DIV. INSECTS.

TENTH ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF

MINNESOTA

TO THE GOVERNOR

FOR THE YEAR 1905.

FOURTH ANNUAL REPORT OF F. L. WASHBURN.

AGRICULTURAL EXPERIMENT STATION,
ST. ANTHONY PARK, MINN.
DECEMBER, 1905.

LETTER OF TRANSMITTAL.

STATE EXPERIMENT STATION.

Dec. 1, 1905.

His Excellency, John A. Johnson, St. Paul, Minn.

DEAR SIR: It gives me pleasure to present to you herewith the tenth annual report from this department.

This has been a year of surprises in that certain destructive pests have been unexpectedly active, while others which we will always have with us and which usually work havoc each year have done little or no injury during the past season. The Hessian Fly has been present on grains and grasses, but to a limited extent, not sufficiently noticeable to cause complaint. It is safe to say, however, that this insect will be more noticeable the coming season, and will, if climatic conditions favor, increase in numbers each year for several seasons, until it reaches its climax in numbers and injury done, after which it will practically disappear, as it has this season, only to repeat the same phenomenon later. This periodic increase and decrease in the numbers of this, probably our most serious grain pest in Minnesota, is due largely to the presence of parasitic insects which prey upon it. As the Hessian Fly increases in numbers, so does its parasites, until the latter get the upper hand, and the fly disappears. But in the killing of its host the parasite has destroyed its food supply, and hence its numbers are materially lessened, giving the Hessian Fly another chance. It is estimated that the average annual loss in the United States alone, due to this fly, amounts to nearly $50,000,000, and about five years ago it raised that tax to $100,000,000 for one year, Ohio and Indiana contributing $24,000,000 of that sum. The Chinch Bug, companion pest of the Hessian Fly, has been conspicuous by its absence, though a few were reported from one or two localities. This insect, also while sparing us this year, will visit us again in destructive

numbers. The United States loses annually, on an average, at the hands of the Chinch Bug nearly $100,000,000. Of other wheat insects, the Wheat Stem Maggot, *Meromyza americana*, has been taken in considerable numbers, and the occurance of the Joint Worm has been reported to this office. These two latter pests, as well as the Frit Fly, are undoubtedly with us, though not in sufficient numbers as yet to be destructive.

I have to report quite a serious loss to farmers who would raise alfalfa seed through the voracious appetite of the Red-legged Grasshopper or Locust, *Melanopus femur rubrum*, which prevented the formation of seed on many acres in Hennepin county. This was not reported to the entomologist until the damage was done; in fact, the farmers themselves did not realize the havoc which was quietly going on in their fields until too late to prevent it. I have little doubt but that next season, fore-warned as we are, a repetition of this can be prevented.

Early in the summer various species of cut worms were reported bad in certain sections, flax growing districts being perhaps the worst sufferers. No specimens reached us with the complaints. We have in Minnesota over two hundred species of caterpillars commonly referred to as "cut worms." In June many inquiries reached us regarding galls on plum leaves. This trouble was caused by a small mite known as *Eriophyes padi*. It has been troublesome before this date, being reported from Minnesota in 1884. The Cottony Maple Scale, *Pulvinaria innumerabilis*, has been again a serious pest. It has been discussed and remedies given in a previous report from this department; we have every reason to believe that it will be finally conquered by parasites and predaceous insects The Stalk Borer, *Papaipema nitela*, has been destructive again, as has the corn worm, *Heliothis armigera*, the cotton boll worm of the South. A serious report of this pest reached us from Cannon Falls, where "every other ear" was said to be infested. No complaint has reached us this season of the Grain Plant Louse, an insect which caused wheat growers some alarm last year. We have had our usual quota of green cabbage worms, potato beetles, and insects affecting squashes and melons. Potato beetles were reported as being especially bad in the northern part of the Red River Valley. The striped cucumber beetle has been kept in check by

dusting air slaked lime on the plants. The White Grub, larva of *Lachnosterna*, sp., has ravaged lawns to a marked extent, its injuries being particularly noticeable in cemeteries and like situations, where large tracts of grass make it a difficult pest to conquer. The robins are amongst our best friends in waging war on this pest, since they find and eat many of them daily. A few years ago we found we could eradicate this grub by the use of bisulphide of carbon, and we made an effort this year to find some other remedy which was perhaps more practical for large affected areas. In the course of our experiments we discovered that the grub could stand immersion in a very strong tobacco solution for several hours

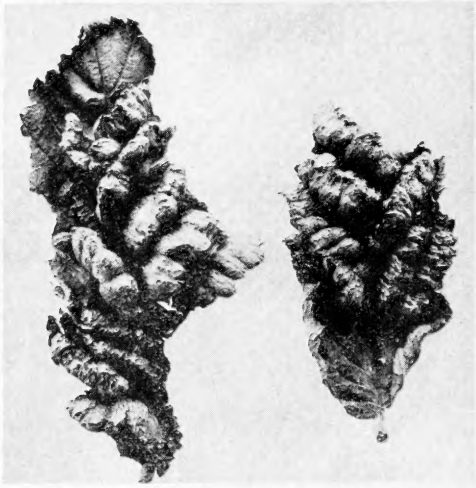


Fig. 1. Cockscomb Gall on White Elm.

without serious results, apparently. Hellebore was used in various ways without success. We have in mind two preventive measures which we shall test next season if opportunity offers.

Bruchophagus (*Eurytoma*) *funebris*, was reared in considerable numbers from crimson clover. Varieties of thistles, amongst them the Canada thistle, were noticeably preyed upon by dark colored caterpillars, the larvae of *Vanessa cardui*, that most cosmopolitan of all butterflies, found everywhere, except in South America and the Arctic regions, and many of these were killed thereby. While abundant, these caterpillars were not sufficiently numerous, of

course, to materially affect the thistles, and, it must be confessed, also turned their attention to garden plants, hollyhock, calendula, etc.

Mention has been made above of a troublesome gall-producing mite on the leaves of plum. We have to report, also, in this connection, Cecidomyid gall makers again injuring leaves of Soft Maples, Box Elder, and the cockscomb gall locally abundant on leaves of White Elm. In one county we secured specimens of the peculiar globe-like galls on Red Elms, caused by the gall-making plant louse, known as *Pemphigus ulmi-fusus.* The Plum Curculio has made its presence felt on apples as well as plums, and the New York Weevil, *Ithycerus noveboracensis.* working on fruit trees,

Fig. 2. *Pemphigus ulmi-fusus* on Red Elm.

has been complained of in some counties. A lepidopteran borer, *Podosesia syringæ,* has attacked young ash trees near Adelaide, so weakening their trunks as to cause them to be broken down by the wind. A green saw-fly larva has worked on the leaves of ash trees, and is at present in our breeding cages awaiting its transformations, that we may identify it.

From one to several inquiries regarding injurious insects have been received from each of the following counties: Becker, McLeod, Morrison, Itasca, Yellow Medicine, Kandiyohi, Ramsey, Brown, Rock, Hennepin, Polk, Lac qui Parle, Stearns, Otter Tail, Wright, Scott, Clay, Nobles, Lake, Norman, Rice, Marshall, Dakota, Freeborn, St. Louis, Waseca, Todd, Isanti, Watonwan, Cass, Nicollet, Big Stone, Dodge, Douglass, Renville, Cottonwood, Crow

Wing, Carlton, Wabasha, Fillmore, Redwood, Blue Earth and Lyon.

Four houses in the Twin Cities, to our certain knowledge, and there were doubtless others, have been over-run with the so-called "book louse," *Troctes divinatoria*, which, by the way, is by no means always confined to books. In these particular cases these tiny pests swarmed in bureau drawers and closets, over clothing, on walls and the backs of pictures, and in fact in every place likely to disgust a sensitive house-keeper. An effort was made by this department to free two houses of this unwelcome guest, and partial success was attained by the use of hydrocyanic acid gas, the families vacating the premises in question for about thirty hours. We were unable to locate the starting point or breeding place of the insects in these two cases. It is a significant fact, however, that all of these residences known to be infested are new houses, built within a year, the present occupants being the first to use them. Serious outbreaks of Psocids are unusual, though some are on record, starting from straw or husk fillings of mattresses, in which they find a congenial breeding place. No such chances were offered the insects in the cases above referred to, and we are constrained to believe, from our observations, that they came from the space betwen the walls, or under the floors, or both. Another family, which, for a year or more, has been troubled by that very common household pest, the little red ant, has appealed to the entomologist for relief, and at date of writing, believe they have been practically conquered by the use of bisulphide of carbon, after they had been traced to their retreat, evidently the walls of the furnace room. Our object in this case, of course, is to kill the queen or queens in the nest or nests thus preventing increase, as well as killing all worker ants in the nest at time of treatment.

In a special report on the Flour Moth, issued in February, 1904, we counselled great care in the use of hydrocyanic acid gas against this pest, and on account of the danger of its application, unless in the hands of experienced parties, it was placed among remedies which were regarded as undesirable for any cause. Personal work with this agent since that date, as well as work done by others in the East, convinces us that it is the most effective and useful of all known remedies when intelligently used. It is absolutely sure death to all eggs, which cannot always be claimed for the freezing

method; it is always available at any time of the year; the gas is most penetrating in its nature, reaching every crack and cranny about the mill; it recommends itself to insurance companies with whom millers hold policies, since it is absolutely non-explosive when used at the strength desired for the Flour Moth, which cannot be said of treatment with bisulphide of carbon. I heartily commend it to our millers as safe and effective when properly used. It should be thoroughly understood, however, that to breathe it is fatal. This very fact makes its use safer, since it is used with great caution by those familiar with it.

