latter in particular—are frequently parasitized by chalcidids, the former by *Chalcis* and *Pteromalus* and the latter principally by the species of the pteromaline tribe *Chiropachides*. *Pteromalus* and *Entedon* are also frequently reared from the burrows of these insects, while *Eurytoma* is said to have been reared from a *Bostrichus* by Ratzeburg. Moreover, Popenoe has reared species of each of the handsome eupelmine genera *Charitopus* and *Ratzeburgia* from the bostrichine *Amphicerus bicaudatus* (See Bull. 3, Kans. State Agric. Exper. Sta.). The ptinid subfamily *Anobiinæ* is also parasitized by *Pteromalus*. The family *Cioidæ* in this group is also rarely parasitized and the peculiar little entedonine *Astichus arithmeticus* is reared in Europe from *Cis glabratus* and *Ennearthron affine*. Among the phytophagous Coleoptera the *Cerambycidæ* are occasionally infested by pteromalines, probably, however, only as hyperparasites upon some of the numerous ichneumonid and braconid parasites of the insects of this group, while there is a somewhat doubtful record by Ratzeburg of the rearing of a *Eurytoma* from a cerambycid burrow, and Ashmead's *Eurytoma dorcaschemæ* was reared by Popenoe from the burrows of *Dorcaschema alternatum*. I am informed, however, by Mr. Marlatt who was with Prof. Popenoe at the time, that there is no certainty as to this parasitism and this *Eurytoma* is in my opinion likely to be a hyperparasite. Concerning all these records of rearings from wood-boring larvæ, in fact, there must always be the greatest doubt on account of the numerous insects which inhabit moribund wood. Many of the records are manifestly inaccurate in their conclusions and a knowledge of the true state of affairs will be a matter of slow growth and continuous observation, just as in an endeavor to arrive at proper conclusions concerning hyper-

*Since this was written Mr. Ashmead informs me that he has reared a Eurytoma from the larva of *Dorcus* in Florida.

parasitism. From the *Bruchidæ* have been reared pteromalines, entedonines and tridymines while the eurytomine genus *Bruchophagus* of Ashmead is parasitic, so far as we know, upon insects of this family. With the *Chrysomelidæ* we should naturally expect many parasites, yet but few are known. The European *Chalcis parcula* is reared from *Cassida fligaginus*, *Eupelmus annulatus* from a *Chrysomela*, and *Homatotylus flaminius* from *Galeruca calmariensis*. From *Odontota suturalis* Dr. Riley has reared *Spilochalcis odontotæ*, *Sympiezus uroplatæ*, and *Derostenus primus* —the latter probably a secondary parasite. While from the eggs of the same species he has reared *Trichogramma odontotæ*. (See my paper on the parasites of *Odontota suturalis*, *Entomologica Americana*, I, 117.) A few entedonines and pteromalines are recorded from this group, but are probably secondary parasites. Among the Heteromera I know only of Giraud's record of *Eurytoma histrionica* from *Mordellistena episternalis*. The *Rhynchophora*, however, are rather extensively parasitized. Perhaps most common are the pteromalines of the tribe *Chiropachides*, as *Rhaphitelus*, *Rhopalicus* and *Chiropachys*. Certain of the *Cleonymides* and *Roptrocerus*, *Aetroxys*, *Holcæus* and others of the *Pteromalides* are also reared. Of the other subfamilies the *Eurytominæ* are represented by several species of *Eurytoma*, the *Eupelminæ* by *Eupelmus*, and the *Tridyminæ*, *Eulophinæ*, *Elachistinæ* and *Entedoninæ* by species of the typical genus of each subfamily. Two species of the curious trichogrammine genus *Poropœa* are said by Ratzeburg to have been reared by Reissig, the one from small larvæ of *Apoderes* and the other from the leaf roll of *Rhynchites*. Both of these records need confirmation as otherwise the egg-inhabiting life is uniform throughout the *Trichogrammina*. There is also an European record of a torymine from a species of *Apion*. The comparatively slight extent of chalcidid parasitism upon Coleoptera which we have just indicated as a summary of our present knowledge, may prove to be indicative of the true condition of their mutual relations, but this I am inclined to doubt for the reason that the early stages of the beetles have not, on account of the difficulty of the study, been so carefully observed as those of insects of other orders. I think it safe to say, however, in view of such facts as are upon record, that the *Braconidæ* are more abundantly parasitic upon Coleoptera than are the *Chalcididæ*.

Of the Diptera we have many chalcidid parasites, which are, however, vastly more abundant as destroyers of the *Nemafocera* than of the other suborders or series. The midges of the family *Cecidomyiidæ* are particularly great sufferers from the attacks of these parasites. The gall-making forms are pierced by the same genera of chalcidids which parasitize the galls of the cynipids and to a certain extent those of the gall-making tenthredinids and microlepidoptera, namely those of the subfamilies *Eurytominæ* and *Torymine* very abundantly, with species of *Pteromalinæ*, and, more rarely, *Tridyminæ*, *Eupelminæ*, *Encyrtinæ*, *Entedoninæ*, and *Elachistinæ* and with certain tetrastichines and one species

