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Deer fly feeding
on nectar
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THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION NEW HAVEN

Checking the quality and consumption of milk at schools

By Lester Hankin

Although 10 percent of the milk sold in Connecticut is sold in schools on days when school is in session, little was known about milk consumption patterns. Therefore, we set out to learn the answers to these questions: What is the age, flavor, and microbial quality of the milk offered at schools? What percentage of students take milk? What kind of milk do students select? And, how much milk is actually consumed?

During the school year 1979-80, the Connecticut Department of Agriculture took samples from 195 elementary, 36 middle, and 40 high schools in 45 towns. Over 152,000 students, about 26 percent of the public school enrollment, were represented in the study. Both large and small schools in large and small towns were included in the survey.

The temperature of the milk at the time of collection and the number of days since bottling were recorded for each sample. The flavor was evaluated by staff of the Connecticut Dept. of Agriculture and chemical and microbial tests were performed by the Connecticut Dept. of Health Services. Staff of the Experiment Station designed the experiment and analyzed the results.

We were interested in learning about the flavor of the milk because differences in flavor could relate to acceptance of milk and may influence whether students prefer chocolate-flavored milk to non-flavored milk. The standard taste tests indicated a mean flavor score of 36.8, where a score below 36 is unacceptable. Although the samples were acceptable on the average, the experts judged 14 percent to have an unsatisfactory flavor. The average age of milk offered for sale at schools was 3.5 days; with a range from 0 to 13 days. In general, the results of tests of microbial quality were within acceptable limits.

Fully 124,123 portions of milk were dispensed daily in the 45 towns, as compared to a total enrollment of 152,248. Therefore, 82 percent of the students took milk. We did not take into account absences, so the percentage of students taking milk could be as high as 85 percent. We found 90 percent of the students in middle schools, 82 percent of the students in elementary schools, and 75 percent of the students in high schools took milk (Table 1). In some schools, as few as 23 servings of milk were taken per 100 students, while in others, more than 100 servings of milk were taken per 100 students.

Except for a few schools where whole white milk was most popular, we found that students prefer chocolate-flavored milk to whole white milk. In some, the preference for chocolate-flavored milk was more than 10 to 1. Students in the lower grades generally preferred chocolate-flavored milk 3 to 1 and students in high schools preferred it 1.5 to 1.

At 19 randomly-selected schools, students put aside milk cartons as they left the cafeteria. All milk of each type remaining in these cartons was combined and then measured to obtain an average amount not consumed. The percentage of milk not consumed ranged from 5 to 25 percent for whole white milk and 2 to 20 percent for chocolate-flavored milk. At most schools, the percentage of whole white milk not consumed was about twice that of chocolate-flavored milk (Table 2).

We found that the temperature of milk in storage was satisfactory. But, we learned that half of the schools served milk from unrefrigerated areas. Only 15.5 percent of the unrefrigerated samples, however, were above 45 degrees F, which suggests that milk is not left unrefrigerated for long.

Results have been made available to school officials

Table 1. Pattern of milk preference by students.

Type of school	Percentage taking milk	Percentage Choosing		
		whole white	chocolate-flavored	low or nonfat
Elementary	81.8	24.7	75.1	0.2
Middle	89.8	26.4	73.1	0.5
High	74.9	37.7	59.1	3.2

Table 2. Percentage of milk taken by students but not consumed.

Type of milk	Type of school		
	Elementary	Middle	High
whole white	15.8	6.5	4.2
Chocolate-flavored	9.0	3.9	2.8
Nonfat	19.8	10.8	3.1

The research reported in this article was by Lester Hankin and George R. Stephens of The Connecticut Agricultural Experiment Station and by Donald Shields and Kathleen Cushman of the Dairy Division, Connecticut Department of Agriculture.

and nutritionists so that they may investigate differences in consumption between schools in their towns. The Connecticut Department of Agriculture plans to study schools where milk consumption is high to learn what motivates the students to drink milk.

ADDITIONAL READING

Hankin, L., G. R. Stephens, D. Shields, and K. Cushman. 1980. Quality of milk and patterns of consumption by children in Connecticut schools and camps. Bull. 782, The Connecticut Agricultural Experiment Station, New Haven.

