

# PSYCHE.

## THE HIBERNATION OF APHIDES.

BY CLARENCE M. WEED, DURHAM, N. H.

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In latitudes where winter is a period of protracted cold, a successful mode of passing through it is of first importance to all animals that cannot follow the swallow with the changing season. Such creatures must not only endure the low temperatures to which they are subjected, but also must so protect themselves that a certain proportion of them, at least, shall escape the attacks of the various enemies that are abroad during this long period of forced inactivity. With insects successful hibernation is of vital importance, and each species appears to have chosen (largely through the action of natural selection) the safest method of passing through. A vast number of them hibernate in the egg state; many in the larval state; many as pupae; and a considerable proportion as adults. Not infrequently the same species may hibernate in two or more of these conditions. In such cases it is evident that if the insect in one stage suffers more loss than in the other, the latter — other things being equal — will gradually replace the former as the hibernating condition.

The aphides furnish an interesting illustration of the various methods the different species of a single family may

adopt to pass the winter. The normal life-history of these little creatures may be briefly summarized as follows. In the spring there hatches from an egg deposited the autumn previous, a little aphid that sucks the sap of its food plant for a number of days — sometimes a fortnight — before it becomes full-grown. During this period of growth, it molts or sheds its skin a number of times to provide for its rapidly increasing size. This insect is sometimes called the stem-mother. She is always wingless. Soon after reaching maturity she commences to give birth to living young, continuing the process usually for several days. These young are most commonly born naked, but in some species they are surrounded by a thin pellicle which ruptures soon after birth. They resemble the stem-mother in general appearance, being of course much smaller. Each soon begins sucking sap on her own account, and in the course of ten days or a fortnight becomes mature. It then begins bringing other aphides into the world: these soon mature and give birth to a third generation. All of the individuals of these early broods are parthenogenetic females giving birth to living young without the

presence of males. Many of them are provided with wings but the majority are wingless. This method of reproduction is continued throughout the warm season, but on the approach of cold weather a true sexual generation is produced, the males of which may be either winged or wingless while the females are always wingless. Sexual union between these two forms takes place, and the females deposit true eggs. These pass through the winter, and in spring hatch into stem-mothers which renew the cycle of existence.

The great majority of aphides pass through the winter in the egg state. This is doubtless the safest way, for even supposing the viviparous or sexed forms capable of enduring intense cold, they would be much more liable to be eaten by birds, scattered by winds or washed away by floods, than the eggs. The latter are nearly always at least partially secured against these vicissitudes, although doubtless millions of them perish from exposure to the elements, or are gobbled up by the hungry beaks of chickadees and other winter birds. But as a rule the eggs are so small and so carefully stowed away, that a sufficient number to propagate the species survive all perils.

Perhaps as simple a method of providing for the eggs as any is that adopted by a handsome yellow Callipterus (*C. discolor* Monell) which I studied in Illinois a few years ago. This species lives on the under side of oak leaves, particularly the Burr Oak (*Quercus macrocarpa*) generally on

limited colonies. In autumn a sexed generation is produced, the males having wings and the oviparous females being provided with a long, tapering ovipositor by means of which they push the eggs through the dense pubescence on the under side of the leaf, generally fastening it firmly against the mid-rib. Many of these leaves remain on the tree until quite late in spring; and it is fair to presume that a sufficient proportion of the aphides hatch before the leaves fall off, climb upon the twigs and begin sucking at the buds, although this has not so far as I know been observed. The eggs are certainly safer hidden in the pubescence of the leaves, from observation by birds, than they would be upon the twigs.

From fastening the egg to the leaf to attaching it to the bark of the twig is a short step, and one which appears to have been taken by a majority of the aphides affecting trees and shrubs. In many cases it has naturally resulted from the insects being compelled to migrate to the twigs by the early falling of the leaves. In many of the states in the valleys of the Mississippi and its tributaries where the Box Elder or Ash-leaved Maple (*Negundo aceroides*) is abundant, its foliage is often infested by a small aphid of the genus Chaitophorus (*C. negundoides*). In autumn the sexed forms leave the falling leaves and congregate in great numbers on the twigs. The males are wingless little creatures with slender flattened bodies, barely two millimeters in length, and

long legs and antennae. The egg-laying females are larger and have much broader bodies. They deposit their eggs irregularly upon the bark of the twigs, especially about the buds. The eggs are elliptical-ovoid, less than one millimeter long, greenish or yellowish brown when first laid, but gradually changing to shining black.