of *Elasmus* as hyperparasites. The nongall-makers are attacked in the larva state by certain encyrtines and eupelmines and by a number of genera of the true *Pteromalides*. The *Tipulidae* are also attacked by a species of the subfamily *Pteromalinæ*. Parasites of the *Brachycera* are rare, the only ones worthy of note being two species of *Smicra* and one of *Monodontomerus* which infest *Stratiomys* in Europe, according to Giraud, but with the *Aschiza* they become more abundant, and from species of *Syrphidæ* are reared *Bothriothorax*, *Encyrtus*, and *Eupelmus*, and very commonly *Pachyneuron*, while Giraud has reared a species of *Pteromalus* from a *Conops* larva infesting a *Bombus*. With the *Muscidæ calyptratæ*, *Lamprotatus* and *Pteromalus* are reared from anthomyiid puparia, *Chalcis* is reared from *Sarcophaga*, *Pachylarthus* from *Lucilia*, *Bothriothorax*, *Entedon*, and *Pteromalus* from *Musca*, and the extremely useful dipterous parasites of the family *Tachinidæ* are attacked in the larva state by certain species of *Chalcis*, by *Perilampus*, by *Pteromalus*, *Eurytoma*, and *Monodontomerus*. With the *Muscidæ acalyptratæ* the gall-making *Trypetidæ* have practically the same chalcidid parasites as the gall-making *Cecidomyiidæ*. Those curious inhabitants of our western alkaline lakes belonging to the family *Ephydridæ* are parasitized by a species of *Pteromalus*, specimens of which were sent to Dr. Riley by Mr. H. W. Turner, who reared them from puparia of *Ephydra californica* collected at Borax Lake, California. The *Agromyzidæ* are infested by pteromalines of the tribes *Michogastrides* and *Sphegigastrides*, and the *Oscinidæ* are commonly parasitized by chalcidids of the subfamily *Entedoninæ*.

With the Orthoptera we have no chalcidid parasites except on the eggs. The egg-cases of certain *Blattidæ* are parasitized in Europe by *Entedon hagenowii*, but this may be a secondary parasite on *Evania appendigaster*. In this country, however, the egg-cases of a Florida tree cockroach are infested by a species of *Eupelmus*, specimens of which have been received by Dr. Riley from Mr. Hubbard. The species of the curious genus *Podagrion*, which possesses characters of both the *Chalcidinæ* and *Toryminæ*, are invariably parasitic all over the world in the egg-cases of the insects of the family *Mantidæ* wherever these occur and we have in addition in this country a *Eupelmus* parasitic in the same egg capsules, as has been shown by Ashmead (Proc. Ent. Soc. A. N. S. Phila., 1885, xv). Among the *Gryllidæ* the eggs of *Œcanthus* in the United States are parasitized by a species of *Eupelmus* and by a species of the eurytomine genus *Ashmeadia*, as shown by the notes of the Division of Entomology. They are also infested by several proctotrypid parasites. Among the *Locustidæ* the eggs of a species which oviposits in pith in Europe are stated by Giraud to be inhabited by a species of *Aphelinus*, while in the United States the eggs of one or more of the species of Katydids are infested by *Eupelmus mirabilis*.

Among the Neuroptera we know parasites of only the *Myrmeleontidæ* and the *Hemerobiidæ*. *Myrmeleon* in Europe is infested by *Hybothorax*

grafii and *Haltichella tarsalis*, while there is also a record to the effect that *Chalcis minuta* has been reared from insects of this genus. These parasites presumably issue from the cocoons of the ant lions. I have already summarized the parasites of the *Hemerobiina* in the Proceedings of the Entomological Society of Washington, Vol. II, pp. 123 and 124. No chalcidids are known to infest these insects in Europe, but in this country the encyrtine genus *Isodromus* is reared from the cocoons of *Chrysopa*. The Chrysopa larva is evidently pierced by *Isodromus* when full grown, for it invariably succeeds in spinning its cocoon. A species of *Perilampus* has also been sent in from Los Angeles, Cal., by Mr. D. W. Coquillet, who reared it from a Crysopa cocoon. Mr. N. Banks has recently sent in specimens of a *Tetrastichus*, which he reared from these cocoons at Shreveport, La., the past June. This parasite, however, is undoubtedly secondary.

HOW THE CHALCIDID LARVA LIVES.

This is a subject which greatly needs careful investigation. It is probable that the same general facts will be observed with chalcidid larvæ as with the larvæ of other parasitic hymenoptera, but even here our information is so slight and so contradictory that it is very difficult to make general statements. Situated at different points between the tissues of their hosts, the quick-growing internal-feeding larvæ absorb through the mouth the blood of their victims and rapidly become adult. The old idea that they feed upon the fatty tissue in a mandibulatory manner seems, at least in the majority of cases, to be untrue. The larva of *Ichneumon atropos*, however, according to Newport, seems to destroy part of the "fatty saeculi" of its host. The mandibles are piercing, and not comminuting, and the other mouth parts are fitted for the reception of liquid food. Exuviation has not been observed in the internal feeders, although Newport has seen it repeatedly with *Panisens*, an external parasite of lepidopterous larvæ; "but," he writes, "the thrown-off covering is of such extreme tenuity and is so gradually and imperceptibly removed, without interfering with the form or enlargement of the body, that, hitherto, the deciduation of the tegument of the apodal larvæ of Hymenoptera has always escaped the observation of naturalists." With the internal feeders there is the same reason against sudden exuviation that there would be against the passing of excrement; either would produce inflammation and the premature death of the host. And so there is no provision in the structure of these larvæ for the passing of the waste products of the body until they have reached full growth and a certain amount of vitality in the host insect is no longer necessary to their existence. Up to this time the alimentary canal of the parasitic larva has consisted of a simple sac, closed at its posterior extremity, and with an imperforate intestine proceeding from it, without an anal opening. When full growth is attained, however, and the assimilation of food begins to be arrested, as no longer needed by the