Monitoring natural changes in Connecticut's forests

By George R. Stephens

One of the more enduring features of our landscape is the forest. By land or by air the conclusion is the same: the forest is everywhere. However, this forest that most of us take for granted wasn't always there. The history of Connecticut's forest can be summarized in three words: elimination, exploitation, and recovery.

When the first European colonists arrived in the early 17th Century only five percent of the forest had been cleared for primitive Indian agriculture, mostly along the coast and major river valleys. In the early 19th Century 75 percent of the forest had been cleared. The forest that remained was largely on land too wet or too steep and rocky for field, meadow or pasture. Clearing had eliminated more than 2 million acres of Connecticut's forest in 200 years.

The forest remnant was exploited for fuelwood, charcoal, and timber during the 19th Century. Fire was common, particularly along railroad rights-of-way. There was scarcely an acre of forest that had never been cut or burned by the early 20th Century.

Today we have many less farms than a century and a half ago, our homes and factories use fossil fuels, and fire is uncommon. So, we wonder what effect this has had on our forest. According to a statewide survey conducted in 1972 almost sixty percent of our land is now forest, down slightly from the estimate of a similar survey two decades earlier. How did our forest recover more than a two-fold increase in area in 150 years? By the early 19th Century the lure of fertile land in the West and the availability of manufacturing jobs in the cities caused even the hardy Connecticut Yankees to abandon farming of the rocky slopes and stony fields.

One of our assets is a temperate climate with abundant, evenly distributed rainfall. As a consequence, forest, not grass, is our natural vegetation. Soon after plowing, mowing or grazing ceases trees and shrubs begin to appear. This can be seen along our roadsides and on recently idled farmland. Redcedar on former meadow or pasture, gray birch or aspen on previously tilled land, and assorted shrubs provide a short-lived forest that is replaced within a man's lifetime by the much longer-lived ash, oak, hickory and maple. This process began on our abandoned farms even while the remaining forest was being exploited.

After three wars, vast changes in technology, an exploding population, and a threatened fuel supply, we suddenly have noticed this forest has been quietly recovering and slowly maturing. The forest is the girl next-door who quietly transformed into a mature beauty while we were looking elsewhere. This beautiful forest provides opportunities for solitude and relaxation; at the same time it arouses our interest as a source of timber and fuel. What has occurred in this recovering forest?

In 1927 five Station scientists began to study the new forest. Three tracts on the Meshomasic and one on the Cockaponsett State Forest were selected. They represented a mixture: pioneer gray birch and redcedar attested that portions of the tracts had recently reverted from abandoned farmland; the presence of large trees indicated that parts had been in forest for a while, but stone walls and barbed wire showed that this, too, was once cleared. Finally, there were some acres which likely had always been in forest because they were too rough or rocky to warrant

Table 1. Representation in the forest (Average of four tracts).

	Number of Stems (% of total)		Basal Area (% of total)	
	1927	1977	1927	1977
Major Species				
Maples (2)[1]	29	38	17	18
Oaks (5)	29	9	38	44
Birches (2)	20	37	21	24
Others (21)	22	16	24	14
No./acre	1067	587	—	—
Ft^2/acre	—	—	63	97
Minor Species (7)				
No./acre	454	198	—	—
Ft^2/acre	—	—	6.8	1.9

[1] The number in parenthesis is the number of species in the group. Maple: red and sugar; Oak: red, black, scarlet, white, chestnut; Birch: black and yellow.

Table 2. Components of change in the forest, 1927-77 (Average of four tracts).

	Stems No./acre				Basal Area ft²/acre					
	1927—37		1967—77		1927.—37			1967—77		
	Ingrowth	Mortality	Ingrowth	Mortality	Growth	Ingrowth	Mortality	Growth	Ingrowth	Mortality
Major Species										
Maples (2)[1]	16	−93	74	−28	3.2	0.1	−1.3	3.8	1.0	−1.8
Oaks (5)	14	−112	8	−14	14.5	0.2	−2.2	5.8	0.5	−6.9
Birches (2)	14	−58	106	−27	5.3	0.2	−2.3	4.4	1.1	−2.4
Others (21)	9	−97	48	−20	4.0	0.1	−2.4	3.0	0.2	−1.9
Minor Species (7)	51	−231	112	−75	1.2	0.4	−2.9	0.4	0.5	−0.7

[1] The number in parenthesis is the number of species in the group.
Maple: red and sugar; Oak: red, black, scarlet, white, chestnut; Birch: black and yellow.

clearing. Like much of Connecticut, these tracts had many deciduous hardwoods, but contained only a few conifers.