There is a pretty little aphid (*A. enonymi*) living upon the under surface of the leaves of the shrub called Burning Bush (*Enonymus atropurpureus*). In autumn the oviparous females congregate on the twigs and deposit their eggs in the crevices about the buds. A curious little Callipterus which I found commonly on the leaves of Beech in central Ohio a few years ago also repairs to the bark for oviposition, but is much more careful in concealing the eggs. The viviparous colonies are found late in summer and early in autumn on the under sides of the leaves, with more or less flocculent matter about them. The sexed forms develop during October, and the oviparous females wander over the bark of the twigs, limbs, and trunk, in search of crevices in which to deposit their eggs. When a suitable place is found the egg is laid, and is then driven into position by the following method. The insect so places herself that her hind legs easily touch the egg; then standing on her four front legs, she brings the two hind ones down upon the egg in rapid succession, striking with considerable force. This serves the double purpose of pushing the egg into place,

and of drawing out a viscid secretion with which it is covered into a thread-like silvery film so similar to the surrounding bark that it is difficult to detect the difference. A minute and a half to two minutes are spent in this process.

Recent observations have shown that a number of species of aphides live upon various trees during autumn, winter, and spring, but for the summer season migrate to more succulent herbaceous plants. The best authenticated example of this is the Hop Aphid (*Phorodon humuli*) which was carefully studied both in Europe and America by Dr. C. V. Riley. The life-history of the species is briefly this. The insect passes the winter in the egg state on plum trees. In spring each egg hatches into a small aphid that sucks the sap from the expanding leaves. This is the so-called stem-mother. She becomes full-grown in a week or two and then begins bringing forth living young at an average rate of about three each day, continuing the process until she has become the mother of a hundred or more rapidly developing aphides. Each of these in turn gives birth to other young in the same way. Three generations of these parthenogenetic forms are produced upon the plum, the last becoming winged and deserting the trees to search for hop plants. On finding them these winged migrants light upon the under sides of the leaves where they start colonies; and the species continues developing upon the hop plant throughout the summer. In early autumn an-

other winged generation is produced, which migrates back to the plum (on which account these forms are sometimes called return-migrants), where each settles upon a leaf and gives birth to three or more young that develop into sexual oviparous females. About the same time winged males are produced upon the hops. They also migrate to the plum where they mate with the oviparous females. The latter deposit the winter eggs upon the twigs about the buds; and on the advent of cold weather all forms but the eggs perish. There is no doubt that a considerable number of the aphides commonly affecting trees and shrubs have a somewhat similar history. For instance our common apple aphid (*A. mali*) spends the summer upon grasses, where they continue breeding until autumn, when they return to the apple, and the winged females establish colonies of the wingless egg-laying form upon the leaves. The males fly in from the summer host-plant. The eggs are then laid on the twigs and buds and the cycle for the year is completed.

The aphid commonly affecting cherry trees (*Myzus cerasi*) has a similar history. It winters over on the twigs in the egg state. Early in spring the young aphides hatch and crawl upon the bursting buds, inserting their tiny sap-sucking beaks into the tissues of the unfolding leaves. In a week or ten days they become full-grown and begin giving birth to young lice, which also soon develop and repeat the process, increasing

very rapidly. Most of the early spring forms are wingless but during June great numbers of the winged lice appear, and late in June or early in July they generally leave the cherry, migrating to some other plant, although we do not yet know what that plant is. Here they continue developing throughout the summer, and in autumn a winged brood again appears and migrates back to cherry. These migrants give birth to young that develop into egg-laying females which deposit small, oval, shining black eggs upon the twigs.