rapid growth of the larva, a rapid change takes place and the alimentary canal becomes narrow and elongated, the cœcal extremity becomes perforated, and by a rapid proliferation of cells the rectal tube is lined with epithelium and, with the change to pupa, the excrement is voided. Of great interest in this connection are the recent observations of M. E. Bugnion upon the structure and life history of *Encyrtus fuscicollis*, a parasite of the European *Hyponomeuta cognatella* (Receuil Zoologique Suisse, v. 1890, pp. 435–70, reviewed in Journ. Royal Mic. Soc., 1891, part 3, June, p. 329). He found in the abdominal cavity of the caterpillars a closed membraneous tube inclosing the "embryos" of the chalcid and also the nutritive substance on which the larvæ feed. This tube seemed to be formed by the ova themselves. According to his observations the larva has an anus, quite in contradiction to the general statements which I have just given. When the store of nutriment in this closed tube is exhausted, according to M. Bugnion's observations, the larvæ burst into the perivisceral cavity of the caterpillar where they feed upon the lymph of their host.

The question of the respiration of these internal feeders is more of a puzzle. The probabilities are that subsisting entirely upon freshly aërated blood, and in intimate connection with the air supply of the host insect, sufficient oxygen is thus derived to purify their own circulatory fluid, rendering unnecessary any direct connection between their stigmata and those of the host which Gerstaecker is said to have traced. When we come to egg parasites the case becomes complicated and here is a field for study. Ganin has shown a most curious hypermetamorphosis with the larvæ of the proctotrypid genera *Teleas*, *Polynema*, and *Platygaster* (sic!) inhabiting eggs, and of the chalcidid genus *Ophionurus*, but their economy is not understood. We have in the *Chalcididæ* an egg parasite of a higher type than any of these in *Eupelmus* and careful studies of the larval growth and economy of *E. mirabilis*, for instance, which inhabits the large eggs of *Microcentrum* are much needed, particularly, as it seems to me, in this matter of its respiration.

This whole branch of the subject has in fact been neglected, and a most interesting field is here open for some careful worker.

The large majority of chalcidid larvæ live within their hosts. As a general rule, however, those which are parasitic upon leaf-mining and wood-boring larvæ, and in fact all endophytous larvæ, feed externally; and the same may be said of the larvæ of the hyperparasites. The growth of the larvæ of this class has not been carefully studied, although Newport (Trans. Linn. Soc. XXI, 83, 1852), has published many interesting observations on the larva of *Monodontomerus nitidus* which inhabits the cells of *Anthophora*, and is externally parasitic upon the larvæ and pupæ of the bee.

True external chalcidid parasites of ectophytic larvæ are rare and belong mainly if not entirely to the subfamily *Elachistinæ*. The larvæ of *Euplectrus*, all of the species of which have this habit, were studied

as early as 1832 by Fonscolombe, but it is from Schwarz (Amer. Naturalist, 1881, pp. 61–63) that we have the most careful account of the larval development. We quote his words concerning the larvæ of *Euplectrus comstockii* Howard:

The delicate eggshell splits longitudinally in the middle of the back and discloses the white larva of the parasite, which gradually works the eggshell more and more down the sides of its body where, for some hours, it remains visible as a black line, but within less than twelve hours it disappears from view beneath the rapidly growing parasite larva. This last, as soon as it has freed its head from the eggshell, pierces the skin of its victim and thereafter remains stationary with its head buried. As soon as it has fairly begun to feed, the white color changes to a bright bluish-green, and the segments and spiracles which in the newly hatched larva were barely visible under high magnifying power are now readily seen. The growth of the larva is very rapid, but seems to vary according to the season, averaging three days in August and four days in September. When full grown the larvæ crowd each other, and if there are five or more of them on a caterpillar they form a semi-globular lump of very striking appearance. Usually their growth is uniform, and retardation in development of individuals in the group results in death. When full grown they turn yellowish-white and relax their hold.

The worm which up to this time showed no signs of being affected, except by its sickly yellowish color and by its very slow growth, collapses and dies as soon as a single one of the parasitic larvæ withdraws, and the same fate overtakes those Euplectrus larvæ which are at the time less advanced in their development or immature. If one of the parasitic larvæ be removed by hand both the victimized worm and the remaining parasites quickly dry up.

The presumption that the Euplectrus larvæ may migrate from one worm to another is unfounded. They always remain stationary on the worm, which the parent fly has chosen as its victim, and they never even move from the spot where the egg has been laid until they are full grown. Every attempt I made to transplant a larva from one worm to another invariably resulted in the death of the parasite.

These observations may be compared with the accounts of external-feeding ichneumonid larvæ by De Geer, Newport, Fitch, and Poulton.

HOW FAST DOES IT DEVELOP?

There is evidently considerable variation in the rapidity of development of the chalcidid larvæ, and consequently of the number of annual generations. This variation is in part according to the particular parasite and in part to the habits of the particular host-insect. It is rather more rapid as a general thing, however, with the *Chalcididæ* than with either the *Braconidæ* or the *Ichneumonidæ*. Ratzeburg has shown that in Europe *Pteromalus puparum* occupied on one occasion from June 11 to July 14 to undergo its entire transformations from egg to adult—thirty-seven days; but in this country Webster has recorded an instance (*Insect Life*, I, 225) in which the eggs of the same parasite were laid August 9, the adult insect developing August 27—seventeen days later. Hubbard has noted (Fourth Report U. S. Ent. Com., p. 103) that the egg of *Aletia xylina* gives forth the adults of *Trichogramma pretiosa* on the seventh day after it was stung by their parents. *Euplectrus comstockii* has been shown by Schwarz to develop from egg to adult in Alabama in midsummer in seven days.