All stems larger than a half-inch in diameter were identified, enumerated and measured on sample transects. This census, updated in 1937, 1957, 1967 and 1977, provides a detailed record of change in the forest during a half-century. What sorts of changes occurred?

In 1927 we could describe the forest as young, populous and of moderate bulk. Although 30 major tree species and 7 minor tree or shrub species, mostly pioneers, were present in the sample, red and sugar maple, five oaks, yellow and black birch contributed more than three-fourths of the stems of major species (Table 1). In terms of bulk or basal area, which is the summation of cross-sectional area of the stems, oaks contributed more and maples less than their numbers suggest. Thus, maples were small and oaks were large in 1927. The pioneering redcedar, gray birch, bluebeech and aspens were present but not numerous.

A half century later much of the forest is mature. The number of stems decreased to half, and the bulk has increased by 50 percent (Table 1). In numbers maples, oaks and birches now comprise 84 percent of the major species. Although the oaks declined numerically, they contribute nearly half of the bulk and tend to dominate the forest. Thus we have few, but large oaks, many small maples and numerous medium-sized birch. The pioneers, aspen and redcedar have disappeared from our sample. Only a trace of gray birch and a small amount of bluebeech remain. Thus, we see from Table 1 that our forest is becoming more maple and birch and less oak, but that the dwindling oaks are large and they occupy our attention. The relative increase in maple and birch is mainly in small stems.

But these figures are the net change during 50 years, they conceal any changes in persistence, newcomers or ingrowth, and mortality. The changes occurring during a decade in young forest (1927-37) and a mature forest (1967-77) are shown in Table 2. In the early decade (1927-37) all species gained few (ingrowth) and lost many stems (mortality); numbers declined. In a recent decade (1967-77) maples and birches gained many and lost few stems; their numbers actually increased. Oaks, however, lost more than they gained; they continue to decline. When we examine bulk or basal area, in addition to ingrowth and mortality, we must consider another component, growth on stems that persisted throughout the decade. If growth of persisting stems plus ingrowth on new stems exceeds mortality, the forest increases its bulk. If mortality exceeds ingrowth on new stems, then growth is diminished but bulk still increases. Finally, if mortality exceeds growth and ingrowth combined, the forest gives up some of its capital and its bulk declines. The forest as a whole has continued to add bulk during the half century of observation, but the pattern is different for individual species or groups. In the early decade maples and birches showed modest growth, little ingrowth, and mortality that canceled nearly half the gain. Oaks, on the other hand, gained much and lost relatively little. They gained bulk rapidly compared to the others. In the recent decade maples and birches continued to grow modestly, and mortality still canceled about half of the gain. However, oaks lost more than they gained. Thus, the relatively small maples and birches grow modestly and display a large turnover. Oaks grew rapidly in the early decades and gained superiority in bulk, but now they are decreasing.

What causes trees to die? When a forest is young it has many small stems comprising relatively little bulk (Table 1). Unless the stems are widely spaced some must die so that others may grow. Death is the result of lack of light or water, insect or disease attack, or a combination of these factors. Trees also die because they are uprooted or broken off by wind, ice or snow. During 1961-64 and again in 1970-72 the tracts were defoliated to varying degrees by gypsy moth, elm spanworm, cankerworm and other insects. During 1957-67 there was noticeable mortality among oak and hickory (Table 3). In maple and birch losses roughly equaled ingrowth; the number of stems changed little. Mortality canceled nearly half the gain in basal area made by maple and three-fourths by birch. Oak was the big loser. Data on the number of trees and basal area lost to mortality shows that the average diameter of an oak tree dying during 1957-67 was over seven inches. This trend continued into the next decade, 1967-77, in which defoliation also occurred (Table 2). Thus, large oaks but small maples and birches died after defoliation.

