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BEETLES FOUND ABOUT FOLIAGE.

BY F. J. A. MORRIS, TRINITY COLLEGE SCHOOL, PORT HOPE, ONT.

During my five years or more of collecting, I have captured, on and about foliage, species belonging to eight or ten of the great families of beetles. Some of these have been merely incidental, and I know of nothing in their habits to connect them with the tree or herbaceous plant on which I found them. For instance, there is a species of *Lagriid*, a family closely related to the *Tenebrionidæ* or Darkling beetles, which I have often taken on foliage—*Arthromacra anea*; usually the beetle is found feeding in blossoms of the dogwood, occasionally on the foliage of that shrub, but quite often I have seen it on the leaves of the May-apple (*Podophyllum peltatum*), the New Jersey Tea (*Ceanothus americanus*), and the Sweet Fern (*Comptonia asplenifolia*); it appears to have a special fondness for this last shrub, and on bright, hot days of July, is often abundant in patches of Sweet Fern.

So far as I know, it does not eat the leaves, but, contrary to the general habit of the *Tenebrionids*, it certainly courts bright sunshine. There is an allied genus in Great Britain (*Lagria hirta*) said to be found on blossoms and in hedges, which, even in the larval stage, is remarkable for its habit of wandering openly about foliage. Most of the *Tenebrionid* larvæ feed obscurely on vegetable matter, preferably in a dry condition; probably the best known—in domestic economy—is *Tenebrio molitor*, the famous meal-worm, which I have occasionally had served to me at breakfast in a plate of porridge.

There are three families of beetles in particular, many of whose members are extremely fond of sunshine. The *Elaters* or Click Beetles, their next of kin, the *Buprestids* or Metallic Wood-borers, and the *Cerambycidæ* or Long-horns.

I have often captured some of the smaller species of *Elaters*, chiefly of the genus *Corymbites*, resting on the upper side of leaves, apparently indulging in the luxury of a sun-bath. Early in May two seasons ago I

took a magnificent specimen of *Buprestis striata* basking on the tip of a branch of white pine, and in August of the same year I saw darting about in the mid-day heat and settling from time to time on the foliage of a spruce the gorgeous little Buprestid, *Chrysobothris harrisii*. This dazzling vision in peacock-blue was vouchsafed to me for a moment only and then withdrawn, but in my mind's eye I have been "following the gleam" ever since. Altogether that proved a red-letter day in my calendar, for I captured on the trunk of a newly-felled balsam fir at the same spot my sole specimen of *Monohammus marmorator*.

A great many of the Cerambycidae or Long-horns are fond of this sun-basking; and I have made occasional captures on foliage of species that usually seek the shade; once a specimen of *Callidium antennatum* on a blade of grass by the roadside, and once a fine specimen of *Calloides nobilis* on a stalk of sedge by the railway track. But of those that are active by day, many of them feeding in blossoms, I have found many species on leaves, especially of the two tribes *Clytini* and *Lepturini*; in one or two cases the insect seems to prefer one foliage to all others, and perhaps such captures ought not to be regarded as merely incidental; for instance, I have found *Clytanthus ruricola* show a decided preference for the leaves of the thimbleberry, though it does not often feed in the blossom of this plant.

The capture I look back upon with greatest pride was that of a small specimen of *Eupogonius subarmatus* in my first season of collecting. I was going through a belt of basswood on the lookout for various things, but chiefly "Walking Sticks" and the larvæ of *Chrysomela scalaris*; by "Walking Sticks" I mean the Phasmid, *Diapheromera femorata*, an Orthopterous insect next of kin to the Praying Mantids; it occurred not infrequently that season about the Rideau on basswood; still more abundant on basswood leaves were the larvæ of *Chrysomela scalaris*, and I was rearing some in captivity. While scanning the under side of the foliage just above my head I noticed a leaf through which the sunlight passed imperfectly; there was a small opaque area near the leaf; in short, something rather smaller than a housefly was casting its shadow on the upper surface. I drew the leaf cautiously down and surprised a diminutive longicorn sunning itself in the middle of the leaf; unfortunately, I surprised it in more senses than one, for, in response to a stimulus of self-preservation, it instantly collapsed, and tumbling down the leaf in a series

of somersaults, like the clown in a pantomime, disappeared from the stage. For nearly half an hour I hunted among the *debris* at my feet, and at last discovered the little harlequin playing 'possum under a twig.