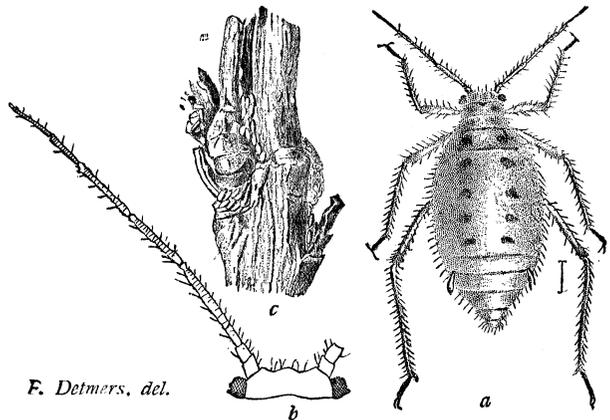
While the aphides affecting deciduous trees commonly live upon the leaves and deposit eggs upon the buds, the rule is reversed in the case of some species found upon conifers. For instance the large Lachnus (*L. pini*) occurring upon the twigs of Scotch Pine deposits eggs in longitudinal rows upon the leaves. The handsome White Pine Lachnus (*L. strobi*) has also a similar habit. Like most plant-lice, this species reproduces viviparously, or by giving birth to living young, during the summer, but on the approach of cold weather the sexual individuals are produced. During October these are usually the only forms present, the oviparous females being congregated in great numbers upon the bark of the smaller branches, with their heads directed towards the trunk of the tree. When disturbed they move about rapidly, usually attempting to conceal themselves on the other side of the branch.

At such times they also wave their long hind legs in the air, probably to frighten away predaceous or parasitic enemies. The males are winged and the oviparous females wingless. The eggs are deposited in longitudinal rows on the White Pine leaflets. Each egg is not quite one-tenth of an inch long, elongate-oval, brownish when first extruded but soon changing to shining black.

Besides the aphides living upon leaves and ovipositing upon twigs, and those living upon twigs and ovipositing upon leaves, there are many species which both live and oviposit upon the twigs. Several such forms occur upon willow, the prettiest one being the Spotted Willow Aphis (*Melanoxanthus salicis*). This insect lives over winter in the egg state on the bark of willow twigs.

Early in spring the eggs hatch into young plant-lice which insert their tiny beaks into the tender bark and suck out the sap. They grow rapidly, and each one soon becomes the mother of several young aphides. The generation from the egg are all wingless, but those of the second generation probably develop into both winged and wingless forms, which are also viviparous. Successive broods continue to appear throughout the entire summer, all being viviparous, and some having wings while others have none. By mid-

summer they have often increased so enormously as to cover all the twigs of infested trees, making them appear filthy and unsightly, as well as impairing their vitality by extracting the sap. In autumn a sexed generation is produced, the males of which may be either winged or wingless. In Ohio I have found only winged males, while in New Hampshire I found both forms, the apterous ones being much the more



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Fig. 1. Flocculent Willow Aphis: a, oviparous female—enlarged; b, head and antennae of same—greatly enlarged; c, eggs on willow bark—one-half larger than natural sizes.

abundant. The oviparous females congregate in one or a few places for purposes of oviposition. In such situations they often cover the bark with their eggs. When first laid each egg is coated with a sticky liquid that dries into a thin, grayish, irregular covering, closely resembling the willow bark in appearance.

Another species, closely resembling the spotted one, and called the Flocculent Willow Aphis (*M. flocculosus*) lives upon the Gray Willow in floccu-

lent colonies, so closely resembling the bark that they are difficult to detect. The males of this species are wingless. The oviparous females seem to take more care than do the spotted ones in depositing their eggs in the crevices of rough bark where the peculiar whitish covering of each helps greatly to conceal it.

There are two other aphides of the genus *Melanoxanthus* which live upon willow twigs but differ from those mentioned above in habits of oviposition. The Bicolored *Melanoxanthus* (*M. bicolor*) is a rather rare species found in many of the western States. The males are winged, and the yellowish brown oviparous females deposit their eggs in the crevices about the buds: the latter after a short exposure to the air become shining black with none of the flocculent covering found on the eggs of the other species. The most abundant member of the genus is that sometimes called the Willow Grove Aphis (*M. salicti*) which is similar to the spotted form, but without the conspicuous white spots. It lives in large colonies on the twigs and branches. The winged males and oviparous females develop in autumn, and the latter oviposit on the twigs about the buds.