Out of the seventy-four listed nurseries in the state, we have inspected, according to law, forty-five, an increase of seven over last year. Their names follow below. The money received for this inspection has been handed to the state treasurer, as evidenced by his receipt:

F. L. Washburn, in Account with State and Nurseries, Debit by Cash Received.

1905.	Name and Town.	No. of Cert.	No. of Receipt.	Cash.
July 5.	Mitchell Nursery Co., Owatonna	66		
July 5.	Clinton Falls Nursery Co., Owatonna	67		
July 6.	Wedge Nursery Co., Albert Lea	68		
July 6.	Albert Lea Nursery Co., Albert Lea	69		
July 6.	Gopher State Nursery, Albert Lea	70		
July 6.	Minnesota State Nursery, Albert Lea	76		$49.61
July 8.	Winnebago Nursery Co., Winnebago City	71		
July 8.	St. John's Nursery, Fairmont	99		
July 8.	McKisson's Fairmont Nursery, Fairmont	75		
July 9.	Amber Lake Nursery, Fairmont	72		
July 10.	Kanaranzi Nursery, Adrian	73		
July 11.	Luverne Nursery, Luverne	74		
July 13.	Hennepin Co. Nursery, Eden Prairie	77	77	5.30
July 15.	Deephaven Nursery, A. O. Hawkins, Excelsior	79	79	1.55
July 15.	Chas. Hawkinson Nursery, Excelsior	78	78	1.55
July 24.	North Star Plant Farms, J. W. Beckman, Cokato	83	83	1.40
July 24.	Wright Co. Nursery, John Eklof, Cokato	80	80	1.40
July 24.	D. M. Bowers Nursery, Howard Lake	81	81	1.40
July 24.	Howard Lake Nursery, W. L. Taylor	82	82	1.40
July 24.	Victor Nursery, W. H. Eddy, Howard	84	..	1.40
July 25.	Rose Hill Nursery, John Hawkins, Minneapolis	85	..	1.00

1905.	Name and Town.	No. of Cert.	No. of Receipt.	Cash.
July 25.	Jewell Nursery Co., Lake City	86	88	5.50
July 26.	Pleasant Valley Nursery, Winona	90	..	4.75
July 27.	Vinegar Hill Nursery, Houston	91	86	6.50
July 28.	Preston Nursery, Preston	92	87	5.50
July 28.	Spring Valley Nursery, Spring Valley	88	..	5.00
Aug. 1.	Twin City Nursery Co., Minneapolis	87	..	2.60
Aug. 10.	Vine Grove Nursery, Minneapolis	89	..	2.60
Aug. 12.	Farmers' Seed Co., Faribault	93	..	2.40
Aug. 12.	Andrews Nursery Co., Faribault	95	..	2.40
Aug. 12.	Brand Nursery, Faribault	94	..	2.40
Aug. 18.	Northwestern Nursery, Pipestone	96	..	8.00
Aug. 29.	L. L. May & Co. (Mayfield, Lakeland), St. Paul	97 and 98	..	5.70
Sept. 11.	West Concord Nurseries, West Concord	111	54	1.50
Sept. 11.	Dodge County Nursery, Mantorville	100	53	2.00
Sept. 11.	Byron Nursery, Byron	101	55	2.00
Sept. 12.	Mankato Nursery and Poultry Yard, Mankato.	102	56	5.00
Sept. 12.	New Ulm Nursery, New Ulm	103	97	5.10
Sept. 14.	Cannon Falls Nursery, Cannon Falls	109	99	5.10
Sept. 15.	G. W. Strand, Taylors Falls	104	..	5.10
Sept. 15.	Old Fashioned Flower Garden, Excelsior	105		
Sept. 15.	Excelsior Nursery, Excelsior	106		
Sept. 15.	Lyman Nursery, Excelsior	107		4.35
Sept. 15.	Brackett Nursery, Excelsior	108		
Sept. 15.	Hoyt Plant and Seed Co., St. Paul	110		1.00
	Total			$150.51
	Credit by cash paid State Treasurer			$150.51

We found the nurseries, for the most part, in excellent condition. A weak point in our law, however, has been brought to our attention. One or more nurseries, it is evident, buy trees from the South, from a region affected by the San Jose Scale, and sell to Minnesota patrons. It does not follow necessarily that their trees are infested with this dread scale, because those districts are fairly well controlled by inspectors; but it is not, as we know from experience, a difficult matter for an infested tree to be overlooked. We do not want such trees in this state. The present law gives the entomologist no option. A man may only own an acre of ground, on none at all; he may have only a thousand trees or less, on rented ground, his entire business consisting of buying and selling, the entomologist's certificate going upon all trees handled by

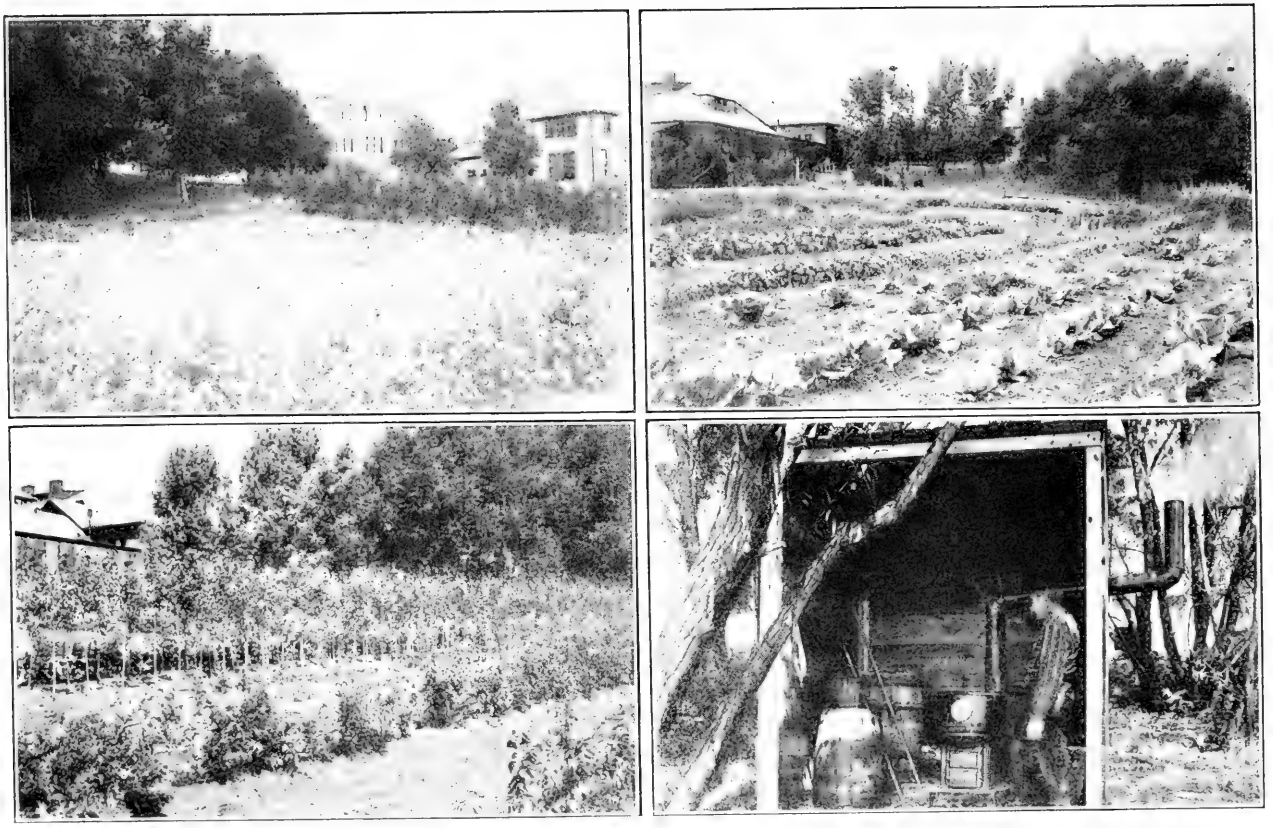


Fig. 3. Views in Entomologist's Experimental Garden; Lower right, shed with boiler. Upper right, cabbages, turnips, etc. used in experiments against Cabbage Maggot. Lower left, nursery rows. Upper left, honey plants.

his agent, no matter from what part of the country they may come. This could easily be remedied by an amendment to the present law. A move in the right direction was made at a combined meeting of nursery inspectors of the National Nursery Men's Association held at Washington, D. C., in November. One object of this meeting was to secure greater uniformity in the inspection laws of the various states. Notice has been sent to all Minnesota nurserymen of the recent passage of an inspection law in South Dakota, making it necessary to attach the inspector's certificate to all shipments into that state.

Since the last report was made we have been allowed by Director Liggett about a quarter of an acre at the Experiment Station, which we make use of as an experimental garden. On this not overly fertile ground we have planted a couple of hundred fruit trees, in nursery rows, current and gooseberry bushes, and raspberry and blackberry vines. We also grew during this season potatoes, onions, squashes and melons, and cabbages, cauliflowers, rutabagas and radishes, the latter four for experiments with the cabbage maggot. In connection with the garden we have installed a stove and boiler for use in making insecticides which require heat. Upon this ground also we have been testing a number of honey plants, grown from seed received from the Department of Agriculture at Washington and elsewhere, to determine their relative attractiveness to bees, their honey producing qualities, and their hardiness in this climate. This experimental garden is to be regarded as a valuable adjunct to our work. In addition to the various honey plants in our garden, we have been able through the courtesy of the Agricultural Department of the Experiment Station, to plant a quarter of an acre with Sanfoin, *Onobrychis sativa*, with the same object in view, namely to test its qualities as bee pasturage. Through the courtesy of the Bureau of Entomology at Washington we have been enabled to add to our experimental apiary a swarm of Carniolan bees and a swarm of Caucasians.

Experiments against the Leaf Hopper, *Empoasca mali*, in large nurseries, have been continued during the past season. We have used a compound of kerosene and water, mechanically mixed by means of kero-water pumps, with considerable success. The work will be continued another season. This pest has not, apparently,

been as troublesome this year as in preceding years. Our chief experimental work during the summer has been against the cabbage maggot, and a report devoted to this pest will be made later. As far as we have gone with the work, we feel that it can best be controlled by the use of carbolic emulsion. Tarred paper disks are not practical in this state. In the burrow of one maggot we captured a Cynipid parasite, *Pseudeucoela gillettei*, Ashm. To the best of our knowledge this parasite has not hitherto been reported from Minnesota. A number of predaceous beetles were also captured, which were observed to feed upon the larvae and pupae of this fly. This pest, which is such a serious menace to the market garden industry, is figured and discussed in the body of this report. On account of the loss sustained yearly through its work, it is well worth serious study.

"Fire Blight" on apple has been seriously injurious this year, one party reporting that he had 2100 Wealthy trees affected. Inquiries in this direction are referred to the Horticultural Department of the Experiment Station.

The entomologist is looking forward with pleasure to being installed in the new building, now in process of construction in the Experiment Station grounds. Sufficient room has been promised him therein to relieve the present over-crowded condition of his department in the Drill Hall. The legislature has also granted $2,500 for an insectary, plans for which are now being made. In this building the life histories and development of Minnesota pests will be studied. Every well equipped experiment station has a building of this kind, its importance being generally recognized.

From Jan. 1, 1905, to Nov. 1, 1905, 1,326 letters have been written by the entomologist, largely in reply to inquiries regarding injurious insects, an average of 132 per month. From Jan. 1, 1905, to Sept. 1, 1905, 930 circulars, bearing upon injurious insects, were mailed. Lectures were delivered to farmers at Benson and Edina Mills, two to the school teachers of St. Paul and one under the auspices of the Minneapolis Y. W. C. A. Papers were also read before the State Horticultural Society, at their spring and winter meetings, before the St. Paul Market Gardeners' Association, before the Association of Economic Entomologists at their annual meeting, and various articles have been written to the press and other publications.