At first I took this beetle for *Amphionycha flammata*, to which superficially it bears an extraordinary resemblance; but I found the unguis or claws (which are divaricate) simple instead of cleft; as they are distinctly cleft in *Amphionycha*, the foot appearing to end in four minute claws, it became certain my capture was *Eupogonius subarmatus*.

Another form of incidental capture is where beetles of a carnivorous habit resort to foliage in search of food. I have once taken *Calosoma scrutator*, and several times *Calosoma calidum* on the foliage of the white pine; these enterprising ground beetles poaching on the arboreal preserves for caterpillars; many of the diurnal fireflies, which are carnivorous, may be found resorting to foliage for the same purpose, and the *Coccinellidæ* or Lady-birds are regularly so taken. One July I found two or three species of Lady-bird resorting in large numbers to an asparagus bed, where they were doing yeoman service in devouring larvæ as they fed on the foliage; on the *menu* of their banquet, if not the *pièce de resistance*, was *Crioceris asparagi*, and they were feasting royally.

Passing from incidental captures to those where the insect was found on its food-plant, I shall begin with an insect I saw in July three years ago, which did not devour the leaves, but using its jaws as a pair of scissors, cut them and rolled them up into cylinders. I mean the weevil, *Attelabus analis*, the oak-leaf roller.

I was examining the leaves of various plants, herbaceous and woody, along the railway track, some 12 miles north of Port Hope—especially willow shrubs and oak-seedlings whose foliage was lush and tender, the leaves being, many of them, still pink and soft—when I noticed a curculio with black head and snout, the thorax and elytra of a shining chestnut-red. I recognized it from having seen cabinet specimens as one of the oak-leaf rollers, and on diligent search I found it fairly abundant and always on young leaves, which no doubt proved more pliable and easily worked by this ingenious little artificer. It was not easy to see much work done, as the beetle is easily alarmed, and drops from the leaf if approached too closely. I was able in one case, however, to watch the actual process of rolling, and in another some of the preliminary work of cutting. Observations published in an American journal of entomology go to prove that,

though the act is instinctive and involves neither practise nor imitation, it is not absolutely perfect ; leaves have been found cut in more than one place and then abandoned as unsatisfactory.

There is a very interesting account of a British leaf-roller (*Rhynchites betule*) given by Sharpe in the Cambridge Natural History. The female beetle goes to the margin of the leaf, at the base, but some way out from the stalk, and cuts through the leaf from the margin to the mid-rib somewhat in the shape of an upright letter S ; it then crosses the mid-rib and cuts through the other half of the leaf to the margin, somewhat in the shape of a prostrate letter S. The beetle then returns to the margin, where it begins cutting, and, much as a grocer makes a paper funnel for sugar, rolls the edge over round an ideal axis till it brings it to the mid-rib ; here it holds the funnel in position with the legs of one side, while with the other three it draws the further side of the leaf towards it and wraps it around the part of the funnel already formed. When it finds the material stiff to work with, it bites the surface of the leaf with its mandibles or pushes it into position with its feet, adjusting means to end like a sailor at work in the shrouds furling canvas. It then enters the funnel, bites two or three small pits into the leaf, deposits an egg in each, and, then emerging, completes the funnel by folding over and tucking in the tip of the leaf.

Mr. Sharpe, in comment, points out that the insect has never seen a funnel in its life, and yet manages to make one perfectly the very first time of trying. But the author's perplexity is partly due to his confusing a purely instinctive act with an act of intelligence (vide the Peckham's book on Wasps). How can an insect be a highly-skilled engineer, working with mathematical accuracy and on a scientific plan ? It is an insoluble problem if you try to state your answer in terms of intelligence and individual consciousness. But place it among impulsive acts, involuntary and more or less mechanical, common to all members of the species, and you can give a fairly satisfactory explanation in terms of instinct.

Among insects especially are found instincts whose perfection is simply diabolical, often involving a highly-complex series of acts performed but once in the whole lifetime of the individual, and therefore admitting of neither practise nor imitation. To look upon such acts as the result of conscious intelligence is absurd ; the intellect has no place here, and would be simply a meddler, likely to bungie and make a botch of the artificer's work. On the other hand, a whole-hearted Darwinian like Weidmann has no difficulty in applying his great principle of selection to such an act, and

seeing in it once more beautiful illustration of how all things living in the world, whether *flora* or *fauna*, are adapted to their environment.