One of the largest aphides living upon twigs is the Sycamore Lachnus (*L. platanicola*) which occasionally becomes extremely abundant in many sections of the United States. The sexed forms appear early in autumn, and eggs are deposited in enormous numbers upon the bark.

Some of the aphides affecting herba-

ceous plants complete their yearly cycle upon them. The large reddish brown species (*Nectarophora rudbeckiae*) so commonly found upon composite plants of the genus *Solidago* and *Lactuca* is one of these. In studying its autumn history in Illinois a few years ago, I found that the sexed forms developed during October, the males having wings. Eggs were occasionally deposited upon the old stems of wild lettuce (*Lactuca canadense*), but much more commonly upon the under leaf surface of the young, first-year plants of *Lactuca* and the closely allied *Muhlenbergia*. Evidently the chances of survival and future development are better in the case of the eggs deposited upon the leaves of young biennials or perennials, than of those fastened to the old stems which are liable to be broken off and blown or washed away, so that if the eggs survived the young aphides would not be likely to find suitable food at hand. In such cases a system of natural elimination must tend toward the preservation of the forms ovipositing upon the young plants.

Perhaps the most remarkable fact connected with the hibernation of aphides is that of the preservation of the eggs through the winter in the nests of ants. This was discovered long ago by Huber, and has since been abundantly confirmed by Schmarda, Lubbock and others. Huber's account is so interesting, and apparently so little known, that I quote it at some length\* :—

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\* The Natural History of Ants by M. P. Huber. Translated by J. R. Johnson. London, 1820, pp. 240-245.

One day in November, anxious to know if the yellow ants began to bury themselves in their subterranean chambers, I destroyed with care one of their habitations, story by story. I had not advanced far in this attempt, when I discovered an apartment containing an assemblage of little eggs, which were for the most part of the color of ebony. Several ants surrounded and appeared to take great care of them, and endeavored, as quickly as possible, to convey them from my sight. I seized upon this chamber, its inhabitants, and the treasure it contained.

The ants did not abandon these eggs to make their escape; a stronger instinct retained them. They hastened to conceal them under the small dwelling which I held in my hand, and when I reached home I drew them from it to observe them more attentively. Viewed with a microscope they appeared nearly of the form of ants' eggs, but their color was entirely different. The greater part were black; others were of a cloudy yellow. I found them in several ant-hills, and obtained them of different degrees in shade. They were not all black and yellow; some were brown, of a slight and also of a brilliant red and white; others were of a color less distinct, as a straw color, greyish, etc. I remarked they were not of the same color at both extremities.

To observe them more closely I placed them in the cover of a box faced with glass. They were collected in a heap like the eggs of ants. Their guardians seemed to value them highly; after having visited them they placed one part in the earth, but I witnessed the attention they bestowed upon the rest: they approached them slightly separating their pincers; passed their tongue between each, extended them, then walked alternately over them, depositing I believe a liquid substance as they proceeded. They appeared to treat them exactly as if they were the eggs of their own species; they touched them with their antennae, and frequently carried

them in their mouths. They did not quit these eggs a single instant; they took them up, turned them, and after having surveyed them with affectionate regard conveyed them with extreme tenderness to the little chamber of earth I had placed at their disposal. They were not, however, the eggs of ants; we know that these are extremely white, becoming transparent as they increase in age, but never acquire a color essentially different. I was for a long time unacquainted with the origin of those of which I have just spoken, and by chance, discovered that they contained little pucerons; but it was not these individual eggs I saw them quit, it was other eggs which were a little larger, found in the nests of yellow ants, and of a particular species. On opening the ant hill I discovered several chambers containing a great number of brown eggs. The ants were extremely jealous of them, carrying them away, and quickly, too, to the bottom of the nest, disputing and contending for them with a zeal which left me no doubt of the strong attachment with which they regard them.