These instances will suffice to indicate the extreme rapidity of growth of many of these parasitic larvæ. The question of number of annual generations is, I believe, entirely one of appropriate food. Copulation takes place immediately after the adults issue, the males usually appearing a little in advance and awaiting with impatience the egress of the females. Very soon after coition the females are ready to oviposit, and in the case of polyphagic species or species which attack insects of great abundance whose generations overlap there must be many so-called "broods" in a single season.

Where host-insects are not accessible, however, there can be no doubt but that the impregnated female can live a long time, and hibernation in this state is frequent. Another common method of hibernation is in the full-grown larva. Those species which issue from the pupæ of Lepidoptera usually overwinter in this condition, transforming to a short pupal stage in the spring.

A curious fact, and one contradictory to the usual rapid development of these insects, is given by Scudder (Butt. New Eng., p. 701), who surmises that the pteromaline parasitic upon *Euphydryas phaeton* possibly requires two years to complete its transformations, since all of the chrysalids of the butterfly which hang through the winter are parasitized. The butterfly larvæ it seems hibernate and transform to chrysalids in May and June, giving out the butterflies in June. When parasitized, however, they hang all summer and through the following winter, the parasites appearing on the wing the following June. While it appears to me that the possibilities in this interesting case are overstated in supposing that the eggs of the parasite are necessarily laid upon the larvæ of the butterfly in late summer and fall, it is still remarkable, for, even on the supposition that the egg is laid in the chrysalis, the parasite must occupy a full year in development, always providing the facts stated are strictly correct.

The preceding remarks apply strictly to the parasites of external feeders, for with parasites of endophytes the period of development is undoubtedly longer. With gall parasites, for instance, I believe that there is never more than one annual generation, for the galls themselves are of annual development and must be pierced at a certain stage of their growth. In such cases, moreover, there may be a retardation of development due to absence of natural moisture, as where galls are kept dry indoors. In such cases Ashmead has shown (Proc. Entom. Soc. Wash., I, 91) that cynipids may be retarded for two years and then brought forth by the application of water to their galls. The same laws will undoubtedly apply also to their parasites.

It may also be worth recording here that Mr. A. Craw, of Los Angeles, Cal., considers that *Dilophogaster california* mihi has but one annual generation. This insect is a parasite of the Black Scale of California (*Lecanium oleæ*), and destroys annually 75 per cent of these scales. According to Mr. Craw the parasite deposits eggs in the mature scales

only, and at the time when these contain eggs, so that the 25 per cent. which escape the parasites are sufficient to again infest the tree, from the fact that each female scale contains from seven hundred to one thousand eggs. From the slow growth of the scales, however, full ten months elapse before they have developed sufficiently to be attacked once more by the *Dilophogaster*, which is not known to have any other host insect. This reasoning indicates only a probability, and Mr. Craw records no actual observations upon mature infested scales showing the rate of growth of the chalcidid. (See Bulletin 57, California State Board of Horticulture, Sacramento, 1891.)

Mr. D. W. Coquillett, of Los Angeles, Cal., in a manuscript report submitted recently to Prof. Riley, states that he bred this species on the 14th and 27th of June from scales collected on the 25th of April, and that on the 22d of September he found a full-grown larva under an adult black scale. He has also captured specimens of the parasite on January 17, July 2, August 31, September 21, and October 12. He argues from these facts that there are at least two and perhaps even three generations of this species annually.

HOW THE LARVA TRANSFORMS.

As a rule chalcidid larvæ which are internal feeders on their hosts transform internally into naked, more or less coarctate pupæ.

With certain *Encyrtinæ*, for one of which Dr. Riley has proposed the excellent descriptive name of the "inflating chalcis-fly," particularly of the genus *Copidosoma*, but also of *Bothriothorax*, *Homalotylus* and perhaps others, the larvæ, inhabiting the host insect in great numbers, when about to pupate cause a marked inflation in the host larva by the formation of oval cells around the parasite. This inflation and the pupal cells which cause it are very noticeable in thin skinned host larvæ. With a small larva like that of *Lithocolletis* the appearance of a dipterous puparia is produced. The nature of this cocoon-like cell and the method by which it is produced are unknown. Its structure shows it not to be silk, nor yet the last larval skin of the parasite, and whether it is an adventitious tissue of the host larva or a secretion of the parasite, or is explicable upon other grounds, I can not say. It is a point for some expert histologist to decide with fresh material which is not at hand at present.

An example of one of the inflating parasites in a thick skinned host larva is shown in a coccinellid larva infested with *Homalotylus obscurus* n. The outlines of the parasitic cells are not so evident as in the Lithocolletis, but the host larva is very distorted and evidently contains these cells.

Species parasitic upon endophytous larvæ and, therefore, feeding externally, transform to pupæ close to the remains of the host in the burrow or leaf mine, usually attached at the anal end by the præpupal excrement. I have observed a curious variation in the case of *Chrysocharis*

singularis in the mine of *Lithocolletis hamadryadella* on oak leaves, which I have described in the American Naturalist for January, 1881. In this case the chalcidid pupa is surrounded by small excremental pillars arranged in an ellipse and connecting the roof and floor of the mine. It can not be stated whether the pillars are formed of regurgitated matter or of anal excrement, although the former hypothesis seems to be more probable. It is likely that such arrangements as this will be found frequently when the parasites of leaf-miners are carefully studied.