As I have begun with one of the weevils which come at the end of the Coleoptera in classification, I will pass to a family not far removed from the weevils, the Blister Beetles (*Meloidæ*), many of which in the mature state occur abundantly on foliage and are very destructive. Four species of the genus *Epicauta* are known in Ontario; some of them occasionally attack the leaves of the potato, but more usually they feed harmlessly on flowers like golden-rod and helianthus or the low herbage by river banks. I have not seen any of this genus, and think it uncommon east of Toronto, or at least in the neighbourhood of Port Hope. One species of an allied genus (*Macrobasis unicolor*), which also attacks the potato, I have found in great abundance about Port Sydney in low grounds, feeding and breeding on the foliage of meadow-rue. The family consists of two tribes, *Cantharidæ* and *Meloidæ*. The former all have power of flight, and are frequently found about foliage or flowers; in the latter the wings are abortive or entirely absent, and the beetle's most daring excursions into the realm of air consists in crawling up a grass-blade or the stem of some herbaceous plant. One or two species of *Meloe* or Oil Beetle are frequently found early in the spring and late in the summer, but the insect does not appear to eat foliage. Both tribes of this family are famous for their possession of a principle known as cantharidine, whence they are called Blister beetles, some of the species being of great medicinal value.

A more remarkable feature about them, which they share with some of their neighbours, the *Mordellidæ*, is the phenomenon of hyper-metamorphosis. They are all parasitic in the larval stage, their hosts being usually bees, occasionally wasps and (in the case of *Epicauta*) locusts. The normal form of the larva is preceded by a very active louse-like insect known as a triungulin (each leg terminating in a triple set of hooks). The larva that succeeds the triungulin is inactive and almost legless; moreover, in some cases the true pupa is preceded by a sort of preliminary pupal form, from which emerges a larva of habit almost as active as the original triungulin, though it does not feed.

The triungulin is a monomaniac, I mean a creature of but one idea, one single goal of ambition, and its six active legs enable it to get there. The loadstone that draws the triungulin like a steel-filing to a magnet is the egg of its host. In the case of *Epicauta vittata*, this is the egg cluster

of a locust, and the present beetle takes the precaution of laying its egg near where the locust has hidden its egg-batches in the ground. Among the Cantharids, whose host is a genus of bee (*Anthophora*), the beetle oviposits near the bee's nest, but in order that the triungulin may reach the egg of the bee, it has to be carried into the nest by a queen bee; its instinct impels it to seize the first hair within reach. This frequently proves to be the leg of a drone, and in some cases the triungulin manages to transfer itself to the leg of a queen bee during the nuptial flight, and so reaches its goal, the egg cell in the hive. But hundreds of triungulins must perish from seizing a wrong object, and in order to compensate for this, selection has enormously increased the fertility of the female beetle, which lays as many as 2,000 eggs. In the *Meloe* or Oil beetle the instinct is even more imperfect; the beetle does not lay her eggs near the home of the host, and the triungulin mounts to the top of grass-stems or enters a blossom and waits there for a hair (any hair will do); this more often than not proves to be growing on the leg of a fly, or if a bee, the wrong kind, and thousands of the triungulins, instinctively seizing the first hairy object that offers, are carried into space to perish miserably. All that saves the *Meloe* from utter extinction is the stupendous fecundity of the female, the clutch of eggs laid by this Apteryx among insects producing a brood of no fewer than 10,000 triungulin chicks.

Apart from the great Phytophagous group of beetles, easily the best known family of leaf-eaters is the Scarabæids. One section of this family consists of scavengers pure and simple, the larva being nourished in manure or rotting wood and the female laying her eggs in such material. But an important branch of the family is phytophagous, the larvæ feeding on living vegetable matter, usually the roots of grasses and herbaceous plants, and the mature insects often feeding voraciously on leaves of trees or soft vegetable tissue.

In this family of beetles, structurally so different from the Phytophagous Beetles, strictly so called, it is interesting to note how far one group has diverged from another in response to conditions entailed by their chosen food material. Among the *Coprini* you find the larval stage completed in a few weeks, or at most months, while the life of the mature beetle (as in *Scarabæus*) extends over a period of two or three years. Among the *Melolonthini* almost the converse obtains; the larva takes two, three or even five years to mature, and the beetle after emerging from the ground lives for only a week or two.