Another destructive agent, fire, swept through a portion of one tract in 1932. This portion, recorded separately from the unburned part, provides a graphic example of the effect of groundfire in a Northeastern deciduous woodland. The comparison with its unburned portion is in Table 4. The fire drastically reduced the number of small stems of all species, but spared the large. The fire apparently stimulated oaks to sprout, for by 1977 there were three times as many oak stems on the burned as on the unburned portion. There were also large increases in black birch and tulip after the fire. The subsequent increase in sprouts and seedlings has produced a large number of stems characteristic of a young forest but with the basal area of a mature forest because of the large trees. Fire has advantages and disadvantages. Although it removed many small stems initially, there were subsequent increases in oak, maple, tulip, white ash and minor species. No species was lost as a result of the fire, but many of the larger trees were damaged, thus reducing their ultimate value for timber.

What implications do these findings have for Connecticut forests? These tracts, as most of the rest of Connecticut's forest, are unmanaged. Nature has been allowed to take its course. Without intervention by man except fire protection the forests have matured to produce wood valuable as timber or as fuel. However, much wood has been wasted in the process. In the young forest small trees occupy little space so there is room for many. But as some grow others are crowded out. When observations began in 1927 on average there were about 1000 stems of major species per acre. During 50 years an almost equal number of stems totaling 65 ft² of basal area died. Therefore, nearly 1000 trees averaging 3.5 inches in diameter died and were left unused. But as the forest grew older the trees grew larger. Thus, each decade those trees dying were also larger. In the first decade they averaged two inches, in the last, more than five. We know from our examination of mortality that the average diameter of oak dying during 1957-67 exceeded seven inches. Thus, trees valuable for timber and certainly for fuel die, fall and return to dust. Although their nutrient content is returned to the soil, man derives no utility from them.

In a managed forest, stems are removed periodically to provide more growing space for those that remain. The amount removed should at least equal the amount of wood that would die before the next visitation, if none is to be wasted. However, seldom do we encounter the ideal situation. Few acres of Connecticut forest are managed in this fashion. In addition, it may not be practical to attempt to use the small trees doomed to die in the young forest. But frequently in older forests usable wood is wasted. To be sure, in this day of expensive oil and cool homes, much dead timber has been salvaged for fuel but mostly within a hundred yards or so of roads. Much goes unused. In addition, in a managed forest the poorly formed and undesirable trees are removed to concentrate growth on desirable stems of good form.

Table 3. Change in a decade with defoliation, 1957-67 (Average of four tracts).

	Stems No./acre		Basal Area ft²/acre		
	Ingrowth	Mortality	Growth	Ingrowth	Mortality
Major Species					
Maples (2)[1]	29	−32	2.8	0.2	−1.3
Oaks (5)	1	−53	6.7	0.01	−16.3
Birches (2)	31	−28	3.1	0.3	−2.5
Hickories (4)	1	−11	0.5	0.04	−1.1
Others (17)	17	−16	1.9	0.1	−1.0
Minor Species (7)	57	−115	0.3	0.2	−1.6

[1] Number in parenthesis is the number of species in the group. Maple: red and sugar; Oak: red, black, scarlet, white, chestnut; Birch: black and yellow; Hickory: bitternut, mockernut, pignut, shagbark.

Table 4. Effect of fire (1932) on stem number and basal area.

	Stems No./acre						Basal Area Ft²/acre					
	Unburned			Burned			Unburned			Burned		
	1927	1937	1977	1927	1932	1977	1927	1937	1977	1927	1932	1977
Major Species												
Maples (2)[1]	171	164	200	143	43	239	14.9	16.9	20.0	10.3	8.6	15.7
Oaks (5)	210	98	51	214	31	150	17.3	23.9	30.2	26.4	15.8	42.6
Birches (2)	191	175	106	118	38	147	22.2	25.9	29.7	19.4	16.8	25.1
Others (21)	178	185	65	226	16	90	10.1	11.2	14.2	15.7	7.6	17.0
Total	750	622	422	701	128	626	64.5	77.9	94.1	71.8	48.8	100.4
Minor Species (7)	325	294	234	260	1	258	6.2	5.8	3.0	6.0	0.2	3.4

[1]Number in parenthesis is the number of species in the group.
Maple: red and sugar; Oak: red, black, scarlet, white, chestnut; Birch: black and yellow.

