Parasitism of Insects

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In general we may say that a parasite is an animal which lives at the expense of another, but this would not include many species which are commonly considered as parasites and which, while dependant upon a host animal for existence take nothing that is of value to the host. On the other hand, if we say the parasite is an animal dependent at some period of its life upon another for existence, we must include many forms which have none of the habits which we commonly associate with parasitism.

Van Beneden has proposed three groups parasites, messmates and mutualists. In the first group are placed all those forms which feed upon the tissues of the host. In the second group are placed those which simply take the food collected by the host, but do not demand its

own substance. In the third group are placed those which simply ask protection or an opportunity to procure food in connection with, or to live upon cast off portions or rejected matter from the host.

Parasitic insects evidently do not constitute a Philogenitic unit, but the parasitic habit has arisen independently in many different orders. These insects do however agree superficially in certain respects; as the result of what may be termed convergence of adaptation. Thus a dipterous larva living as an internal parasite, in the presence of an abundant supply of food has no legs, no eyes, no antennae, and the head is reduced to a mere rudiment, sufficient simply to support a pair of feeble jaws; the skin, moreover is no longer armor-like but is thin and delicate, the body is compact and fleshy, and the digestive system

is of a simplified type. The same modifications are found in hymenopterous larvae under similar food conditions, except that the head usually undergoes less reduction.

Parasitism is a condition widely spread in the animal kingdom. Parasites may be external or internal, as they cling to the outer surface of their host or burrow within the body; permanent or temporary as they live their whole life or only part of it in or on the host. The various external parasites lack wings almost invariably, and the eyes, instead of being compound are either simple or else absent. In some special cases, however as in a few dipterous parasites of birds and bats, the wings are present, either permanently or only temporarily, enabling the insects to reach their hosts.

This is called parasitic degeneration, widespread among animals in general

and consisting chiefly in the reduction or loss of locomotor and sensory functions in correlation with an immediate and plentiful supply of food, results in a simplicity of organization which is to be regarded not as a primitive condition, but as an expression of what is, in one sense, a high degree of specialization to peculiar conditions of life. This exquisite degree of adaptation to a special environment however sacrifices the general adaptability of the animal, makes it impossible for a parasite to adapt itself to new conditions; and while parasitism may be an immediate advantage to a species there are few parasites that have attained any degree of dominance among animals.

In their general life history many of the parasitic insects travel nearly identical courses, owing to the similarity of the conditions under which

they live. But when we consider the semi-parasitic forms and free species we meet a great variety of habits.

With regard to the number of parasitic individuals that may live at the expense of a single host individual no generalization can be made; the number varies, Howard says, from 1 to 3000. From large hosts are often bred large numbers of parasites, but with some parasitic species only one or a few eggs are laid on a single host, whether it be large or small. Small hosts cannot provide food for many parasites and hence the number in their case is always limited. Still from a single scale insect hardly more than 1/8 in. long a dozen and more tiny parasites have been bred.

A question of interest is that regarding how many individuals of a single host species may in a given

locality, be parasitized. The success of any form of parasitism in any one locality in a given season brings up also the interesting matter of host and parasite cycles. It is obvious that in the face of a scarcity of host individuals the dependent parasitic species are bound to find difficulty in maintaining themselves; and conversely, that with the increase of the host in number the maintenance of life for the parasite is made easy. But the good times bring hard ones in their turn; for when hosts are abundant the parasites increase so rapidly in numbers as soon to overcome and sometimes almost extinguish in any given locality the host species, which means starvation for the new parasite.

The parasitic habit is the prevailing one of a majority of Hymenopterous insects. Although we think of bees, ants and wasps as the typical Hymenoptera and as constituting the bulk of the order,

it is a fact that in point of numbers they are far outnumbered by the parasitic forms whose life is, like that of the social Hymenoptera, also highly specialized. In a half dozen families including the largest in all the order, nearly every species is a parasite and a parasite of other insects.

The super-families and families meant to be included among the insects referred to when the general term "parasitic Hymenoptera" is used are the great super family Proctotrypoidea, a great group of mostly minute species, many of which pass all their immature life within the eggs of other insects or of spiders; the super family Chalcidoidea, an even larger group, also of small species, but with a few forms which are gall makers, and not parasites; and the super family Ichneumonoidea, including the larger Hymenoptera. Each of these superfamilies includes a number of

families, and the three together comprise an enormous host of mostly little known insect species.