This department has the graduating class of the school in Entomology for an hour each day from October to Christmas, and courses in Forest Entomology and Economic Entomology to college students during the first half year. The entomologist also lectures to farmers in the short course on insect pests or Agriculture. This, with the work belonging to the department as Station Entomologist and State Entomologist, occupies the time completely. Press Bulletin No. 22, "Insects and Insectlike Animals Attacking Live Stock in Minnesota" was issued in April. We have added materially to our insect collections this year, notably in Diptera.

Our acknowledgments are due our office force for faithful work; the press of the state for helping us to place before the farmers timely publications; the director of this station, and the Agricultural, Veterinary, Horticultural, Mechanical and Chemical Departments of the institution for cordial and generous co-operation; the Bureau of Entomology, United States Department of Agriculture, at Washington, D. C., for various favors. Acknowledgments are also due the Great Northern; Northern Pacific; Chicago, Great Western; Minneapolis, St. Paul & Sault Ste. Marie; Minneapolis & St. Louis; Chicago, St. Paul, Minneapolis & Omaha; Northwestern, and Duluth & Iron Range railroads for courtesies in the way of transportation for the entomologist or his assistant.

Respectfully yours,

F. L. WASHBURN.

State Entomologist.

FINANCIAL STATEMENT FOR FISCAL YEAR, AUG. 1, 1904, TO AUG. 1, 1905.

1904.		Amount.	Requisition No.
Aug. 11.	E. B. Meyrowitz, photographic supplies	$12.53	2426, 2428
Aug. 10.	Harrison & Smith, envelopes	4.00	1986
Aug. 20.	E. S. Black, stenographic services	11.00	
Aug. 4.	Deming Company, spraying machinery	17.51	1986
July 28.	Deming Company, spraying machinery	20.64	1986
Aug. 2.	Deming Company, spraying machinery	1.98	1896
Aug. 17.	H. G. Doble, carpenter work	2.50	2430, 2000
July 21.	Doubleday, Page & Co.	6.80	2431
July 28.	Samuel N. Rhoads	7.28	2431
July 31.	Western Union Telegraph Co. (J. A. Vye)	2.39	....
June 22.	A. J. Dahl & Co., binding books	72.60	2414, 2427
Aug. 12.	Henry Holt & Co.	4.57	2431
July 9.	J. A. Vye, express	2.60	
Aug. 31.	A. G. Ruggles, traveling expenses in Freeborne, Dodge and Washington counties	14.03	....
Aug. 31.	A. G. Ruggles	100.00	....
Aug. 31.	Hope Willis, stenographer	32.30	....
Aug. 27.	Edith Reed, drawings for annual report	38.40	....
1903.			
Aug. 3.	J. A. Schlener	1.00	2427
1904.			
Jan. 21.	J. A. Schlener	.45	1986
1902.			
July 9.	J. A. Schlener	.80	1986
July 23.	J. A. Schlener	.25	1986
Sept. 30.	J. A. Schlener	.50	1986
Oct. 21.	J. A. Schlener	.48	1986
June 2.	J. A. Schlener	.60	1986
1904.			
July 17.	J. A. Schlener	6.15	1986
.....	F. L. Washburn, traveling expenses in Brown, Olmsted and Freeborn counties	10.98	....
Sept. 7.	A. I. Root Co., bee supplies	3.26	2432
Aug. 7.	Standard Oil Co.	2.13	1986
Aug. 13.	W. M. Simms	2.00	1986
Aug. 27.	Tobacco Warehousing and Trading Co.	2.63	1986

1904.		Amount.	Requisition No.
June 1.	Twin City Telephone Co. (Vye)	9.00	....
April to Sept.	Twin City Telephone Co	15.00	....
Sept. ..	Express and freight (Vye)	9.05	....
Sept. 13.	Stamps (Vye)	17.50	....
Oct. 1.	A. G. Ruggles	100.00	....
Sept. 30.	Hope Willis, stenographer	32.30	....
Sept. 9.	Kny-Scheerer Co	18.18	....
Sept. 30.	F. L. Washburn, miscellaneous and traveling expenses	57.90	....
Oct. 1.	R. M. Graham, field work	4.00	....
Oct. 1.	W. McKenzie, field work	4.00	....
Oct. 1.	Lizzie L. Ley, field work	4.00	....
Oct. 1.	A. Jensen, field work	4.00	....
Oct. 1.	Ray Cook, field work	4.00	....
Oct. 1.	Albert Larson, field work	4.00	....
Oct. 1.	O. E. Abrahamson, field work	5.50	....
Oct. 1.	Ole Hjelle, field work	4.00	....
Oct. 1.	Rudolph Emerson, field work	4.50	....
Oct. 1.	Robert Wedge, field work	3.00	....
Oct. 1.	George Orton, field work	4.50	....
Oct. 1.	T. A. Horton, field work	4.00	....
Oct. 1.	Chas. E. Moore, field work	5.00	....
Oct. 1.	S. Z. Roach, field work	5.00	....
Oct. 1.	Roy Woolery, field work	3.00	....
Oct. 1.	J. W. Newland, field work	4.00	....
Oct. 1.	Chester Olson, field work	5.00	....
Oct. 1.	Edson Washburn, field work	4.50	....
Oct. 1.	Oluf Foss, field work	4.00	....
Oct. 1.	P. A. Pederson, field work	4.00	....
Oct. 1.	Chas. F. Nelson, field work	5.00	....
Oct. 1.	O. W. Moore, field work	8.00	....
Oct. 1.	Ruth Holmberg, field work	3.00	....
Oct. 1.	Ed. Swenson, field work	6.00	....
Oct. 17.	Robert Wedge, field work	20.00	....
July 13.	J. A. Vye, stamps	10.00	....
Oct. ...	J. A. Vye, express and freight	1.95	....
Oct. 5.	J. A. Vye, Western Union Telegraph Co	.50	....
Oct. 1.	Twin City Telephone Co., October	3.00	....
Sept. 12.	E. R. Williams, office supplies	4.85	2432
Oct. 6.	G. E. Stechert	1.37	24.31
Oct. 17.	Harrison & Smith Co	14.50	1986
Oct. 3.	Nicotine Mfg. Co	3.30	1986
Sept. 1.	Genera Insectorum	30.00	2431
Nov. 1.	Genera Insectorum	20.00	2431
Oct. 28.	Harrison & Smith Co	6.00	1986

1904.		Amount.	Requisition No.
Oct. 25.	Harrison & Smith Co.	13.00	1986
Oct. 28.	Edith Reed, drawings for annual report	55.35	....
Oct. 3.	Spencer Lens Co.	20.12	2432
Oct. 25.	H. G. Doble	1.25	....
Oct. 31.	Hope Willis, stenographer	38.80	....
Oct. 31.	A. G. Ruggles, expenses, Clay county	11.95	....
Nov. 1.	A. G. Ruggles	100.00	....
July 30.	W. Junk, books on insects, $26.63, $168.60	195.23	....
Nov. 5.	"Rural New Yorker," Aug. 28, 1904, to Aug. 26, 1906	2.00	2436
Nov. 5.	E. B. Meyrowitz	3.60	2412
Nov. 2.	J. A. Schlener	2.00	2430
Nov. 21.	Ole Hjelle	2.35	....
Nov. 21.	Chester Olson	2.16	....
Nov. 30.	Hope Willis, stenographer	48.40	....
Nov. 30.	A. G. Ruggles	100.00	....
Nov. 17.	R. C. Wedge, field work against Leaf Hopper	21.14	....
Nov. 30.	J. A. Vye, expressage	1.60	....
Nov. 30.	J. A. Vye, stamps	15.00	....
Nov. 30.	Edith Reed, drawings for report	10.45	....
Nov. 1.	Twin City Telephone Co., November and December	6.00	....
Dec. 1.	J. A. Vye, freight and express	24.19	....
Dec. 7.	Austin Engraving Co.	.86	2435
Nov. 28 and 5.	E. B. Meyrowitz, photographic supplies	8.00	2436
Dec. ..	Art Engraving Co., cuts for report	90.55	2435
Dec. 2 and Nov. 12.	W. Junk, books on insects	57.65	2431
Nov. 28.	Mrs. Heidemann, models of injurious insects	83.00	2434
Nov. 29.	Harrison & Smith	10.00	2436
Dec. 31.	Hope Willis, stenographer	42.65	....
Dec. 31.	A. G. Ruggles	100.00	....
Nov. 1.	Natural Science Association	12.00	2431
Nov. 26.	Leggett & Bro.	3.15	1986
Dec. 20.	A. Hoen & Co., colored plates for report	220.00	2435
1905.			
Jan. 16.	Mica Heidemann, models of injurious insects for use in lectures to farmers	81.00	2434
Jan. 15.	N. Y. Ent. Society	4.00	2438
Jan. 1.	Twin City Telephone Co.	3.00	....
1904.			
Dec. 24.	Country Gentleman	1.50	2436
Dec. 17 and 7.	J. B. Lippincott	4.00	2435
Dec. 24.	Canadian Entomologist	2.00	2436
1905.			
Jan. 6.	John A. Schlener & Co.	8.85	2436

1905.		Amount.	Requisition No.
Jan. 3.	Western Press Clipping Exchange	14.63	2430
Jan. 12.	M. V. Slingerland, colored slides of insects	13.00	2436
Jan. 20.	Hope Willis	47.25	....
Jan 31.	A. G. Ruggles	100.00	....
Jan. 20.	F. L. Washburn, September, October, November and December, 1904, and January, 1905, traveling and miscellaneous expenses	106.80	....
Jan. 12.	Stamps, A. R. McGill	25.00	....
Jan. ...	J. A. Vye, expressage and freight	7.56	....
Jan. 10.	Stamps, A. R. McGill	32.00	....
.....	J. A. Vye, expressage, $4.11; Western Union, $0.82	4.93	....
1904.			
Nov. 23 and 28.	E. R. Williams	5.50	2436
1905.			
Feb. 21.	Tice and Lynch	6.10	2005
1904.			
May 25.	Tice and Lynch	.79	....
1905.			
Feb. 25.	A. G. Ruggles	100.00	....
Feb. 6.	A. T. Thompson & Co., lantern slides for lectures to farmers	4.00	2438
Feb. 14.	R. W. Hegner, lantern slides for lectures to farmers	5.50	2438
Jan. 23.	Mrs. Aurelia Steward, lantern slides for lectures to farmers	10.00	2438
Jan. 27.	J. A. Schlener & Co	1.74	2436
Jan. 28.	Harrison & Smith Co	6.25	2438
Feb. 1.	Twin City Telephone Co., for February	3.00	....
Feb. 7.	J. T. Barnum, chest for conveying models, etc., to farmers' meetings	15.00	2439
Feb. 4.	Yawman & Erbe Mfg. Co	1.85	1986
Feb. 10.	M. V. Slingerland, slides for lectures	15.40	2438
Feb. 16.	J. B. Colt Co	2.25	2438
Feb. 25.	Hope Willis, stenographer	53.00	....
Feb. 25.	Hope Willis, extra time	20.00	....
Mar. 23.	Edith Reed, drawings for annual report	24.65	2440
Jan. 15.	Concilio Bibliographico	9.02	1986
Feb. 8.	S. E. Cassino	2.12	2431
Feb. 27.	Ginn & Co	4.00	2440
Feb. 18.	Whitall-Tatum Co	3.56	2438
Mar. 1.	E. B. Meyrowitz	2.50	2438
Mar. 6.	R. B. Williamson	1.50	1986
Mar. 1.	Twin City Telephone Co	3.00	....
Mar. ...	Margaret T. Hubbard, lantern slides for use in lectures to farmers	14.00	2438