The internal parasites of externally-feeding larvæ also transform to outside pupæ in a few instances, as with the eulophine genera *Cratotechus* and *Sympiezus*, and probably with other genera of this subfamily. These forms are common parasites of several large lepidopterous larvæ which feed on the leaves of oak in the United States. The host-larva affords food for a number of the parasitic larvæ and is almost entirely consumed by them. When ready to transform the parasitic larvæ crawl out upon the leaf, void their excrement and change to shapeless dark-colored pupæ nearly erect in position, the anal portion of the body being attached to the leaf by means of a small mass of light-colored excremental pellets. They seem preferably to station themselves in the form of an irregular ellipse about the remains of the host larva, each group consisting of from fifteen to forty individuals.

Scudder, in his "Butterflies of New England" (p. 455), gives a happy picture of the appearance of the pupæ of an undescribed species parasitic on the larva of *Vanessa atalanta*, in the following words: "* * * And still another [parasite], a species of Eulophus, the coal-black chrysalides of which one may sometimes find to the number of twenty or more, standing erect on their hinder ends around the corpse they have destroyed, like tombstones in a cemetery, a most melancholy spectacle on opening a nest to get a young caterpillar." In correspondence with me Mr. Scudder has always referred to them as "my tombstone pupæ," and the term is an admirably descriptive one.

The chalcidid larvæ which feed externally on outside-feeding larvæ, and we know only one genus in which this habit uniformly prevails, spin a coarse rough silk, attaching the depleted skin of the host-insect to the leaf on which it had been feeding, and transform to pupæ, side by side, in a regular transverse row in the silky mass. Frequently the host larva has supported so many parasitic larvæ that their web attaches the entire shriveled skin from end to end; but, again, they do not occur in sufficient numbers to accomplish this result, and only half of the skin is thus fastened (Schwarz states that with the cotton worm and Comstock's *Euplectrus* it is usually the anterior portion), and the remaining portion hangs down, is doubled back, and breaks off.

The larvæ of the closely allied genus *Elachistus* pupate externally, but do not spin the loose silk characteristic of *Euplectrus*. I have seen the naked pupæ of *Elachistus cacœciæ* attached by their anal end to the silk spun in its leaf-roll by the larva of *Cacœcia rosaceana*, while the pupæ

of *E. spilosomatis* MS. are found attached in a group among the long hairs on the dorsum of the abdomen of the larva of *Spilosoma virginica*. In the allied genus *Miotropis*, *M. platynota* transforms without its host in the leaf-rolls of *Platynota rostrana*, as observed by Hubbard (Orange Insects, p. 153).

Euplectrus, although it spins silk, can by no means be said to form a cocoon, and therefore does not form a true exception to the rule that the pupæ are naked with the *Chalcididæ*. The oft-repeated and hitherto accepted observation of Haliday, to the effect that *Coryna clavata* does spin a true cocoon, would, however, form a distinct and unexplained exception were it not for the fact that I fully believe the statement to have been unfounded. Haliday, in speaking of plant-louse parasites (Entom. Mag. II, 99), writes: "Some of these last [parasites of *Aphidius*] (*Corona clavata* Walk., Ent. Mag. I, p. 386), not content with the covering which protects the *Aphidius* to its final change, when they are full fed leave the cavity and spin a white silky web between the belly of the Puceron and the leaf, and in this undergo their transformation."

This statement has been quoted by Westwood in his Introduction and by subsequent writers, and Buckton, in Vol. II of his Monograph of the British Aphides, gives a somewhat elaborate illustrated account of the cocoon-spinning of a species which he calls *C. dubia*. He figures one cocoon broken open and showing several shining black pupæ which he considers to be parasites of the *Coryna*. *Coryna*, it may be stated, is identical with the Pteromaline genus *Pachycrepis* of Foerster. Now cocoons precisely similar to those described by Haliday and figured by Buckton are found in this country. Miss Murtfeldt has found them under a rose aphidid in Missouri, and Dr. Riley tells me that he has seen them abundant under dead aphides upon his rose bushes in Washington. We breed from these cocoons here not *Pachycrepis* but the aphidiid genus *Praon*, and as it is quite out of the question that *Praon* should be hyperparasitic upon *Pachycrepis*, we may safely conclude that *Praon* makes the cocoon and that *Pachycrepis* (or *Coryna*) is a hyperparasite. It is more than likely that the several pupæ of the unknown secondary parasite figured by Buckton are those of *Coryna* itself, while the larva which he watched so carefully under glass and figured in the act of making its cocoon was undoubtedly braconid and not chalcidid. We have then no cases in which a chalcidid larva transforms to pupa within a true cocoon.

HOW MANY DEVELOP IN A SINGLE HOST?