The general course of the life and the character of the various stages of a parasitic hymenopteron are as follows; the winged free-flying females searches for its special host species in that stage, egg or larval, on or in which its eggs are to be laid. This host may be always an individual of a particular species or may be one of any of several usually allied species. The hosts represent most of the larger insect orders, although caterpillars of moths and butterflies furnish the great majority of hosts for the parasitic Hymenoptera. On the surface of the body or more rarely, inserted beneath the skin, the parasite deposits one or more eggs. The footless, maggot-like larvae soon hatch, and if not already inside the host's body very soon burrow into it. Here they lie, feeding on its body, growing and developing until ready to pupate.

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They may now eat their way out of the infested and probably dying host to pupate in little silken nests on or off its body surface, or may pupate within the body. In the latter case the issuing winged adults have to bite their way out.

While Lepidopterous larvae undoubtedly furnish the majority of hosts for the parasitic Hymenoptera, they are by no means the only ones. The eggs and pupae of Lepidoptera as well as the larvae, Diptera, Coleoptera, Hymenoptera in both egg and larval stages, some Hemiptera especially scale insects and plant lice, the eggs of locusts and other Orthoptera and some Neuroptera in egg and larval stage, may be infested.

As a general rule each parasite confines its attacks to a single host species, but the host itself may be attacked by more than one parasitic species; most of our familiar Lepidoptera are parasitized by several different parasitic Hymenoptera. For example the

American tent-caterpillar has been found by Fiske to be attacked by twelve species.

An interesting phenomenon in the biology of these parasites is that of hyperparasitism. It frequently happens that the parasites of a given host are themselves parasitized by other parasitic Hymenoptera, while even these secondary parasites are not infrequently parasitized in their turn by still other species, and there is some reason to believe that even the quaternary type exists. An excellent example of hyperparasitism is revealed by Fiske's careful study of the hymenopterous parasites of the American tent-caterpillar. Of these twelve, six are themselves attacked by parasites, of which as many as six species may attack a single species of the primary parasite. Among these secondary parasites are not only species distinct from the primary parasites, but some of the primaries parasitize each other as well as the caterpillars. Of the secondary

parasites; four species are in turn parasitized by other parasites, and finally one of these tertiary parasites is infested by another of the tertiary group, which becomes a quaternary parasite.

Insects belonging to several diverse orders have become peculiarly modified to exist as parasites either upon or within the bodies of birds or mammals. Almost all birds are infested by Mallophaga, or bird lice, but they should not be confused because of this name, with the true blood-sucking lice that infest many kinds of animals. The biting-bird lice constituting the order Mallophaga never suck blood, but feed exclusively on bits of dry feathers. More than a thousand species are known of which about two hundred and fifty have been found on North American birds. Sometimes a species of Mallophaga is restricted to a single species of bird, though in a majority of cases this is not so. Several mallophaga species often infest a single bird; thus

nine species occur on the hen, and no less than twelve species, representing five genera, on the American coot. These parasites spread by contact from male to female, from old to young, and from one bird to another when the birds are gregarious. When a single species of bird louse occurs on two or more hosts, these are almost always closely allied, and Kellog has suggested the possibility that such a species has persisted unchanged from a host which was the common ancestor of the two or more present hosts. Mallophaga are not altogether limited to birds however, for they may be found on cattle, horses, cats, dogs and some others.

The life history of the Mallophaga is very simple. The small elongated eggs are glued separately to the hair or feathers of the host, and from them young soon hatch which closely resemble the parent. These young begin immediately their hair or feather diet, grow larger, molt a few times, and in a few weeks reach maturity. There is never in young

or old, any sign of wing or wing-pads. The body is flattened, the antennae are short and the legs are strong each foot bearing two claws.

The fleas allied to Diptera, but constituting a distinct order Siphonaptera, are familiar parasites of chickens, cats, dogs and human beings. These insects are well adapted by their laterally compressed bodies for slipping about among hairs. Their wings are reduced to mere rudiments, their eyes when present are minute and simple and their mouth parts are suctorial.

Among Diptera, there are a few external parasites, the best known of which is the sheep tick, though several highly interesting but little studied forms are parasitic upon birds and bats.