What have we learned? No matter what we do to our land, if we leave it alone long enough forest will return. In our unmanaged forest we have great diversity although a few species may predominate. This diversity persists through much of a man's lifetime. The struggle for survival among trees results in mortality and frequently, waste of wood. Fire suggests some intriguing possibilities for enhancing the population of desirable species, but management will likely be necessary to capitalize on this advantage. We have seen what nature can do. We now need to determine if we can do better.

ADDITIONAL READING

Stephens, G.R. and P.E. Waggoner. 1980. A half century of natural transitions in mixed hardwood forests. Bull. 783, The Connecticut Agricultural Experiment Station, New Haven.

Studying parasites of the gypsy moth to increase their effectiveness

By Ronald M. Weseloh

During the last outbreak of defoliation in the early 1970's, the gypsy moth and the elm spanworm concurrently defoliated a record 655,107 acres in Connecticut. The elm spanworm was virtually eliminated by a tiny egg parasite, which was discovered by Harry Kaya and John Anderson of the station staff; but a similar fate evidently does not await the gypsy moth without the help of man.

None of the natural enemies that helped keep the gypsy moth under control in its natural range in Europe and Asia were here when it was accidentally released in this country in 1869. Once the gypsy moth was recognized as a problem, attempts were made to introduce many of its natural enemies. Twelve parasites and predators that range from tiny, stingless wasps to large flies have become established. Although these have not prevented outbreaks, they provide an initial pool of biological agents that could be manipulated to provide better control of the gypsy moth in Connecticut.

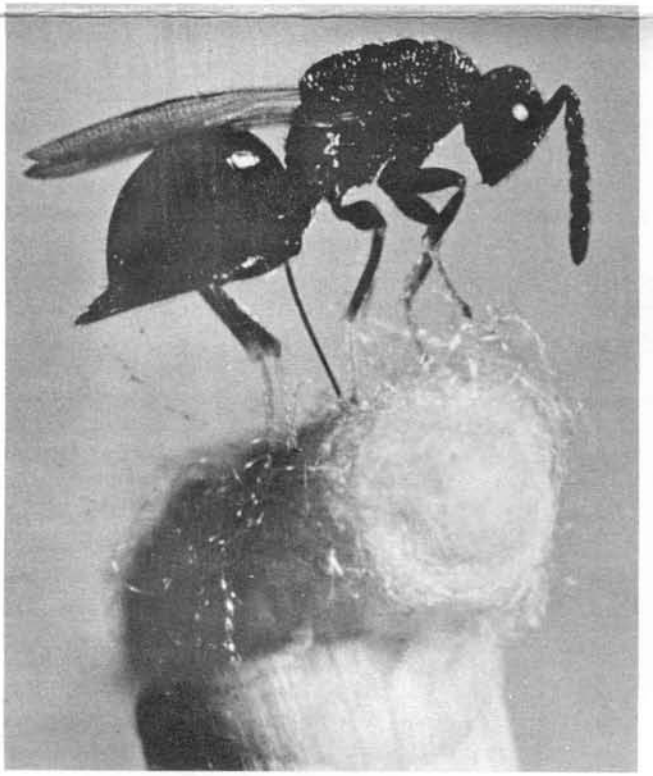

Figure 1. Female of the hyperparasite, *Eurytoma appendigaster* drilling through cocoon of *Apanteles melanoscelus*.

Apanteles melanoscelus is one of these parasites that has been intensively studied at the Experiment Station. This stingless wasp attacks the gypsy moth in the caterpillar stage. It was described in *Frontiers* (Spring, 1976). One of the limits to the effectiveness of this wasp is that it has parasites of its own, known as hyperparasites, that reduce its numbers and therefore its effectiveness in controlling the gypsy moth.

I have been studying about 20 hyperparasites of the parasite *Apanteles* in hopes of reducing their impact and therefore increasing the effectiveness of *Apanteles* against the gypsy moth. The hyperparasites drill through the cocoons of *Apanteles* and deposit eggs on the hibernating larva within. Attacking from late June until fall, these hyperparasites can kill up to 90 percent of the hibernating *Apanteles*. This means that although *Apanteles* may build its population during the time the gypsy moth is prevalent, and it can hibernate until the host caterpillars again become available, the heavy losses greatly reduce its overall effectiveness in controlling the gypsy moth.