The answer to this question is brief—from one to three thousand! With the larger species but one individual issues from a single host unless the latter is of extraordinary size. No more than one specimen of *Chalcis robusta* issues from the chrysalis of a swallow-tail butterfly, but with *Spilochalcis maria*, a parasite of nearly equal size, Chambers reared 48 from a single cocoon of the large American Silk-worm *Telea polyphe-*

mus. The number developing in a single host depends (*a*) upon the size of the host and (*b*) upon the size of the parasite. Six or eight specimens of a little *Copidosoma* will issue from the larva of a *Lithocolletis*, while, as actual count has demonstrated, over 2,500 specimens of a congeneric species of the same size will issue from the larva of a *Plusia*. The number varies in this instance from some cause from this down to something over a thousand. Between the extremes there is every gradation. Usually a single *Coccophagus* inhabits a single *Mytilaspis*, but from two to six specimens of *Coccophagus lecanii* issue from *Lecanium hesperidum*, while thirteen specimens of the same species have been reared from *Lecanium quercitronis*. From two to four specimens of *Trichogramma minuta* will issue from a single egg of *Basilarchia archippus*, from three to eight specimens of *Homalotylus obscurus* from a single larva of *Megilla maculata*, from ten to thirteen specimens of *Bothriothorax peculiaris* from a full-grown larva of the syrphid genus *Allograpta*, from thirty to forty specimens of *Cratotechus basalis* from a larva of *Datana ministra*, or from 600 to 700 specimens of *Pteromalus puparum* from a single chrysalis of one of the larger butterflies.

No observations have been made bearing upon the number of eggs laid upon the host by the parent parasite, and just how far the mother grades the number of eggs laid to the size of the host-insect is unknown. The probabilities are that she does regulate her oviposition in this way, but it is also probable that she somewhat overstocks each host, as Poulton has observed the Ichneumonid *Paniscus cephalotes* to do with *Dicranura vinula* and other large European larvæ (Trans. Ent. Soc. Lond. 1886, p. 162). A complication arises when we come to consider the very few cases of a very small chalcidid attacking a large host insect. I say the "very few cases," for it is a fact that as a rule these parasites do not attack insects which they can not completely stock with their egg supply. With the case of the genus *Copidosoma*, however, the parasite is exceedingly small and many of the host insects are large, as *Plusia* and other large noctuids. As just stated, over 2,500 specimens of *Copidosoma truncatellum* have been reared from one larva of *Plusia brassicæ*, and the eggs from which these parasites came must have been laid by several females, as in no case have I been able to count over 160 eggs in the ovaries of a *Copidosoma*. It is true that my methods of making this count have been rough. I have simply crushed the abdomen of living individuals under a cover glass in glycerine and forced out the ovaries under pressure, counting the eggs by means of the coördinated eye piece micrometer; but judging from my experience with the ovaries of larger insects, I have probably counted at least half. Probably, then, seven or eight females oviposited in this one Plusia larva, and also at the same time, as all larvæ developed together, and transformed together, and issued nearly together.

PROPORTIONS OF SEXES IN ISSUING.

De Geer recorded the singular fact that male parasites alone were produced in considerable numbers from one leaf-rolling caterpillar and only females from another (Mémoires, I, 583), and on this as a basis Kirby and Spence (IV, 223) conjectured that the eggs producing the two sexes are arranged separately in the two ovaries. Unfortunately De Geer's observation has never been repeated, so far as I know, while multifarious instances are recorded in which individuals of both sexes have issued in varying proportions from the same host; and the proportions are very variable even with the same species. Westwood reared 20 males and 36 females of *Pteromalus puparum* from a chrysalis of *Vanessa urticæ*, and Walker reared 82 males and 26 females of the same species from a single chrysalis. Riley has reared 25 ♀ and 28 ♂ specimens of the same parasite from a chrysalis of *Papilio turnus*, and 41 ♂, 39 ♀ from another. Scudder has reared 17 ♂, 108 ♀ from a chrysalis of *Basilarchia archippus*, and the same author has reared and counted over 2,000 from *Pieris rapæ* in France (Butterflies of New England, p. 1215). His experience with regard to the proportion of the sexes was as follows: "In almost all cases where the total number was very great, the males exceeded the females; as a whole the females averaged a little over 35 to a little over 25 males, and in only one-third the instances where the number of the females fell below the average the males outnumbered them. The most excessive case was 81 males to 12 females, or 7 to 1." Of the same parasite Webster (*Insect Life*, I, 225) records a rearing of 68 ♂, 4 ♀ specimens from a chrysalis of *Pontia protodice*.

With other species counts have not been so frequent. Scudder reared 9 ♂, 70 ♀ specimens of *Trichogramma minutissimum* from five eggs of *Papilio glaucus*. Riley reared 12 ♀, 8 ♂ of *Podagrion mantis* from a single egg case of *Stagmomantis carolina*, and the notes of the Division of Entomology show 11 ♀, 1 ♂ of the same species from another egg case of the same host.

Other isolated counts like this could be made in number from the biological collection of the National Museum, but would accomplish nothing beyond showing an extreme variability in the proportions of sexes. Could we have an accumulation of counts of the same parasite affecting the same host, with coördinate observations such as are indicated by Scudder in his remarks on *Pteromalus puparum*, interesting results could without doubt be obtained. His statement, for instance, that in almost all cases where the total number was very great the males exceeded the females and the reverse, is well worth thought and the labor of verifying it and conducting many additional counts, for it apparently affords a new argument to the few who still contend that sex is influenced by larval food. The numerical relationship is, however, probably insignificant, and the cases in which the males so greatly preponderate are probably to be explained on the ground that these

are the offspring of nonfecundated females. (See section on parthenogenesis.)