1905.		Amount.	Requisition No.
Mar 10	A. Hoen & Co., colored plates for report	102.00	2440
.....	J. A. Vye, freight and express	7.68	....
Mar. 17.	Miller-Davis Printing Co	2.38	2440
Mar. 31.	A. G. Ruggles	100.00	....
Mar. 24.	F. L. Washburn, miscellaneous and traveling expenses during January, February and March	29.01	....
Mar. 31.	Hope Willis, stenographer and extra time	88.00	....
.....	J. A. Vye, freight and express	7.68	....
.....	A. R. McGill, stamps	15.00	....
1904.			
Dec. 15.	Genera Insectorum	13.65	2431
1905.			
May 1.	Hope Willis, stenographic services and extra time	67.75	....
May 1.	A. G. Ruggles	100.00	....
April 1.	T. V. Moreau	7.30	2440
April 3.	Southern Printers Supply Co	1.06	2441
Feb. 23.	Farwell, Ozmun, Kirk & Co	2.45	2441
Mar. 20.	James Vicks' Sons, spraying utensils	7.84	1986
April 1.	Twin City Telephone Co	3.00	....
Feb. 24 and Mar. 8.	Pioneer Press Co., printing annual and special reports	1,455.16	....
.....	Express	3.80	....
.....	Western Union Telegraph Co	2.07	....
.....	Express	.50	....
May 1.	Twin City Telephone Co. and Lake City L. D.	3.45	....
May 10.	W. S. Nott Co	7.94	2442
May 6.	The Plumbing and Steamfitting Supply Co	8.52	2447
April 15.	B. Ellsworth Call	2.40	2438
May 8.	Noyes Bros. & Cutler	4.60	2441
May 8.	Minneapolis Paper Co	3.75	2441
May 15.	Lyman-Eliel Drug Co	8.84	2441
April 3.	Lyman-Eliel Drug Co	.50	2441
April 24.	W. K. Morison & Co	4.70	2441
May 15.	American Soap Co	4.00	2441
May 9.	Farwell, Ozmun, Kirk & Co	18.27	2441
May 15.	Edith Reed, drawings for annual report	29.35	2440 and 2438
May 20.	A. G. Ruggles	100.00	....
May 20.	Hope Willis, stenographer	41.50	....
May 6.	Ohio Naturalist	1.00	2427
May 20.	Gust Larson, wages in experimental work	25.00	....
.....	J. A. Vye, express, etc	7.13	....
.....	Western Union Telegraph Co	1.34	....
	Total	$5,216.80	
	Credit by cash received for nursery inspection	150.41	
	Total	$5,066.39	

EXPLANATION OF PLATE I.

(Figures are all natural size.)

1. Sargus viridis, Say, *Stratiomyidæ*.
2. Eurosta (Trypeta) solidaginis, Fitch, *Trypetidæ*.
3. Odontomyia binotata, Loew, *Stratiomyidæ*.
4. Chrysophila thoracica, Fab., *Leptidæ*.
5. Straussia (Trypeta) longipennis, Wied., *Trypetidæ*.
6. Pseudopyrellia (Lucilia) cornicina, Fab., *Muscidæ*.
7. Odontomyia cincta, Oliv., *Stratiomyidæ*.
8. Echinomyia (Jurinia) algens, Wied., *Tachinidæ*.
9. Eristalis tenax, Linne., *Syrphidæ*.
10. Gastrophilus equi, Clark, *Oestridæ*.
11. Heliophilus latifrons, Loew, *Syrphidæ*.
12. Calliphora vomitoria, Loew, *Syrphidæ*.
13. Tabanus costalis, Wied., *Tabanidæ*.
14. Spilomyia quadrifasciata, Say, *Syrphidæ*.
15. Thereva frontalis, Say, *Therevidæ*.
16. Eristalis flavipes, Walk., *Syrphidæ*.
17. Leptis mystacea, Macq., *Leptidæ*.
18. Chrysops hilaris, O. S., *Tabanidæ*.
19. Psilopodinus patibulatus, Say, *Dolichopodidæ*.

EDITH REED, DEL

PLATE I. SOME MINNESOTA FLIES.

THE DIPTERA OF MINNESOTA.

TWO-WINGED FLIES AFFECTING THE FARM, GARDEN, STOCK AND HOUSEHOLD.

BY F. L. WASHBURN, State Entomologist.

When one reflects that out of the $795,100,000 which the United States loses annually at the hands, or rather at the mouths, of insects, the Hessian Fly alone is responsible for $50,000,000 a year (raised to $100,000,000 in 1900); that the loss on hides caused by the work of the Ox Warble Fly has frequently amounted to $40,000,000 a year, or higher, in the United States; and that our crop of cabbages and cauliflowers is frequently lessened by one-half through the agency of the disgusting Cabbage maggot fly, one can readily see that, in spite of benefits derived from certain members of the order, the members of Diptera, or Two-winged Flies, clearly rank among our serious pests, and are worthy of a special treatise.

Not only does stock suffer from the Ox Warble, and to a less degree from what we call "horse flies", "deer flies" and "bot flies," but at times and in certain localities it perishes through the attacks of myriads of black flies, the small voracious pest so abundant during summer in northern localities of the United States and Canada as to sometimes cause the death of a man lost in the woods and enfeebled through fatigue and lack of food. Certain domestic animals in South Africa suffer and die through what is called "Nagana" or the "fly disease," induced by a germ introduced into the blood by the bite of the notorious Tse-tse Fly. Much more serious than this is the part many two-winged flies play in relation to diseases which cause suffering among hundreds of people, and at times are the active agents in awful epidemics. We refer to the mosquito, *Anopheles*, whose bite is evidently a necessary means of carrying the malarial germ; to that other mosquito known as

Stegomyia fasciata, which is the direct cause of the spread of yellow fever; to various flies, among them the dangerous Screw-Worm Fly, which lay their eggs in wounds and external cavities of men and animals, causing suffering and frequent death, and particularly to our common, ever present house fly, which is a constant menace as a carrier of disease germs. It is said on good authority that while only about 250 men were killed in battle during the Spanish-American war, we lost 5,000 through the agency of house flies. This refers to the carrying of typhoid germs from hospital trenches to the food and other effects of our men while in camp.

While denouncing the above pests, we must not lose sight of the fact that we also find in this same order some beneficial forms, notably the Tachina Flies, which, very abundant as far as individuals go, are of marked assistance to the farmer and gardener, by parasitizing injurious caterpillars and preying upon grasshoppers and other pests. We also have the Syrphus Flies, the larvae of many of which feed upon plant lice, nor must we overlook the benefit which we derive indirectly from the removal of carrion and decaying vegetable matter through the work of the maggots of Blow Flies, Flesh Flies, and others. These points are emphasized in the following treatise in connection with the useful species. However, in mentioning this fact it may be well to bear in mind that the same is true of a number of injurious orders, wherein we find some redeeming features, but not sufficient to remove these orders from under the ban.

We quote Osten-Sacken, a prominent worker in Dipterology, who has the following to say regarding this group:

> Diptera during the past century have gradually risen in public estimation, especially among men of science. The superiority of their organization has been recognized by systematists, and observers of living specimens have noticed peculiarities in their behavior which prove a higher development of their faculties than of those of other orders.
>
> Diptera, more than all other insects, show a distinct love of *freedom*, while Hymenoptera, with all their perfections, betray *drill*. Owing to their organization, Diptera have more control over their motions than any other insects, in consequence of which there is a remarkable stamp of *individuality* in their actions. They can suddenly arrest their flight, and poise in the air; they can not only swarm, but *dance* in cadence, or gambol in the air in the most extraordinary manner. It is principally the males who dance, play and frolic together; during courtship they perform most ludicrous antics. Schiller said: "The ani-

mal, the child, as well as man, *play*; the sense of strength, and the higher sense of freedom derived from strength, give rise to the joy of playing."

It was evidently the intention of our predecessor, Dr. Lugger, to publish a monograph on the *Diptera* of Minnesota, as he had on the four orders, *Orthoptera, Coleoptera, Lepidoptera,* and *Hemiptera*, before death put an end to his valuable work. We found some drawings and other evidence of this intention on his part, and it seemed quite fitting and a mark of respect to the memory of him who stood for so much in Entomology to endeavor to complete the work he undoubtedly had in mind. There is, further, a demand on the part of our agriculturists, stock raisers and others for a report on the pests which occur in this group, with remedies for the injuries caused by them, or means to prevent such injuries.

For four years, therefore, we have been accumulating specimens, drawings and data with that end in view. Dr. Lugger was no man for notes. He left absolutely no data in this group, and this fact has added materially to the difficulties of the work. It must be acknowledged, too, that the labor involved in properly depicting this one group alone, as it occurs in Minnesota, is so great that we feel, in its presentation, we have fallen short of the ideal cherished by us at its first conception. Yet, although humbled by this realization, we present this report on the "DIPTERA, or TWO-WINGED FLIES OF MINNESOTA," without an apology, hoping that through means of the excellent illustrations and the two colored plates the citizens of the state may be able to recognize the leading pests, and also beneficial insects which occur in this group, and that the student who is interested in the flies of Minnesota may be helped in his study. In fact, with this latter end in view, we have so arranged the report that it may, like other similar publications from this department, which have been in great demand, serve a double purpose, namely, while it is primarily a bulletin on injurious flies, it can at the same time be used in schools, illustrating, as it were, one department of rural school agriculture. At the end of the book will be found a complete index, together with a special index of two-winged pests and remedies therefor.

In accomplishing this work we have been hampered by lack of data, as mentioned above; in some cases by erroneous labeling of specimens which we found in the collection, notably in the family

of *Simuliidae*. We have not hesitated, therefore, to ask for co-operation wherever needed, and have called upon specialists in certain groups for identifications. These have been cheerfully given. Many of the Empidids and Dolichopods were identified by W. M. Wheeler; Stratiomyids and Leptids by C. W. Johnson; Phorids by C. T. Brues, and the snarl in the condition of our Simuliids was unraveled by O. A. Johannsen. We have sent many specimens to Mr. Coquillet of the Bureau of Entomology at Washington, for corroboration of our own identifications, or for the independent naming of specimens, and a large amount of material from this office has passed through his hands. The colored drawings have all been made in this department, and under our direction, by Miss Edith Reed. The same is true of a very large proportion of the figures in the text. A few of the latter, however, have been used in previous publications of this department, and a very few have been obtained from outside sources. Fig. 150 is one of Prof. Slingerland's; Fig. 29 was obtained from Vernon Kellogg; Figs. 34 and 35 appeared in "How to Make a Flower Garden" published by Doubleday Page & Co., Fig. 36 was obtained from the Department of Agriculture at Washington, D. C., and is one of Dr. L. O. Howard's. We hereby acknowledge these courtesies. Many of the photographs were made by Mr A. G. Ruggles, my assistant.