The most common hyperparasite of *Apanteles* is *Eurytoma appendigaster*. My experiments show that it attacks cocoons placed on tree trunks more often than those on leaves. My observations also show that even if other hyperparasites attack the cocoons, *Eurytoma* usually emerges. Laboratory studies show that *Eurytoma* larvae kill the larvae of other hyperparasites within the *Apanteles* cocoon. This means that it would be important to control all hyperparasites, not just the most abundant one; for if one is eliminated, another may become prevalent when competition is reduced.

I am investigating a strain of *Apanteles* from India that may help me indirectly control hyperparasites. This strain is almost identical to the local *Apanteles melanoscelus*, but the cocoon that the Indian strain spins around itself has a larger "halo" of coarse silk than the cocoon of *Apanteles melanoscelus*. This larger halo may be more difficult for hyperparasites to penetrate than the halo of *Apanteles melanoscelus*. When the Indian and American strains are cross-bred, a larger halo is inherited. I plan to test cocoons of both the American and Indian strains in a forest this summer to see which best survives attack by hyperparasites.

I am also studying a tachnid fly, *Compsilura concinnata*, which looks like a housefly and attacks a wide variety of caterpillars, including the gypsy moth. Although it is not abundant in areas where gypsy moth populations are high, it is easy to rear. To learn more about where it attacks hosts, I placed colored sticky panels in the forest canopy and near ground level throughout the spring and summer. I found that *Compsilura*, like *Apanteles melanoscelus*, is present most often in the canopy where the caterpillars it attacks are also located.

Few *Compsilura* survive the winter because its immature stage must overwinter within a caterpillar or pupa; that is, in some insect besides the gypsy moth which overwinters as an egg. Releases of *C. concinnata* in spring might give this parasite an early start each year. Although *Compsilura* is easy to grow, rearing of the large numbers needed would be expensive. Therefore, I am studying *Compsilura* to learn how they attack caterpillars, in hopes of using this knowledge to increase their effectiveness and am also working to develop an artificial medium that will substitute for live caterpillars.

First, I need to learn what characteristics of the host induce female *Compsilura* to deposit their live young into host caterpillars. For example, I give a female parasite a choice between a living and a dead host and then observe which one she examines and attacks most often (in this case it was the live one). My results show clearly that movement of the host is important, as is the texture of the host skin. *Compsilura* will even inject larvae into moving gypsy moth skins filled with an agar-jelly solution. I hope to develop an artificial host to induce injection of the larvae, and then an agar-based, artificial diet upon which to rear them.

Because the existing pool of established parasites is not large, we try to introduce new parasites of the gypsy moth whenever we can. Last summer, John Anderson and I released in Northeastern Connecticut two new parasites that were imported from Japan by the U. S. Department of Agriculture. They are *Coccygomimus disparis* and *Brachymeria lasus*. *B. lasus* is similar to the established species *B. intermedia*. Both exotic parasites attack the pupal stage.

We released 21,000 *B. lasus* and 12,000 *C. disparis* in two plots each in late June, 1979. We collected gypsy moth pupae from the plots and held them in the laboratory to see if they had been attacked by parasites. We also set out pupae of the greater wax moth, *Gallaria mellonella*, to see if they would be attacked after gypsy moth pupae were no longer available.

Parasite adults emerged from these hosts, which proves that the two species reproduce successfully in the field. *B. lasus* emerged almost exclusively from gypsy moth pupae, while *C. disparis* emerged almost exclusively from wax moth pupae. *C. disparis* attacked the pupae under most forest conditions, but *B. lasus*, like its established cousin *B. intermedia*, preferentially attacked those in sunny areas. Gypsy moth pupae, however, are often found in shady spots. Therefore, *B. lasus* may be ineffective because it does not attack the gypsy moth pupae where they are usually found.

C. disparis appears to prefer wax moths over gypsy moths, and therefore may not readily attack the gypsy moth in the field. It is impossible, however, to predict whether a parasite will be effective before it is established. *C. disparis* adults held in outdoor cages survive the winter, therefore there is some evidence that the parasite may become established. I am also trying to induce *B. lasus* to enter a state of arrested development in the laboratory, which is necessary for winter survival.