As to the relative time of the issuing of the sexes, it has been my general experience that the males issue before the females and await the appearance of their mates, just as is so often noticed by rearers of Lepidoptera and Coleoptera and as Harrington has shown in the ichneumonid genus *Thalessa* (*Canadian Entomologist*, November, 1887). A single instance may suffice to illustrate this point. My original breeding record of *Pentacladia bucculatricis* shows that May 19 there issued 5 ♂, no ♀; May 20, 7 ♂, 1 ♀; May 21, 3 ♂, 8 ♀, and May 22, no ♂, 12 ♀. So well marked is this that when a new-reared chalcidid is brought to me from a host insect of which there is a plentiful material in our breeding cages I anticipate a great preponderance of males, and look forward to the next day or two to bring a supply of females. With this in view Mr. Scudder's contradictory experience with *Pteromalus puparum* is strange. He writes (*loc. cit.*): "In some instances the entire brood would emerge in a single day; at others the bulk would emerge the first day and others would straggle out one after another for a week or more; sometimes again they would come out daily or almost daily for several weeks, as in one instance from February 24 to March 14; and in another, the most extended, from March 18 to April 28. *Males and females seem to be equally early and late.*"

Confirmatory of my own experience and contradictory to Mr. Scudder's is the statement of Adler, in whose extensive rearings of this parasite from the chrysalids *Vanessa io*, *V. polychloros*, *V. urticæ*, and *Pieris rapæ* the males regularly appeared first.

As so much attention has been given in this section to *Pteromalus puparum*, I may advert to Brischke's statement (D. Ichn. d. Prov. West. u. Ost-Preussen, II Fortsetzung, p. 125) that this species, when infesting *Pieris brassicæ*, *Rhodocera rhamni*, *Vanessa urticæ*, and *V. polychloros*, is hyperparasitic. There can be no doubt but that this statement is a grave error, and it is inconceivable that a man of Brischke's care could have been responsible for it. I prefer to believe that it was simply a printer's error in underscoring this species. (All species underscored are indicated in a footnote to be parasites of parasites.)

PHYTOPHAGIC HABIT.

Ever since Nees v. Esenbeck, in 1834 (Hym. Ichn. Aff., 415), made the statement that his *Eurytoma rosæ* was the maker of the galls on *Rosa centifolia*, the parasitic or vegetal-feeding habit of certain eurytomines has been under dispute among entomologists.

Since the publication of Mayr's able paper, "Arten der chalcidier-Gattung Eurytoma," in 1879, there has been no doubt about the habit of the Neesian species, for it is shown to be a common parasite on the makers of no less than 56 different European cynipid galls. Even as late as 1871, however, Walker (Notes on Chalcidæ, p. 11) considers

Nees's observation as "proof that the Eurytomæ are not all parasitic," and goes on to say: "Whether one species of this family is sometimes parasitic on other insects and sometimes herbivorous, and has thus the choice of two ways of perpetuating its existence, has yet to be ascertained."

The lengthy discussion, extending over many years, concerning the true habit of the American Joint Worm (*Isosoma hordii*), and how even after the proof of its phytophagic habit adduced by Harris, Fitch, and Walsh (the latter changing from the wrong to the right side of the question after ascertaining the generic distinction of the Joint Worm from *Eurytoma*), the fact was still not accepted by many European entomologists as late as 1882 need not be elaborated here—it is common information to all American entomologists. Since the publication of Riley's articles on *Isosoma tritici* and the admirable summary of the entire subject by the veteran Westwood (Trans. Entom. Soc. Lond., 1882, 307–327) no word of opposition has been advanced to the conclusion that *Isosoma* at least is phytophagic.

In the early concensus of European opinion against the views of American entomologists on this important point, however, we must not lose sight of the fact that three Dutch observers, Ritsema, Weyenbergh, and Snellen von Vollenhoven, had at least as early as 1870 proven that a gall on beach grass (*Ammophila arundinacea*) was produced by *Eurytoma* (?) *longipennis*, the first observation having been made by a brother of H. Ritsema in 1867. (See Archives Neerlandaises des Sciences Exactes, v, 1870, and Tijdschrift voor Entomologie, Second Series, VI, 1871, pp. 118.) This species is probably not a *Eurytoma*, but an *Isosoma*, although I can find no published statement to this effect. It is not included by Mayr, however, among the species of *Eurytoma*.

The grape-seed feeders formerly placed in *Isosoma* belong to *Eroxysoma* Ashm., and unpublished notes of the Division of Entomology show that *Eurytomacharis* Ashm., *Isosomorpha* Ashm., and *Philachyra* Hal., are also gall-makers. (The type of the last named genus was found in straw roofs near Lucca, Italy). These three genera are, however, much more closely related structurally to *Isosoma* than to *Eurytoma*, *Decatoma*, or other eurytomine genera. Others of Ashmead's recent genera resembling *Isosoma* will probably also be found to have the phytophagic habit.

As before mentioned, the habit of *Eurytoma* has been questioned by Walker largely on the strength of Nees's observation. Westwood (*loc. cit.*) says of his Ceylonese *Eurytoma taprobanica*, "I have but little doubt that this beautiful species is the real maker of the gall (on *Ficus*) from which specimens of both sexes have been reared." No good proof, however, has ever been advanced to show that *Eurytoma* proper is ever anything but parasitic, while the possible hypothesis that it may be inquilinous in the gall from which it is so abundantly reared is to a great extent disproven by my observations on *Eurytoma pruinicola*, larvæ of

is concerned. Garman (List of N. A. Rept. and Batr., 1884, p. 17) shifts the locality still further west by assigning *S. marmoratus* to "Southern California."