A large amount of dipterous material, representing many months of collecting, was kindly placed at our disposal through the courtesy of O. W. Oestlund, of the Department of Zoology in the State University. This has been of material help. Dr. E. B. Frick, of Fort Snelling has collected certain Culicids not previously in our collection, and has courteously given us data in this connection.

The word "Fly" in common parlance, is frequently applied to almost everything in the insect line which has the power of flight. It really belongs only to one order of insects, the Diptera, in which only one pair of wings (the front pair) is present, the rear pair being absent, but represented by two "halteres" or "balancers," knob-like organs to which various functions are ascribed by workers in entomology. We have in North America over 8,000 known species of these two-winged flies, representing sixty families, and in the following pages these various families

are described at greater or less length, emphasizing the two-winged pests of Minnesota. A very common misatke of the uninitiated, when large and small flies are observed together,—on a window, for example,—is to regard the small flies as the young of the larger ones. This is not so, like insects of other orders, flies never increase in size after having attained the winged or perfect stage, and the small flies observed are the adults of species different from the larger species. In other words, flies only increase in size during the larval or "maggot" stage, at which time they, like other larval forms, have a voracious appetite. They are maggots, therefore, which the farmer squeezes out of the small holes on the back of his cattle, maggots which issue from a horse with the droppings when he has the "bots," and maggots which are sometimes found in open wounds of stock running in pasture. We are all familiar with the maggot or larval stage of the blow fly, seen on meat which has been exposed to its attacks. It should also be recognized that it is in the maggot stage in which the Hessian fly, joint worm fly and frit fly work injury. Maggots are footless, and many are provided with two tiny hooks in the mouth, probably the mandibles or jaws.

With a few exceptions where maggots are produced alive directly from the parent, or where, very rarely, a maggot brings forth living maggots, or a pupa lays eggs, every maggot comes from an egg laid by the adult female fly upon the plant or animal or other substance which is to furnish food for the larva. Familiar examples of flies' eggs are seen on meat, as intimated above, and in the "nits" which the bot fly so skillfully fastens to the hair of horses. We also see the white eggs of parasites attached to caterpillars, from which eggs the tiny maggots hatch, and at once bore into the tissues of their host.

When a maggot has attained its full growth, it changes to what is known as a "pupa," in which, with a few exceptions, it remains inactive for a period, until it transforms to the perfect fly. Frequently in forming this pupa the skin of the maggot contracts, turns brown and hardens, thus forming a pupal case or *puparium*, in which the maggot transforms to the pupa, and from which the changed pupa, or perfect fly, emerges later. It is these puparia which one sees in the earth about stalks and cabbages or cauliflowers—elliptical, brown bodies from which the perfect cabbage

maggot flies emerge. The maggots in the backs of cattle and the maggot known as the bot of horses (the same being true of the rabbit bot, found in the neck of rabbits) bore into the ground, where they pass the pupal stage. The "flax seed" stage of the Hessian Fly is the period in which the brown puparium of this pest, resembling somewhat a flax seed, is found against the stem. The puparium of the house fly is found in filth, notably horse manure, where the egg is commonly laid, and where the maggot lives.

We have then, with a few exceptions, already noted, four stages

Fig. 4. Side view of House Fly, *Musca domestica*. Original.

in the life history of every fly, namely, the egg stage, the larval or maggot stage, the pupal stage and the adult stage, or the stage represented by the perfect fly in the winged condition. The adult fly, as in other insects, is referred to as the *imago*.

The structure of this "imago," or adult fly, since it is the condition with which we very commonly become acquainted with flies, deserves a short description. Fig. 4 illustrates the common house fly, viewed from the right side, drawn with its right wing elevated to enable one to see the various parts of the insect. One will at

once notice that the insect is divided into three distinct parts,—the head, the middle part or thorax, which bears the wings and legs, and the abdomen, the latter composed of four visible rings or segments. The large compound eyes, composed of 125,000 facets, occupy the greater portion of the side of the head. A glance at Fig. 6 will show the appearance of a portion of the surface of the compound

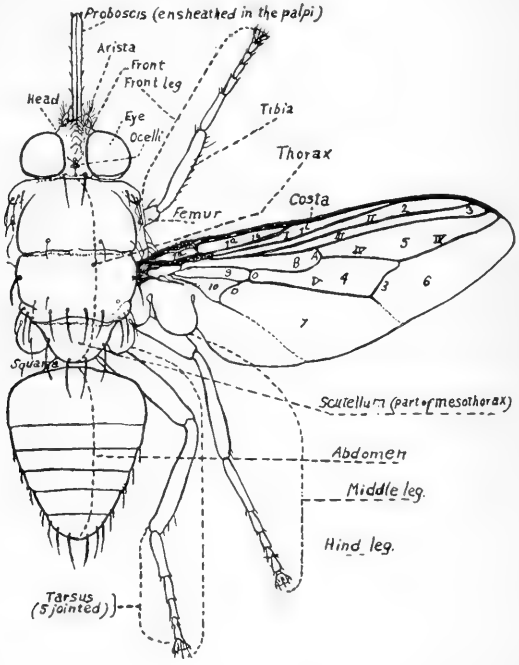


Fig. 5. Dorsal view (*diagrammatic*) of Tsetse Fly to show details of anatomy; from Austen's "Monograph of the Tsetse Flies." The numbering of the veins of the wings and the nomenclature of the cells differ from that employed by Comstock I. a. Auxiliary vein; I first longitudinal vein; II, second longitudinal vein; III, IV, V and VI are the 3d, 4th, 5th and 6th longitudinal veins respectively. A and B are respectively the anterior and posterior transverse veins; C and D are the anterior basal and posterior basal transverse veins.

eye. Each hexagonal portion is called a "facet," and represents the end of a tube, as it were, running down to nerve endings, which are sensitive to light. There are, therefore, as many "tubes" as there are facets. Fig. 7 shows a vertical section through a compound eye; *c* equals the cornea; *l*, the corneal lens; *rh*, the great rods or rhabdomes, sometimes solid, but more generally tiny sacks filled

with fluid; *rt*, retina just below basilar membrane. Upon this "retina" the image is probably formed. It must not be supposed, however, that the House Fly sees as many images of an object as it has facets for such cannot be the case; nor must we believe that the sight of flies or any other insects is comparable to ours. Just how much a fly can see is a mooted question, and introduces arguments altogether too lengthy for this report. Students are referred to Lowne's "Blow Fly," in two volumes, for an exhaustive discussion of this point, as well as other points which touch on the anatomy and physiology of flies.

In addition to these compound eyes there are, in most flies, three simple eyes, or *ocelli*, on the top of the head, between the compound eyes. There may be but two of these. While without much doubt they have to do with the discernment of light or shadow, their exact function is unknown. We show in Fig. 8 a longitudinal section of a very much enlarged simple eye. The cells at the bottom of the eye are connected with a nerve, *n*, and are probably sensitive to light.

Attached to the front of the head are feelers or *antennae*. Since in Fig. 4 they lie close to the head, and are therefore not easily seen, the reader is referred to Fig. 9, where various forms of antennae peculiar to different families are shown in detail. As seen in this drawing, the third joint bears an appendage called the *arista* if it is bristle-like, or a *style* if it is more like a hair. The *arista* shows in the drawing of the House Fly, Fig. 4. The various shapes and peculiarities in structure of the antennae are important factors in classifying flies. In one division, or sub-order, there is a crescent shaped piece just above the antennae, called the frontal *lunule*. In most of the members of this sub-order which have a frontal lunule is a suture, separating the lunule from that part of the head which lies above it. The *palpi* (the right one is shown in Fig. 4), are appendages of one of the mouth parts, the *maxilla*.

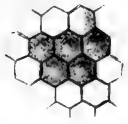


Fig. 6. Corneal facets of a compound eye, surface view, much enlarged.

On the under side, ventral side, of the head, about the mouth are the mouth parts. A very few species which take no food in the adult stage, have but rudimentary mouth parts. The mouth parts of all flies, though variously modified, are adapted for suck-

ing. Some flies which pierce or stab before they suck, have firm, strong mouth parts for that purpose, (see Fig. 5), but the majority, since they take food for the most part in a liquid state, have mouth parts adapted for that habit.

The middle portion of the fly, the thorax, as shown in Fig. 4, bears the wings and legs. Each part of the thorax seen in the figure has a name, but it is unnecessary to place these technical names before the reader here. Each of the six legs (only the three of the right side are shown in the figure) is composed of five parts; the *coxa*, attaching the leg to the thorax, the *trochanter* or second joint, next the *femur* (generally the longest, stoutest joint), next the *tibia*, and finally the *tarsus*, generally composed of five small joints. On the fifth or last joint are two *claws*, and between them often is a pad or bristle, known as the *empodium*. On the last joint of the tarsus, below the claws, are two fleshy pads (not always present) called *pulvilli* (see Fig. 10).

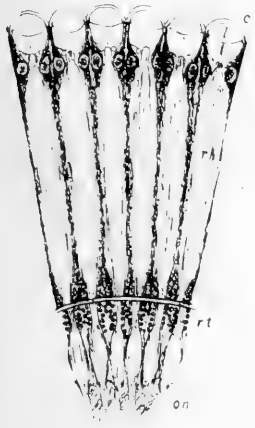


Fig. 7. Vertical section through compound eye, much enlarged. From Lowne's "Blow Fly."

The *halteres* or balancers are short club-like organs shown in Fig. 4, one of which is shown on the upper and rear portion of the thorax, just under the *alulae* or alulets. These latter are two membranous scales, one overlapping the other, on each side of the fly, just back of the base or root of the wing, well shown in our illustration. Different workers ascribe different functions to the *halteres*, which represent the second pair of wings. They may be used as balancing organs, or have also auditory functions.

The wings are, in the classification of the Diptera, the most important feature, since the different families are characterized by the different arrangement of the veins which, as seen in the illustration of the House Fly, are horny thickenings in the otherwise homogenous structure of the wing. The veins are really double tubes, an

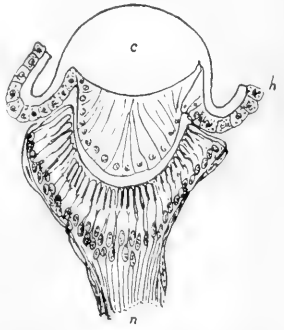


Fig. 8. Vertical median section through simple eye, or ocellus, much enlarged. From Lowne's "Blow Fly." c=corneal lense; h=so-called hypodermal cells of the integument; n=nerve.

inner or air tube enclosed in an outer tube, which latter carries blood at an early stage of its formation.