Desirous of conciliating their interests as well as my own, I took the ants and their treasure and placed them in such a manner that I might easily observe them. These eggs were never abandoned. The ants took the same care of them as the former. The following day I saw one of these eggs open, and a puceron fully formed, having a large trunk, quit it. I knew it to be a puceron of the oak; the others were disclosed a few days after, and the greater number in my presence. They set immediately about sucking the juice from some branches of the tree I gave them, and the ants now found within their reach a recompense for their care and attention.

This recompense consisted in the liquid "honey-dew" excreted by the aphides.

Huber following Bonnet thought that these aphid eggs consisted simply of a pellicle containing a developed aphid, that "the insect in a state nearly perfect quits the body of its mother in that covering which shelters it from the cold in winter, and that it is not as other germs are, in the egg surrounded by food, by means of which it is developed and supported." But this is erroneous, as these are true eggs, a fact which has already been pointed out by Lubbock and many other naturalists.

A species of aphid living upon the English Daisy was found by Sir John Lubbock to deposit, in autumn, eggs upon the leaf-stalks. These eggs were taken by the common yellow ants to their formicaries where they were "tended by them with the utmost care through the long winter months, until the following March, when the young aphides which hatch are brought out and again placed upon the young shoots of the daisy." This eminent naturalist adds: "This seems to me a most remarkable case of prudence. Our ants may not perhaps lay up food for the winter; but they do more, for they keep during six months the eggs which will enable them to procure food during the following summer, a case of prudence unexampled in the animal kingdom."

The instances above cited relate to aphides living upon plants outside of the nests of the ants. But there are certain species living underground in care of the ants, whose eggs are similarly tended. For many years an insect called the Corn Root-aphid (*A. maidi-*

*radicis*) was destructive to Indian corn in many of the western States. It was found from spring to autumn upon corn roots, always tended by the little Brown Ant (*Lasius sp.*) which dug channels for it and cared for it in every way. The winter history of this aphid had proven a decided enigma to entomologists. No one had been able to find it during winter in any stage. Some years ago, while investigating this subject under the direction of Professor S. A. Forbes, one day late in April, I came across a mass of aphid eggs in a nest of the ant just mentioned—the formicary occurring in an old corn field in central Illinois—which were carried to the State Laboratory of Natural History. They hatched the next day into aphides that subsequently developed into the species in question. Many similar observations were subsequently made at the conclusion of which I summarized the life-history of the insect as follows:—

During the first warm days of spring, usually before the ground is plowed, there hatch from the eggs small greenish lice that are transferred by the ants to the roots and radicles of *Setaria* and *Polygonum*, where they are carefully tended by the ants. In about a fortnight these young have become adult stem-mothers and give birth to quite a number of young. In the meanwhile the ground has probably been plowed, and some crop sowed. In case this crop is corn the ants transfer the lice to the corn roots; but if it is oats or wheat they may continue to rear the lice on *Setaria* and *Polygonum*. The young from these stem-mothers become adult in about a fortnight, and some of them are apterous and others winged. The winged

specimens fly to other hills either in the same or neighboring fields, where the ants are waiting to receive them and proceed to establish colonies. This second generation bring forth viviparous young (mostly wingless); and generations of viviparous females continue to develop on corn roots throughout the summer. In autumn the true sexes are produced (both being apterous), and the eggs are deposited by the oviparous females in the mines of the ant colonies. These eggs are cared for by the ants through the winter, and the young lice that hatch from them in spring are provided for as already described.\*

While the above observations are sufficient perhaps to indicate that the great majority of aphides spend the winter in the egg state, it is by no means true that they all do so. There are many species in which so far as we can judge no sexed individuals or eggs are ever developed. One of these, which is often extremely abundant on the branches of alders in New England is the flocculent aphid (*Pemphigus tessellata*). This insect abounds throughout the summer months in the condition of parthenogenetic females; and in autumn enormous numbers of little aphides are produced. These migrate down the branches and trunk to the bases of the shrubs, where on the larger roots or among the leaves and rubbish they settle down for the long and dreary New England winter. No doubt millions of them perish or are washed away, but in spring those that are left crawl up the alder stems, and finding satisfactory positions insert their

beaks through the bark and begin to feed and grow. In a short time they mature and give birth to young. They secrete a large amount of flocculent material, causing affected branches to appear as if covered with a cottony vegetable growth. They are not usually attended by ants, and the large amount of "honey-dew" they excrete encourages the growth of a black fungus.