Blood and sugars are needed to nourish deer flies and horse flies

By Louis A. Magnarelli and John F. Anderson

Deer flies and horse flies (tabanids) can be a nuisance in some areas of Connecticut during June and July. Their biting, which is painful, is necessary for the ingestion of vertebrate blood, a blood meal. Protein nutrients in the blood are digested and are subsequently used to nourish eggs.

Of the 81 or more species of tabanids found in Connecticut, 27 are abundant enough to create discomfort for man and animals. Deer flies bite a variety of mammals—humans, cattle, dogs, deer, and rabbits. Horse flies prefer cattle and horses; therefore, they rarely attack humans when these other animals are present.

Tabanid biting can sometimes reach a level that af-

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fects recreation and in pastures, these insects often become a major pest of livestock. Cattle react to bites by stamping their hoofs, flicking their tails, rippling their skin, and licking. The cutting mouthparts of horse flies can cause numerous bleeding wounds on the sides and legs of animals.

Because horse flies are easily disturbed while feeding, they commonly leave a host before they receive a full blood meal. A tabanid that has ingested a partial blood meal will persistently seek additional hosts until it obtains enough blood to develop eggs.

Although most inland species need vertebrate blood to produce eggs, those of three salt marsh species receive the nutrients for their first batch of eggs from their soil-dwelling immature stages. Egg production in the second and later cycles is dependent upon vertebrate blood.

Blood may not always be ingested during an interrupted feeding, and as the number of hosts visited rises, the chance of a tabanid acquiring a disease-causing organism and transmitting it to another host also increases. Therefore, we have made studies to help us estimate the prevalence of partial feedings among tabanids.

We use an insect net or a canopy trap baited with CO_2 from dry ice to collect host-seeking females. The net is used to capture deer flies that swarm around the heads of cattle, dogs, and humans. The canopy trap is a plastic structure that mainly attracts horse flies. A black beach ball, suspended under the trap, simulates movement of a large animal. Carbon dioxide, the dark color, and movement of the beach ball combine to attract the flies. Once the insect is inside, it is attracted toward light coming through the top, moves upward, and is confined in a transparent container.

We take captured specimens to the laboratory where they are dissected and examined under a microscope to see if vertebrate blood is present. If we find blood, we remove tissues for further tests. The source of a blood meal is identified by drawing a blood sample into capillary tubes and reacting it against a number of different antisera, which are reagents made by injecting bloods of animals into rabbits or roosters. A white precipitate forms when the appropriate animal blood combines with the proper antisera.

We examined 2,559 horse flies and deer flies and found 271 (10.6%) with partial blood meals. The majority of these were from bovines, but we also found deer, dog, horse, and rabbit bloods.

Only female tabanids seek vertebrate blood. The males do not bite animals, but they maintain themselves on sugars in nectar. Our studies indicate that females of 33 inland and 3 coastal tabanids also feed on nectar sugars at least part of the time. Utilization of plant sugars is important because the energy derived from these carbohydrates fuels flight and survival. Two tests are used to detect sugars. In the first test, a tabanid is crushed on a depression slide to release the sugars from its body and then a reagent is added. If the reagent changes from yellow to blue-green, fructose or sucrose is present. In the second test, thin-layer chromatography, sugars are extracted from specimens, placed on silica gel plates, and eventually identified by separation patterns and specific color reactions. We found that 71 percent of the 1,339 females that we analyzed in 1978 and 1979 contained common nectar sugars. We have also observed an occasional female probing aphid honeydew, which contains the same sugars found in nectar.

We experimented with females of a coastal species that had taken cow blood from paper tissues in the laboratory. Half were fed distilled water and half were given 10 percent sucrose solutions through cotton pads. We found that females that had ingested both blood and sugar lived 2 to 3 weeks longer than those that had fed on blood and distilled water. In other tests, females that had fed on sucrose solutions but were not given blood lived as long as those that had taken blood and sugar meals.

Therefore, our research indicates that if you are bitten by a deer fly, chances are plant nectars provided the energy it used to get to you.

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