The venation or neuration of a fly's wing, that is, the arrangement of the veins, is so important that we have ventured to include under the various families a number of illustrations, showing different types. A student working with Diptera soon becomes so familiar with the venation in the different families that he can tell at a glance the group to which his specimen belongs. These figures have been taken from Comstock, and in reproducing his excellent drawings we reproduce his method of numbering, which, it must be said, is not now generally used. The *cells* of the wing, that is, the spaces enclosed by the nerves, are named in each

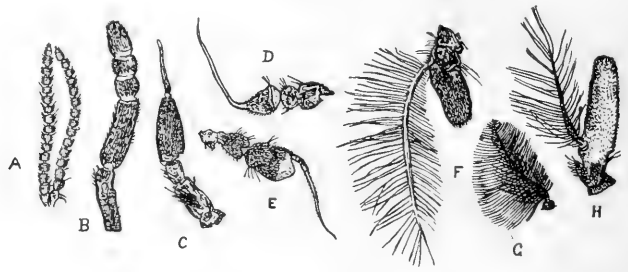


Fig. 9. Different types of antennae found amongst the flies. A, the two antennae of a Mycetophilid; B, antenna of the Tabanidae; C, Asilidae; D, Leptidae; E, Dolichopodidae; F, Syrphidae; G, Chironomidae (male); H, Muscidae, H and F are similar. Figs. A, B, C, D, E, and F after Wandolleck; G and H after Comstock, much enlarged.

case from the vein just in front of that cell. For example, in the illustrations, the cell just behind Vein III, is cell III; the cell behind II is cell II, and so on. Where a vein represents the coalescence of two, like III 2+3 the cell behind is cell III3, taking its name from the last numbered vein. When a cell is completely surrounded by cells it is said to be *closed*, but when it extends to edge of wing it is *open*. The base of the wing is where it is attached to the thorax; the apex is the opposite end.

The abdomen, consisting of several rings or segments, making up the posterior part of the fly's body, is well shown in Fig. 4. On the side of each segment of the abdomen shown in the drawing is a small hole, a *spiracle*, through which the air is drawn in respiration, being distributed by means of small tubes called tracheae

over the entire body. Three of these spiracles show on the thorax in Fig. 4. It will be seen, therefore, that one could hold a fly's head under water indefinitely without drowning it, but if all these breathing holes or spiracles are closed the insect dies. In order to make the anatomical details more clearly understood we give a dorsal view, Fig. 5 of Glossina, taken from Austen's "Monograph of the Tse-tse Flies."

A few words on the internal anatomy of a fly may not be out of place. The mouth parts have already been referred to. In the figure of the House Fly, page 24, only the lower end of the labium

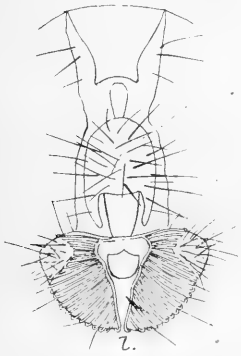


Fig. 9a. The labella of a house fly, greatly enlarged, showing rasp-like surface, used in scraping or tearing delicate surfaces.

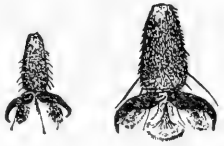


Fig. 10. Two types of the last tarsal joint. Each shows pulvilli. The left figure has the empodium *bristle like;* the figure on the right has the empodium *pulvilliform.*

shows, the so-called proboscis. The end of this proboscis, the *labella,* is practically the food-obtaining organ. It is covered by many tiny horny ridges (see Fig. 9a), with which solid food may be rasped, and the fine particles obtained by this rasping, mixed with and dissolved in a salivary secretion, are sucked into the mouth, and thence find their way into the oesophagus. A glance at Fig. 12 will give the reader a very good idea of the alimentary canal of a fly. *Calliphora erythrocephala ; oe,* is the oesophagus connected with the crop, *cr,* and through the proventriculus, *pv,* with the chyle stomach, *ch.* This latter passes into the proximal intestine shown in a coil, and this, through the distal portion of the intestine, *di,* connects with the rectum. The tracheae supplying these organs with oxygen are marked *tr* in the drawing; *trs*—the tracheal sacs; *mm* represent the malpighian tubules, which, upon

high authority, are believed to function as a combined liver and pancreas, and not as a kidney; the rectal papillae, shown at *rp*, Lowne believes to have a renal function.

The nervous system of a fly is well shown in Fig. 13. The nerve cord, which lies in life in the floor of the body cavity, shows a large swelling, *thg*, known as the thoracic ganglion, from which various branches go to the wing muscles, halteres, legs, muscles of skin of abdomen, etc. This collection of nerve cells, the thoracic ganglion, appears to be the vital nerve center of the organism, for if that is injured or destroyed, all motion ceases, and death results, whereas a decapitated fly or other insect will walk about for hours with no apparent lessening of vitality, although many nerves and nerve centers have been removed with the head. The ventral nerve cord forms a collar about the oesophagus near the mouth, and above the oesophagus we have enlargements, ganglia, as shown in the drawing. The nerves going to the antennae are marked by an *a*; *o* equals the nerve to the ocelli; *o g* is the optic ganglion; *o n* the optic nerve, and *c* equals the retina of the compound eye.

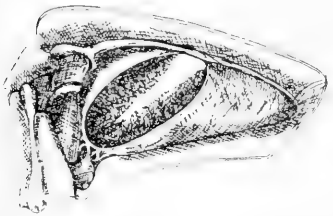


Fig. 11. Internal view of posterior thoracic spiracle of Blow Fly, showing valve, and on the left the elevator and depressor muscles of halteres. From Lowne. Much enlarged.

Fig. 12. Alimentary canal of fly, much enlarged. From Lowne's "Blow Fly."

As might be expected, the blood system of a fly is very simple; a dorsal vessel, the so-called heart, lying along the mid line just below the body wall, by its pulsations, or rather by the pulsations of a thin walled sac, the pericardial sinus which surrounds it, drives the blood forward to the anterior end of the vessel, whence it finds its way over the air sacs and viscera of the thoracic and abdominal cavity, being taken into the dorsal vessel again through valvular openings in the walls of the latter. The blood obtains a part of its oxygen probably from delicate tracheal vessels lying in the walls of the pericardial sinus.

Fig. 13. Central nervous system of Blow Fly, much enlarged. From Lowne.

What can we say about the sensations of a fly? The sense of smell is evidently located in the antennae, and some believe all over the body. The antennae are likewise apparently the chief organ which has to do with the tactile sense, yet this sense is also without doubt also located over various parts of the body. The auditory sense of a fly is, it is believed, located in certain organs at the base of the halteres, but since in other insects it is thought that certain hairs on the antennae are auditory in function, we must believe that the same is true with flies. The sense of taste in many insects is apparently located in certain of the mouth parts.

If a living fly be held by the legs, its wings will vibrate rapidly as in flight, the apex of the wing producing a figure 8 in the air (see Fig. 15), the entire wing by its vibrations producing the appearance of a double cone, the apex of wing forming the bases of the two cones, and the shoulder or base of the wing forming the single apex which the two cones have in common. Ordinarily about 330 complete vibrations are made by a fly's wing each second. This rapid movement of the wings produces a buzzing sound, but if the wings are cut off and the fly held captive, sound is still produced, made in part possibly by air rushing into the spiracles. If, however, the latter are stopped with varnish, we still have a production of sound, which we have reason to believe is made by certain segments of the body moving upon each other, as well as possibly the vibration of the stump of the wing. It will be seen, therefore, that the voice of a fly is quite complicated. The ability of a fly to walk on smooth vertical surfaces, like glass, or on the ceiling, is not due to suction, but to a secretion on the bottom of the last four tarsal joints. This secretion issues from a large number of hollow pores on each joint and is sufficiently adhesive to support the fly's weight.

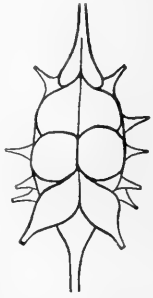


Fig. 14. Thoracic ganglion, much enlarged. After Lowne.

With this brief description of the anatomy of a fly, we turn at once to a consideration of the families of Minnesota flies, but pre-

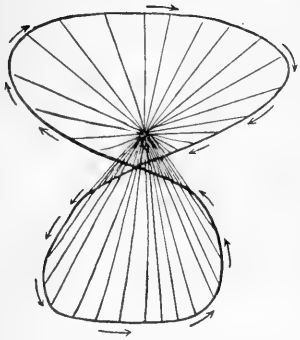


Fig. 15. Diagram to illustrate motion of a fly's wing in flight. After Lowne.

face that consideration by a simple synopsis, which we believe will be easily understood by the beginning student, and may be of some service in helping him to place in its proper family any fly which he may have captured in the state. The synopsis is taken from Comstock's "Manual for the Study of Insects." Since the family Muscidae has been separated into several, we have called the same division Muscidea (a term used by Williston) where the family name occurs in Comstock's key, placing in connection all the families which are included therein. The three last families, however, *Hippoboscidae, Nycterybiidae* and *Braulidae* are left in the same position assigned them by Comstock. We have also introduced, in its proper place, the family *Acanthomeridae.*

SYNOPSIS OF THE DIPTERA.

Fig. 16. (After Comstock.)

THE STRAIGHT SEAMED FLIES. Flies in which the pupa escapes from the larval skin through a T-shaped opening (Fig. 16), which is formed by a lengthwise split on the back near the head end and a crosswise split at the front end of this, or rarely through a crosswise split between the seventh and eighth abdominal segments; adults without a frontal lunule. Sub-order ORTHORRHAPHA.

The Long-Horned Orthorrhapha or Nematocera. Flies with four or five-jointed pendulous palpi and with many-jointed antennae, which are usually long. The segments of the antennae, except the basal two, are similar in form, and are more than six in number. They are often fringed with hairs or bristles.

The True Nematocera. The antennae usually long, and frequently bearing whorls of long hairs, especially in the males; legs long and slender; abdomen usually long and slender.

The Moth-like Flies, Family PSYCHODIDAE, p. 35.

The Midge-like Flies.

The Crane-flies, Family TIPULIDAE, p. 36.
The Net-winged Midges, Family BLEPHAROCERIDAE, p. 38.
The Dixa-midges, Family DIXIDAE, p. 39.
The Mosquitoes, Family CULICIDAE, p. 40.
The Midges, Family CHIRONOMIDAE, p. 52.
The Fungus-gnats, Family MYCETOPHILIDAE, p. 54.
The Gall-gnats, Family CECIDOMYIDAE, p. 57.