The only other American author referring to it under the name of *S. marmoratus* is Yarrow, who, in his Check-list of North American Reptilia and Batrachia (p. 58, 1883), refers to it two specimens, one (No. 4116) from "Redmond's Ranch, Rio Grande," the same mentioned by Professor Baird (*loc. cit.*), and another (No. 2885) from "San Diego, California." The latter specimen is correctly identified, but the statement as to the locality involves a double error, for, in the first place, the original No. 2885 did not come from San Diego, California, but from San Diego, Nuevo Leon, Mexico, and in the second place this specimen is not at all No. 2885, but a much more valuable one, as attested by the original parchment label which is still firmly attached to it, for it is nothing less than the type specimen of Hallowell's *Sceloporus delicatissimus*, which was thought to have been lost.

It was the examination of this specimen that proved to me conclusively that *S. marmoratus* is nothing but a synonym of *Sceloporus variabilis* of Wiegmann.

The latter name has but recently been introduced in the herpetological works as occurring within the United States. Boulenger in the third volume of the Catalogue of Lizards in the British Museum (1887, p. 503) mentions three specimens from "Duval County, Texas," collected by W. Taylor, Esq., and Cope, about simultaneously (Proc. U. S. Nat. Mus., 1888, p. 397), records nine specimens as belonging to the National Museum from the same source.* He adds: "First found in the United States near Corpus Christi, by Francis Aaron," but as *S. marmoratus* is the same as *variabilis* the species was found within the United States long before it was collected by Mr. Aaron.

The identification of *S. marmoratus* with *variabilis* extends the known range of the latter considerably, as San Antonio, whence came the type, is situated about 120 miles north of San Diego and Corpus Christi. The species does not seem to be rare even so far north, for we have, in addition to the type of *S. delicatissimus*, another specimen, a female from Medina, the county on the southwest of Bexar, as well as a female collected by Mr. G. W. Marnock at Helotes, in the latter county. Both of these specimens I found labeled "*Sceloporus scalaris*" (and the first one is so recorded by Yarrow, Bull. U. S. Nat. Mus., No. 24, p. 62), with which species there is no good reason for confounding them. However, Professor Cope (Zool. Pos. Texas, p. 17) states that *S. scalaris* "is abundant in the region southwest of San Antonio, according to Mr. Marnock, from whom I obtained specimens," and it may therefore be that both species occur there, though our Museum possesses no specimen of true

* Of these I have been unable to find more than two specimens in the collections of the Museum, and only these are, therefore, included in the list of specimens examined given below.

Sceloporus scalaris from the region in question. On the other hand, Professor Cope records "seven specimens" received from San Diego, Texas, as "*Sceloporus ? scalaris*" (Proc. U. S. Nat. Mus., 1888, p. 397) as if he was uncertain as to their belonging to this species, an uncertainty which I am inclined to extend to all the alleged specimens of *S. scalaris* from southwestern Texas. That I am unable to express any final opinion upon the San Diego specimens is due to the fact that the specimens, although stated to belong to the Museum, have not been found in spite of an extended search.

There are two more Texan specimens in the collection, viz, No. 11457, collected by Mr. George B. Sennett in "Texas," presumably somewhere on the lower Rio Grande between the mouth and Hidalgo where Mr. Sennett was collecting during April and May, 1877. The other specimen is No. 4116, from "Redmond's Ranch" on the Rio Grande, the same as Bellville, about 70 miles below Laredo.

There remains one specimen which requires special mention on account of the uncertainty of its origin. It has a tin tag attached to it numbered 2882, which, if correct, would give it "China, Nuevo Leon, Mexico" for a locality, and Lieutenant Couch for a collector, but to one of its legs is tied an original parchment label which reads, "4108, Utah, December," and the record book gives the information that it was "removed from No. 2877," a bottle containing numerous specimens of *Sc. gratiosus* collected at Salt Lake, Utah, by Captain Stansbury. Several other "removals" took place at the same time, however, and it is almost certain that both numbers are wrong. At any rate it would not do to credit Utah with *S. variabilis* on the strength of the present specimen.

In order to facilitate the identification of this species, which has been so singularly overlooked within our territory, I may point out some of the most salient characters by which it may be recognized.

Sceloporus variabilis differs from all the species hitherto found within the United States by having the scales of the sides of the body considerably smaller than those of the back; a white half moon-shaped mark on the side above the insertion of the fore limb is present in both sexes and is quite characteristic. The male, moreover, is readily distinguished by the flank patches of a pink (in alcohol grayish) color, which come very close together on the belly and are bordered by a dark bluish line, the latter joining a large dark patch on the shoulder behind the white semilunar mark. Among the other characters the following may be mentioned: Head-shields wrinkled; lateral scales directed obliquely upwards; femoral pores about twelve on each side, not meeting medially across the belly; about fifteen dorsal scales in a head length; anterior frontal divided longitudinally.

Sc. scalaris, on the other hand, is easily distinguished by having the series of femoral pores nearly meet across the belly; the scales on the sides are nearly as large as those of the back, and these are much larger

all orders, then we no longer wonder at their great numbers or at the great variety exhibited among them.

The family *Chalcididæ* will, in my opinion, prove to be by far the largest of the 40 odd families of Hymenoptera, with the *Braconidæ* second, the *Ichneumonidæ* third, and the *Proctotrypidæ* fourth, and there is little doubt in my mind that the immense numbers of undescribed species in three of these families will eventually place the Hymenoptera numerically above every other order of insects.