The Tachinidae is an enormous family of flies, the larvae of which live parasitically in other living insects, Lepidopterous larvae being especially haunted. The females fasten their eggs to the skin of young caterpillars, the hatching larvae burrow into the body of

their crawling host and feed on its body tissues. Sometimes the caterpillar is killed before it can pupate, but usually not, spinning its cocoon and pupating with its fatal parasites still feeding inside. But the butterfly never issues; in its place buzz out several of these bristly Tachina-flies.

The flower-flies, Syrphidae and the bee-flies Bombyliidae are numerous and beautiful. Some of the bee-flies have an unusually long slender proboscis held straight out in front of the head like a spear at rest. It is used to suck up sweet nectar from flower cups. The larvae of the bee-flies are carnivorous, living parasitically in the egg cases of grasshoppers, or on the bodies of wild bees and various caterpillars. One of these bee fly larvae burrowing into a grasshopper's egg-pod can do considerable harm to the embryo grasshopper, but at the same time much

good to us.

The larvae of the bot flies, Oestridae are common internal parasites of mammals. The sheep bot fly deposits her eggs or larvae on the nostrils of sheep; the maggots develop in the frontal sinuses of the host, causing vertigo, or even death, and when full grown escape through the nostrils and pupate in the soil. The horse bot fly glues its eggs to the hairs of horses, especially the fore legs and shoulders, whence the larvae are licked off and swallowed; once in the stomach the bots fasten themselves to its lining, by means of special hooks, and when they have attained their growth they release their hold and pass into the soil.

The most important parasitic beetles constituting the order Coleoptera is the wasp parasite. These parasites belonging to the family Stylopidae possess an extremely interesting and wonderfully

specialized life-history, and show a marked degenerate structure due to their parasitic habits. The males are minute with large fan-shaped wings and reduced, short, club-like elytra. The females are wingless and never develop beyond a larvae or grub-like condition. They live in the body of a wasp or bee; certain foreign species parasitize ants, cock roaches and other insects, while the free flying males live from only fifteen or twenty minutes to a day or two; three days is the longest observed life time of active adult existence. The youngest larva of the Stylopids is a minute six-legged creature, not unlike the Meloid triungulin, which attaches itself to the larva of a bee or wasp and burrows into its body. There it lives parasitically, meanwhile undergoing hypermetamorphosis in that after its first moult it becomes a footless maggot or grub. In this state it

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continues until, if a male, it pupates in the host's body and issues for its brief active adult life. If a female there is no pupation, but when the host larva itself pupates the Stylops pushes one end of its own body out between two abdominal segments of the host, and there gives birth alive to many little triungulins. How the triungulins find their way to their bee-larva host is not very clear, but they probably lie in wait in flowers and when a bee comes along they cling to its leg and are thus carried to the nest where the larvae are. There are two genera of Stylopidae in our country, Xenos which parasitizes the social wasps, Polistes, and Stylops which parasitizes the mining-bees, Andrena.

The family Rhipiphoridae includes a small number of beetles, which are very remarkable in structure and habits. The

wing covers are usually shorter than the abdomen, and narrowed behind; sometimes they are very small and in one exotic genus they are wanting in the female, which lacks the wings also, and resembles a larva in form. The adult insects are found in flowers. The larvae that are known are parasites, some in the nests of wasps, and some on cockroaches.

Much may be said of the economic importance of parasites. Howard says, "Most breaks of injurious insects are frequently stopped as though by magic by the work of insect enemies of the species." Hubbard found in 1880, that a minute parasite, Trichogramma pretiosa, alone and unaided, almost annihilated the fifth brood of the cotton worm in Florida, fully ninety per cent. of the eggs of this prolific crop enemy being infested by the parasite. The Hessian-fly, that destructive enemy to wheat crops

in the United States is practically unconsidered by the wheat growers of certain states, for the reason that whenever its numbers begin to be injuriously great its parasites increase to such degree as to prevent appreciable damage.

The control of a plant feeding insect by its insect enemies is an extremely complicated matter, since the parasites of the parasites play such an important part. The undue multiplication of a vegetable feeder is followed by the increase of hyperparasitism. Following the very instance of the multiplication of the shade-tree caterpillar, Howard was able to determine this parasitic chain during the next season down to quaternary parasitism.

Entomologists have made many attempts to import and propagate insect enemies of various introduced insect pests, and some of their efforts

have been successful, as was notably the case when the lady-bird beetle was taken from Australia to California to destroy the fluted scale.