The Anomalous Nematocera. The antennae are composed of many segments, but are shorter than the thorax, and without whorls of long hairs. The segments of the antennae are short and broad, and closely pressed together. Except in the first family the abdomen is comparatively stout, and the legs are shorter and stouter than in the True Nematocera.

The False Crane-flies, Family RHYPHIDAE, p. 67.
The Solitary Midge, Family ORPHNEPHILIDAE, p. 67.
The March-flies, Family BIBIONIDAE, p. 68.
The Black-flies, Family SIMULIDAE, p. 70.

The Short-Horned Orthorrhapha or Brachycera. Orthorrhapha with one or two-jointed, porrect palpi, and with usually short, three-jointed antennae. The third segment of the antenna is sometimes distinctly ringed, showing that it is really composed of many segments grown together; and sometimes the antennae are four or five-jointed.

The Anomalous Brachycera. The third segment of the antennae is ringed, showing that it is composed of several segments grown together. The body is not furnished with strong bristles.

The Horse-flies, Family TABANIDAE, p. 76.
The Soldier-flies, Family STRATIOMYIDAE, p. 80.
The Acanthomerids, Family ACANTHOMERIDAE, p. 82.
The Snipe-flies (in part), Family LEPTIDAE (*Xylophagidae* and *Coenomyidae*), p. 83.

The True Brachycera. The antennae are usually three-jointed, but sometimes four or five-jointed. The third segment is not ringed, but usually bears a style or bristle. The body is usually furnished with strong bristles.

True Brachycera with the empodia pulvilliform. Flies in which there are three membranous lobes beneath the tarsal claws (Fig. 10).

The Snipe-flies (in part), Family LEPTIDAE, p. 83.
The Small-headed Flies, Family ACROCERIDAE, or CYRTIDAE, p. 85.
The Tangle-veined Flies, Family NEMESTRINIDAE, p. 86.

True Brachycera with the empodia not pulvilliform. Flies in which there are only two membranous pads beneath the tarsal claws.

Vein III of the wings four-branched.

The Robber-flies, Family ASILIDAE, p. 86.
The Midas-flies, Family MIDAIDAE, p. 88.
The Apiocerids, Family APIOCERIDAE, p. 88.
The Bee-flies, Family BOMBYLIDAE, p. 89.
The Stiletto-flies, Family THEREVIDAE, p. 91.
The Window-flies, Family SCENOPINIDAE, p. 92.
The Dance-flies (in part), Family EMPIDIDAE, p. 93.

Vein III of the wings three-branched.

The Dance-flies (in part, Family EMPIDIDAE, p. 93.
The Long-legged Flies, Family DOLICHOPODIDEA, p. 94.
The Spear-winged Flies, Family LONCHOPTERIDAE, p. 98.

Fig. 17. (After Comstock.)

THE CIRCULAR-SEAMED FLIES. Flies in which the pupa escapes from the larval skin through a circular orifice made by pushing off the head end of it (Fig. 17). Adults with a frontal lunule. Sub-order *Cyclorrhapha.*

Cyclorrhapha without a frontal suture (ASCHIZA).

The Surphus Flies, Family SYRPHIDAE, p. 98.

The Big-eyed Flies, Family PIPUNCULIDAE, p. 102.

The Flat-footed Flies, Family PLATYPEZIDAE, p. 102.

The Hump-backed Flies, Family PHORIDA, p. 103.

Cyclorrhapha with a frontal suture (SCHIZOPHORA).

Normal Schizophora.

The Thickhead-flies, Family CONOPIDAE, p. 103.

The Bot-flies, Family OESTRIDAE, p. 125.

The Muscids, Division MUSCIDAE (Families, BORBORIDAE, p. 105; AGROMYZIDAE, p. 105; GEOMYZIDAE, p. 105; OSCINIDAE, p. 106; DROSOPHILIDAE, p. 111; EPHYDRIDAE, p. 112; DIOPSIDAE, p. 113; SEPSIDAE, p. 114; MICROPEZIDAE, p. 115; PSILIDAE, p. 116; ORTALIDAE, p. 116; TRYPETIDAE, p. 117; SAPROMYZIDAE, p. 118; RHOPALOMERIDAE, p. 119; HELOMYZIDAE, p. 119; HETERONEURIDAE, p. 119; SCIOMYZIDAE, p. 120; PHYCODROMIDAE, p. 121; SCATOMYZIDAE, or SCATOPHAGIDAE, p. 121; ANTHOMYIDAE, p. 122; OESTRIDAE, p. 125; SARCOPHAGIDAE, p. 141; MUSCIDAE, p. 143; TACHINIDAE, p. 156; DEXIIDAE, p. 159).

The Pupa-Bearing Flies (PUPIPARA).

The Louse-flies, Family HIPPOBOSCIDAE, p. 159.

The Bat-ticks, Family NYCTERIBIIDAE, p. 164.

The Bee-louse, Family BRAULIDAE, p. 164.

It has been our aim to make this a treatise on Minnesota species of Diptera. Where we have departed from this principle, indication is made in the text. We have made use of numerous drawings of Dr. Lugger's, which were found here. A few of them do not represent species which are at present in our Minnesota collection. We have further included amongst the Minnesota species some specimens labeled "South Dakota," since, although we have not yet met them here, they probably occur within our state boundaries. In every such case, however, the designation "So. Dak." follows the insect's name. Inasmuch as we are still working with some Dipterous material as this report goes to press, in all probability new species will be added to our list later. Therefore, anyone desiring a more extended list of our Diptera should write us six months from now. It is planned to include the names of flies not yet listed, in next year's report.

In many cases Washington authorities give us only the generic names of specimens sent to them for identification; this is especially true of *Chironomidae* and *Tipulidae*.

PSYCHODIDAE.

Extremely small, fragile moth-like flies, well covered with "hair," whose larvæ are found in water, decaying vegetable matter, and even sometimes in cow dung. They are frequently found on the lower surface of leaves and upon windows, and especially in shady places. The different species are hardly one sixth of an inch in length. While they are fairly active on foot, their flight is

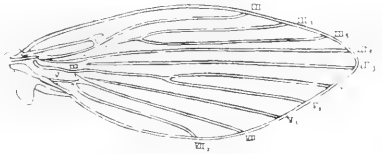


Fig. 18. Wing of moth-like fly, much enlarged. After Comstock.

not strong. Only four genera are in North America—*Psychoda*, *Pericoma*, *Sycorax* and *Trichomyia*, the most common species, *P. alternata*, Say, occurring pretty generally over the United States. A few specimens of this species are in our collection. The accompanying drawing, Fig. 18a, represents this fly enlarged.

Fig. 18a. *Psychoda alternata*, enlarged about 8 times. (Original.)

Psychoda alternata, Say, and a *Trichomyia*, sp., occur here.

TIPULIDAE.

Crane Flies.

Almost every one is familiar with these long legged, somewhat delicate flies, which in England are called "Daddy Long-Legs." Comstock, in describing the family, fittingly quotes:

> "My six long legs, all here and there,
> Oppress my bosom with despair."

They must not, however, be confused with the spider which in this country we refer to as "Daddy Long-Legs." Probably few realize the large number of species found in this group, nearly or quite 1200, 300 of which occur in the United States, ranging in size from that of a large mosquito to forms over two inches long, resembling superficially a giant mosquito. These are the flies which are so prone to lose a leg or two when handled, though this loss does not seem to inconvenience them in any way. They all have as a distinguishing mark a *V* shaped suture on the upper part of

Fig. 19. *Helobia hybrida*, Meigen. (Original).

the thorax. Most of them, the larger species particularly, are clumsy in flight, keeping rather close to the ground and frequently alighting, but some of the smaller species are capable of more sustained flight, and are seen in cloud-like swarms at twilight in early spring, and in autumn, and occasionally in winter on warm days. Found commonly in fields, meadows and woods, which places are frequented by the larvae, the latter living commonly in decaying vegetation; some, however, are aquatic; some are found on leaves

Fig. 20. Larva (on the left) and pupa (on the right) of the Giant Crane Fly. The central figure is the posterior end of the larva, enlarged, showing spiracles. Larva and pupa three-quarter natural size. From Kellogg's "American Insects."

of plants, and some are of economic importance, since they destroy the tender roots of grass and grain. The terrestial larvae, often called "leather jackets," are produced from the egg generally laid in the ground, in something more than a week. The eggs are grayish or brownish in color. The internal organs are partly visible through the integument and body wall, and the "worm" moves awkwardly by the action of transverse swellings on the body provided with small bristles. Of the adults a few are wingless, one, *Chionea,* frequenting the surface of snow. This fly, mating males and females, Dr. Lugger has captured in this state, about Christmas time, crawling about over the snow, with the thermometer below freezing. The drawings illustrate *Chionea valga,* Harr.; *Bittacomorpha clavipes,* Fab., whose larvæ are aquatic, and

Fig. 21. *Bittacomorpha clavipes.*

Helobia hybrida, Meigen. A colored figure of one of the smaller species, *Pachyrhina ferruginea*, Fab., is shown in Plate II.

Minnesota species: *Bittacomorpha clavipes*, Fab.; *Pachyrhina ferruginea*, Fab.; *P. erythrophrys*, Will; *Helobia punctipennis*, Meig.; *Tipula*, Sp.; *T. abdominalis*, Say; *Discobola argus*, Say; *Pedicia albivitta*, Walk.

Fig. 22. Larva of *Bittacomorpha clavipes*. Natural size. After Hart.

A large number of specimens returned from Washington, labeled simply *Tipula*, sp., would indicate that this group has not been at all well worked, and offers a fertile field for a dipterologist.

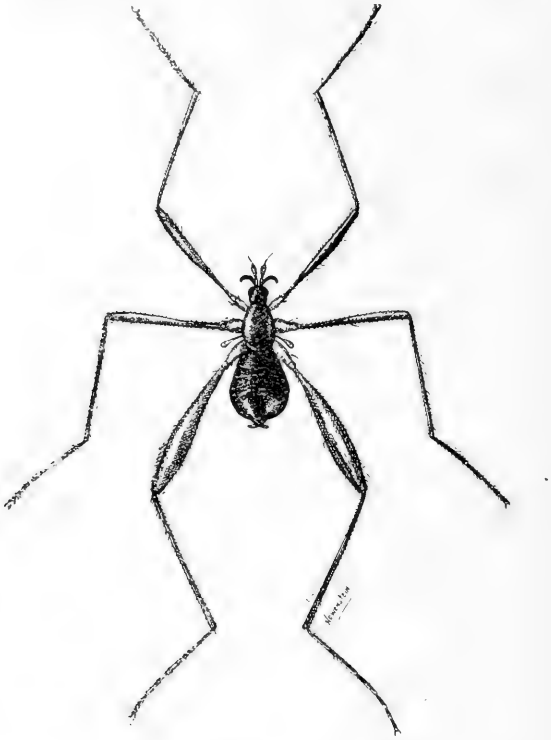


Fig. 23. *Chionea valga*; "Snow Fly," Lugger.