In Ontario the most familiar of these phytophagous scarabs are the leaf-chafers, popularly known as June bugs. After three years passed in subterranean obscurity the beetles emerge, often in vast quantities; they are inactive during the day, and remain hidden in the grass at the foot of trees or on the foliage itself, but at dusk they rouse up from their lairs and fly about among the trees in irregular flight, noisy and blundering; before midnight their activity on the wing ceases. The life of the individual beetle after emerging from the ground lasts little more than a week or two, and you would naturally expect its chief concern to be the perpetuation of its kind.

But often *Melolonthinus*, like Launcelot Gobbo, is a huge feeder, sometimes entirely stripping fruit trees and ornamental shade trees of their foliage. There are one or two genera in this group containing species a good deal smaller than *Lachnosterna*, the true June bug, which are also very destructive in some parts and seasons. The Rose-chaffer (*Macroductylus subspinosus*), not content with eating the buds and petals of rose blossoms, frequently attacks the grapevine and the foliage of various fruit trees; it is also sometimes a pest on young corn; it does not seem so far to have made its way east of Toronto in any serious numbers.

A closely-allied genus is the *Dichelonychia*, one species of which (*D. elongata*) I have often seen eating the foliage of basswood. Three seasons ago it was very abundant in the woods near Port Hope, and responsible for a good deal of damage done in July to the foliage of forest trees; it shows a decided preference for basswood, eating its foliage more readily and more rapidly than other leaves, though I have found it on hawthorn and on maple.

Another genus, that of *Hoplia* (*trifasciata*), occurs often on hawthorn leaves, but is almost entirely a pollen-feeder, like *Trichius piger* and *Euphoria inda*. *Hoplia*, which occurs often on choke-cherry, early alder and hawthorn, the males appearing at the beginning of May and the females a fortnight later, disappears at the beginning of June. Another species of *Euphoria*, a beautiful beetle called *E. fulgida*, I suspect of eating forest leaves; I have picked it up several times under trees in open rocky hardwoods on the north shore of the Rideau.

Among Scarabs that frequent foliage are also two species very destructive in the tribe *Rutelini*, large, handsome beetles—*Pelidnota punctata*, found on grapevines, and *Cotalpa lanigera*, chiefly on pear trees, but occasionally on elm, poplar and oak. I have never found this

beetle, but the *Pelidnota* has been taken occasionally in the neighbourhood, usually on the cultivated grapevine, but once or twice on wild vines some miles north of the town; it does not appear to be at all frequent east of Toronto.

I mentioned at the outset of my paper the Buprestids as a family peculiarly fond of basking in the sun. There are two genera of Buprestid that eat leaves, *Agrilus* and *Brachys*. The first of these is a long, narrow beetle, taken occasionally on the leaves of basswood, but more common on the foliage of raspberries. The larva bores in the stem of the raspberry. A curious feature about the *Agrilus* is that in appearance and shape, as well as in some of its movements for escape or to elude observation, it closely resembles the longicorn beetle *Oberca*; moreover, the habits and life-history of the two beetles are almost identical; they both lay their eggs in raspberry stems, where the larva bores and feeds, and they both in maturity resort to the leaves of the plant as a resting place and occasionally for food.

The genus *Brachys* is a short form of beetle, almost as broad as it is long, the species I have most commonly found being *Brachys ærosa*; it is not uncommon on basswood and two or three other forest leaves, but I have usually found it feeding on the foliage of a hazel (*Corylus rostrata*), where it is sometimes abundant. It is stated in Sharpe's article on insects in the Cambridge Natural History, that some of the smaller kinds of Buprestid have been discovered to feed on the parenchyma of leaves. I know nothing about the larval habit of *Brachys*, but arguing on analogy from *Agrilus*, I would hazard the guess that the larva is a leaf-miner on hazel or other forest leaves.

In drawing a parallel between *Agrilus* and *Oberca*, I referred to both form and habit. The form of *Brachys*, short and broad and somewhat flat, suggests the form of *Odontota*, a leaf-miner among the *Chrysomelians*; in habit, since the mature beetle of *Agrilus* responds to the same food stimulus as its larva, the eating of hazel and other leaves by the *Brachys* beetle may mean that the larva mines in such leaves. (Vide CAN. ENT., 1887, XIX, 159.

I have found a great many instances among the Coleoptera where the mature insect seems to be affected in a greater or less degree by the same stimulus as the larva. Perhaps the sight of the larva's food-plant strikes on some happy chord of childish recollection in the mature beetle.