It has already been explained that the divers methods of hibernation adopted by the aphides may be explained by the principles of natural selection. With these insects we have all the essentials for the working of the method of elimination which permits only the fittest to survive. Individuals are produced in such enormous numbers that a large proportion of them may well be sacrificed without injury to the species.

The habit of migrating in summer from trees to herbs may also be explained in a similar manner. By so migrating the aphides obtain at least three important advantages, viz.: (1) escape from enemies; (2) more succulent food; (3) lessening the injury to, or even saving from destruction their host-plant. By returning to the trees when the herbs begin to die, they find a comparatively safe place for the deposition of their eggs. In both the spring and autumn migrations the laws of natural selection would find opportunity to operate.

To bring out more clearly the bearing of the laws of natural selection upon

\* Bulletin Illinois State Laboratory of Natural History, v. III, art 3.

the facts of aphid hibernation as we find them to-day, we will briefly review the methods outlined in the previous pages and apply to each these principles.

For our present purpose Professor Lloyd Morgan's term 'natural elimination'\* is more lucid than Darwin's 'Natural Selection.' Reduced to its simplest form this theory rests upon the fact that "in every generation of every species a great many more individuals are born than can possibly survive; so that there is a perpetual battle for life going on among all the constituent individuals of any given generation. Now in this struggle for existence, which individuals will be victorious and live? Assuredly those which are best fitted to live: the weakest and least fitted to live will succumb and die, while the strongest and best fitted to live will be triumphant and survive."†

Among the lower animals it is often not so much a struggle between the individuals of a species, as it is with other species and the natural conditions of existence; not so much a matter of what Morgan calls selection proper,—involving the element of individual or special choice,—as it is a matter of natural elimination. "And the factors of elimination are three: first, elimination through the action of surrounding physical or climatic conditions, under which head we may take such forms of disease as are not due to living agency; elimination by enemies, including para-

sites and zymotic diseases, and thirdly, elimination by competition."\*

In applying these factors to explain the hibernation of aphides we must bear in mind the prodigious powers of multiplication possessed by these insects,—because of which the autumn progeny of a single stem-mother may amount to millions of individuals. We must also remember that on account of the crowding caused by this rapid rate of multiplication, it must often happen that the oviparous females are compelled to deposit their eggs in all sorts of situations upon the food-plant; and that to-day, even when no crowding occurs, the oviparous females often exhibit a considerable diversity in habits of oviposition.

The eliminating agencies with which most aphides in their hibernating condition have to contend appear to be chiefly confined to the action of climatic conditions and natural enemies. A large proportion of the eggs deposited upon smooth bark without special protection must be blown off by winds, or washed away by rain or melting snow and ice. Species which like the Oak Callipterus and the White Pine Lachnus live upon trees the leaves of which remain upon the branches until the following spring have a decided advantage in oviposition because their eggs are less exposed to dangers of this kind than those which are simply consigned to the bark. This is particularly true of

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\* Animal Life and Intelligence, p. 80.

† Romanes, Scientific Evidences of Organic Evolution, p. 3.

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\* Morgan, l. c., p. 80.

the oak species, the eggs of which are much more snugly enconced than those of the Pine Lachnus. In the case of many bark-depositing species, which develop on the leaves, it is easy to see that the elimination of the unfit is still taking place, and that there is an enormous waste of individuals which might be saved by a more perfectly developed old-fashioned 'instinct.' The Apple Aphis, for example, perishes in great numbers every autumn by the falling of leaves containing developing colonies of the oviparous form; such leaves not only bear immature specimens of this form, but often also adults which have not migrated to the twigs with sufficient promptness. This loss is due largely to the lateness of the arrival of the return migrants to the apple foliage, and would be to a considerable extent at least prevented by the earlier development of the latter upon their summer host. The oviparous forms also exhibit even now considerable diversity in sites chosen for oviposition, many eggs being deposited upon smooth bark, although the great majority are placed about buds or in the interstices of rough bark. The action of elimination must evidently tend toward the preservation of the latter and the destruction of the former.

The case of the Beech Callipterus described above is evidently an illustration of a much more perfectly developed instinct than is exhibited by the ordinary twig-depositing species. In this case each egg is carefully placed

in a specially chosen site, and is then not only securely fastened in position, but also concealed from view.

The four species of *Melanoxanthus* mentioned on preceding pages as living upon willow twigs furnish an interesting illustration of the gradual perfection of habits of oviposition of species of one genus. The first species (*M. salicti*) oviposits on smooth bark and about the buds, eggs being developed in great numbers. The second species (*M. bicolor*) confines itself as a rule to the region of the buds; in both these the eggs are plain black with no protective covering. In *M. salicis* a decided step in advance has been taken: the oviparous forms congregate upon the gray bark of the trunk and larger branches and deposit their eggs side by side over a considerable area. The sticky covering with which most aphid eggs are provided when first extruded is here abnormally developed. It serves to hold the eggs more firmly in place and also, on drying, leaves a thin gray coating which gives an appearance so similar to the surrounding bark that the eggs are visible only by the closest scrutiny. In *M. flocculosus* this is carried a step farther, the protective covering being more perfectly developed and the insects apparently choosing rougher bark where there are more interstices in which to conceal the eggs.

It is less easy to account for the origin of the method of hibernation adopted by those species whose eggs are kept through the winter by ants in their nests. It seems most prob-

able that the ants first acquired the habit in the case of the underground species like the corn root-aphis. The oviparous females of this form wander through the galleries of the formicary, occasionally extruding an egg and then die. Of course any suggestions as to how the first eggs came to be carried through the winter can only be speculative. It apparently is not impossible that the ants noticed some quality about the eggs as they were first extruded which led them to recognize them as a part of their food-giving pets; or possibly the first eggs were overlooked and allowed to pass the winter where the mother aphid deposited them, and been discovered in spring at the time the aphides were hatching; or the eggs may have been first stored up for food, and the surplus left over in spring have hatched. However the habit may have originated it evidently is so useful to all it would be fostered. Having once become an established routine of the ants' yearly cycle, it is not difficult to imagine that they would recognize the eggs of aphides

living above ground, especially those living in covered outside tunnels of the ants, and thus gradually develop the habit of carrying the eggs in and the resulting young out.

Passing now for a moment to the group of aphides whose hibernating condition is exemplified by the Woolly Aphis of the alder (p. 359) it is easy to see how natural elimination may have brought about the existing conditions. This species appears never to develop any eggs: consequently it must pass the winter in some living stage. The colonies of viviparous forms are constantly bringing forth multitudes of living young which of course are more abundant in autumn than at any other season. The crowding produced by numbers would often compel them to wander over all parts of the shrub. Those reaching late in autumn the bases of the main stems would stand a much better chance of surviving the effects of wind, snow, rain and ice than those on other parts of the tree. This constant elimination of the unfit and the 'inherited memory' of the fit would lead to present conditions.

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#### OVIPOSITION AND HATCHING OF *THANAOS JUVENALIS*.

May 16, 1894, I followed a specimen of *T. juvenalis* which was apparently searching for a food plant among the scrub oaks of Middlesex Fells at Malden, Mass. The insect flew down to the base of a small, six-inch seedling of *Quercus alba* and laid a single egg upon the stem of the plant, an inch from the ground, among the tender, reddish,

scale-like leaves. The act of oviposition lasted about ten seconds, during which the insect's wings were folded back to back, her fore-feet grasping the stem, while the mid- and hind-feet were rubbed quickly together and along the sides of the abdomen, appearing to assist the process of egg-laying. This occurred on a warm, sunny day, an hour before noon. The egg, delicately greenish when laid, soon became white and within twenty hours was orange in color. Seen



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