To the student of animal instinct it is no doubt far more wonderful that an insect in its comparatively short life should at different stages respond to two quite distinct food-stimuli. The syrphus fly, *Eristalis tenax*, whose larva feeds in liquid manure, is, at maturity, a honey-sucking haunter of blossoms; in extreme cases, like that of the parasitic oil beetles, as many as three distinct food-stimuli occur in the life of the individual.

But in my ramble through the realm of Coleoptera, it is the opposite phenomenon which has struck me most. I mean the number of beetles that are attracted to the food of their larva. I have noticed this especially among the Cerambycidae. In many of them the smell of fermenting sap (where a tree is newly felled or has been injured by the lopping of branches or the mutilation of bark) seems to act as a direct and powerful stimulus in liberating the instinct of reproduction. This is specially noticeable in the Monohammi. In others again, where perhaps the smell of sap has first drawn the insects to the tree for breeding purposes, the sight of the foliage seems to impel the beetles to eat the leaves. This is particularly the case in some genera that approach most nearly to the Chrysomelians. We have a familiar illustration of it in *Tetraopes*, the Milkweed beetle, whose larva feeds in the stem of the plant, while the beetle resorts in large numbers to the leaves, on which it feeds freely as well as breeding. Less conspicuous examples of the same phenomenon are the *Oberrea*, and still more the *Saperda*. I have several times captured *Saperda vestita* feeding on the sheaf of leafy twigs surrounding the basswood stumps, under whose bark the eggs are laid. I have found *Saperda moesta* eating the leaves of the poplar where its larva develops, and on a single willow I once counted over 200 specimens of *Saperda concolor* breeding on the leaves and eating the foliage with evident relish.

These last few paragraphs have brought me right into the great group of Phytophagous beetles, properly so called, whose larvæ, without exception, find support on living vegetable tissue. They comprise three families, the Bruchids, which devour seeds; the Cerambycids, which attack the woody tissue of trees and shrubs, and the Chrysomelids, which feed at all stages on foliage and the more succulent parts of vegetation.

The Bruchids form only a small group, and the genus *Bruchus* is the only one of much importance; besides the Pea and Bean Weevils (so called), the only species I have found at all abundant is a minute insect, *Bruchus discoides*, sometimes plentiful in the blossoms of the white *Convolvulus* or Morning Glory.

The Cerambycids appear to have been in their origin scavengers, rarely attacking sound wood ; but the larvæ of many of them before reaching full growth eat right into solid timber, while others appear to eke out their existence by draining the afflux of sap to the part they have wounded ; yet others again have deserted the forest tree that formed their ancestral home and taken up their abode in the fruit trees of our orchards. The larvæ develop slowly, and must greatly reduce the vitality of the tree they infest. They are exceedingly tenacious of life, and many instances are on record to show that the larval stage is capable of enormous extension.

The imago of *Monohammus* has been known to emerge from chairs and tables years after the manufacture of the furniture. Mr. C. O. Waterhouse, an English Naturalist, heard one of these larvæ at work in a boot-tree (an implement for stretching top boots) which he had in his possession for 14 years ; he then presented the implement to the Natural History Museum at Kensington, where for six or seven years longer the larva continued to saw wood. The entire absence of sap had of course arrested the development of the larva, and it was unable to complete its transformation. Sereno Watson, the American botanist, relates another case (Packard, U. S. Ent. Comm., 1890, p. 689), that seems to prove the life of one longicorn to have lasted 45 years. When you add to this tenacity of life the larval obscurity which makes even detection difficult, it will be seen how serious a pest the longicorns may and often do become.

The Chrysomelians, on the other hand, live openly on foliage, which they devour as beetles no less than as larvæ. The larval stage is short and the insect, as a rule, helpless and easily destroyed. They more than compensate, however, for their exposure to attack by their rapid breeding, many genera producing two broods every season. There are 11 tribes of the family in boreal America, all of them represented in Ontario. But the great bulk of our Chrysomelidæ belong to the four consecutive tribes—*Cryptocephalini*, *Eumolpini*, *Chrysomelini* and *Galerucini*—the last of these is far the greatest, and contains more genera and almost as many species as the other three combined. Together these four tribes contain more than two-thirds of the entire genera and species in the family.

As, geologically, the woody fibred vegetation preceded the leafy and succulent plants, it is probable that the Cerambycidæ attained their greatest development far earlier than the Chrysomelidæ. But the two families are undoubtedly closely akin, and the Donacias may be regarded, both in form and in habit, as in many respects intermediate between some of the less highly-specialized genera of Cerambycids and the Chrysomelids.