BLEPHAROCERIDAE=LIPONEURIDAE.

Net-winged Midges.

Rare flies of moderate size, frequenting the neighborhood of swift

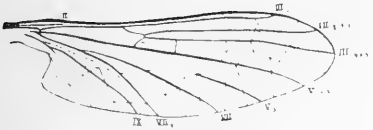


Fig. 24. Wing of net-winged Midge. After Comstock.

running streams. In 1896 Williston gave seventeen known species distributed as follows: Six in Europe, one in Asia, six in North America, one in West Indies and three in South America. The larvæ live in the swiftest water, at least one species being provided with six suckers on its ventral side, evidently of use in the swift current. The complete life history of any one species is not known. From the fact that the larvæ inhabit clean swift streams, it follows that these flies are more numerous in mountainous districts than they are in low lands. The food of the larvæ is said to be chiefly diatoms. The pupæ are found fastened to rocks.

Kellogg says, in commenting on the emergence of the imagoes from the pupal cases, that so many are swept away before their wings are unfolded or before their legs can be loosened from the pupal sheath that it seems no wonder that the family is a disappearing one.

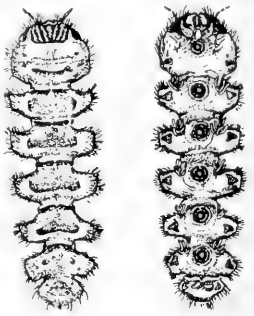


Fig. 25. Dorsal and ventral view of the larva of a net-winged Midge. From Kellogg's "Net-winged Midges."

DIXIDAE.

The Dixa Midges.

Only one genus, *Dixa*, is found in this family, which appears closely allied to *Tipulidae* on the one hand and *Culicidae* on the other. They are small gnat-like flies, with long, slender legs, resembling mosquitoes in a general way, but quite unlike the latter in wing

Fig. 26. Larva of Dixa. From Miall's "Aquatic Insects."

Fig. 27. Pupa of Dixa. From Miall's "Aquatic Insects."

structure. The species (about twenty in number) are found in shady, swampy places, and, like other midges, have the habit of

forming dancing swarms in the air. The larvæ are aquatic, and not unlike the larvæ of mosquitoes.

The genus *Dixa* is widely distributed over the world. Ten species appear to have been taken in North America, and four species not known in North America occur in Great Britain.

CULICIDAE or MOSQUITOES.

Veritably no family among insects offers such peculiarly interesting matter for discussion as the present one. The world over mosquitoes are anathematized, not only on account of the discomfort caused by their presence, but, and this is far more serious, it has been proven that the bite of certain mosquitoes, under proper conditions, causes malaria, yellow fever, and probably one or more other diseases. Fortunately the knowledge of this evil has shown us how to avoid these diseases in affected localities.

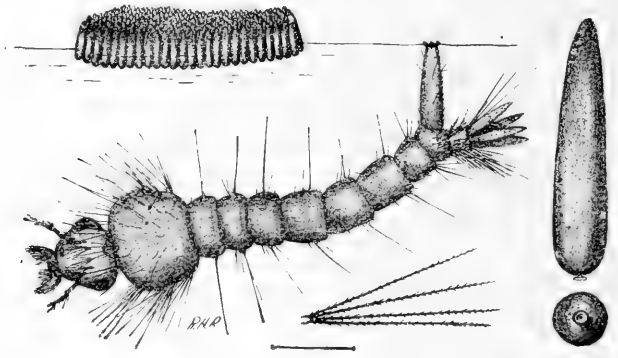


Fig. 28. Mosquito larva and eggs; also a single egg. Greatly enlarged. Lugger.

This family has become of such economic importance, on account of its disease bearing qualities, that many books are published on it alone. Perhaps the most comprehensive is that of F. V. Theobald, who under the title of "A Monograph of the Culicidae of the World," gives us three volumes of text and plates on this interesting group. Col. George M. Giles, of the British army, has published a thick volume on mosquitoes, and Dr. Howard, Chief of the Entomological Bureau at Washington, has written, and is constantly writing much of economic value of these pests to man. The same may be said

of Dr. J. B. Smith of New Jersey, who has recently issued a most complete and voluminous report on the mosquitoes of his state.

Fig. 29. Mosquito, larva, pupa and imago. From Kellogg's "American Insects."

The word "mosquito," which we see rendered in America also as "Musquito," and even "Musqueto" and "Musketo," is the diminutive form of the Spanish "Mosca," which means fly. In France mosquitoes are called "M o s t i q u e s," "Maringouin," "Cousin;" in Germany "Stechmucker;" in Russia "Camari," and in Italy "Zanzare," or "Zanzaroni."

Many other small flies are frequently mistaken for mosquitoes, notably the midges, belonging to the family *Chironomidae,* which bear a close resemblance to mosquitoes, but have not their despicable habits. Small crane flies, *Tipulidae,* also slightly resemble members of this family.

As intimated at the head of this article, the family is cosmopolitan, its members being found in arctic regions as well as in the tropics, nor is altitude any barrier, for in Java they are found at 3,000 feet, and are reported as very troublesome in the Himalayas at 13,000 feet. Of the genus *Anopheles* alone, twelve species are known to be in India, five in Asia, six in West Africa, four in the West Indies, five or six in Europe and four in Australia. Further study will probably swell the list. To illustrate their wide distribution over the globe, we note that one of our most common species in Minnesota, *C. pungens* (syn. *C. fatigans*) is found over all the United States, the West Indies, Argentina, Brazil, Panama, British Guiana,

Demarara, all of Africa and the islands near its eastern coast, Malay Peninsula, China, Austria, Fiji and Mauritius.

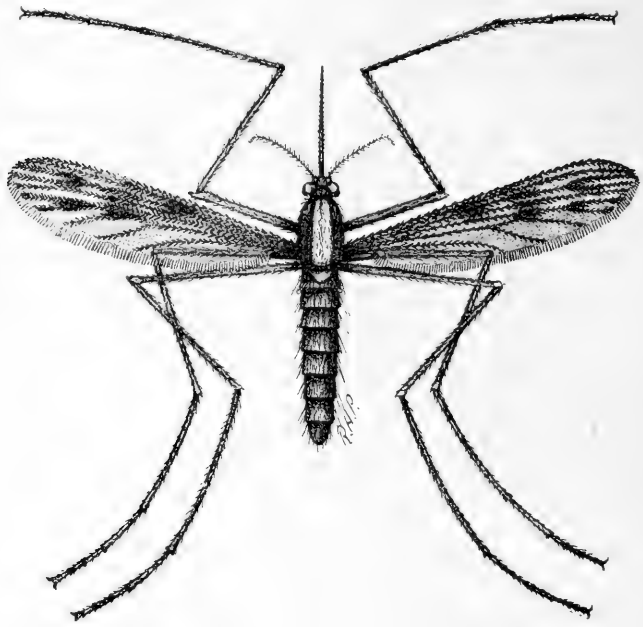


Fig. 30. *Anopheles maculipennis,* the malaria-bearing mosquito. Lugger.

C. pipiens, another common species in Minnesota, is found throughout the United States and Canada, in Bermuda, Algeria, and all of Europe.

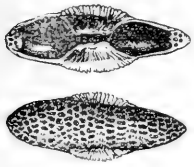


Fig. 31. Eggs of *A. maculipennis,* much enlarged. After Howard.

Anopheles maculipennis, which we have quite commonly here, and which is the elaborator of the germs which cause malaria, spreading the disease from one individual to another, is found over the United States, Canada and all of Europe.

C. consobrinus, also common in Minnesota, is found over all of the United States and Canada.

Stegomyia fasciata, not, as far as we know, in Minnesota, the dread carrier of yellow fever in districts subject to this disease, besides being in some of the southern parts of the United States, is found also in the West Indies, Italy, Spain, Portugal, Gibraltar, Africa, India, Malay Peninsula, Japan, Australia, Bermuda, and many other localities.

To account for this distribution of the various families of mosquitoes, it must be borne in mind that they are easily spread from one locality to far distant points in various ways, the cars and ships being the most common means of dispersal.

As the male of the human race finds it convenient to lay the blame of all mishaps to the opposite sex, so may the head of the house in the mosquito family say with equal emphasis, "The woman, she did it," for with one or two isolated exceptions the female mosquito does all the biting. She it is which drives sleep away from our eyes in the summer, distracts us in the open, and causes unlimited profanity. The sufferer from yellow fever goes to his grave as a result of her bite. The disease known as Filariasis can be laid at her door, and the malarial patient can ascribe his helplessness to the lady Anopheles, not to her mate.

Now, while it is believed that mosquitoes which are associated with warm blooded animals, man included, apparently cannot lay fertile eggs until fed upon blood, it is very evident that mosquitoes breed by the millions in localities where no such food is at their command. They may and do attack cold blooded animals, such as turtles and the like, but this limited diet would not suffice for the myriads which are found on the edge of the Arctic circle and elsewhere, where even cold blooded animals are very few in number. We are forced to the conclusion, then, that originally these pests were, as they must be now in certain localities, vegetable feeders, and that the blood sucking habit, upon which many of them have become so dependent, is an acquired habit. To bear out this theory is the fact that they appear very fond of bananas, clustering about the growing fruit, and have been kept alive upon slices of this fruit. They are apparently fond of any juicy fruit, and even jam, or a syrup made from sugar. Theobald has observed *C. pipiens* in England feeding upon decaying apples, and we know that they are attracted to beer and wine. Doubtless the fermentation of the juices of the apple, referred to by Theobald, was the attraction.

BREEDING HABITS.

Mosquitoes breed mostly in fresh water, though some frequent salt water for this purpose, and some breed in both fresh and brackish water. Almost without exception they require the water to be still,

and not too deep. Open tanks and cisterns, drains, ditches, puddles, shallow ponds, post holes, depressions under side walks, watering troughs where the water remains unchanged for some time, muddy holes made by the feet of cattle and other stock, marshy places, old basins, tin cans, bottles, broken crockery, cess-pools and rain barrels are a few of the places chosen by these pests in which to deposit their eggs; any place, in fact, that will hold half a pint of water for ten or twelve days may be the source of a hundred or more. Even if the water almost dries up in depressions where the eggs have been laid, or where the young "wigglers" are living, if it is then renewed by a slight shower, it is probable that "wigglers" survive and complete their development.

Fig. 32. Overlooked breeding places.

The eggs of many of our common species resemble, superficially, a little speck of soot on the top of the water, which resolves itself, upon being examined by a glass, into a little skiff shaped mass, consisting of several eggs fastened together. The eggs of *Anopheles maculipennis*, however, are laid separately, and are not fastened together, except that they naturally adhere more or less when they come in contact wth each other.

The popular belief that mosquitoes breed in grass is doubtless thus accounted for. The grass is sought for shelter from heat and

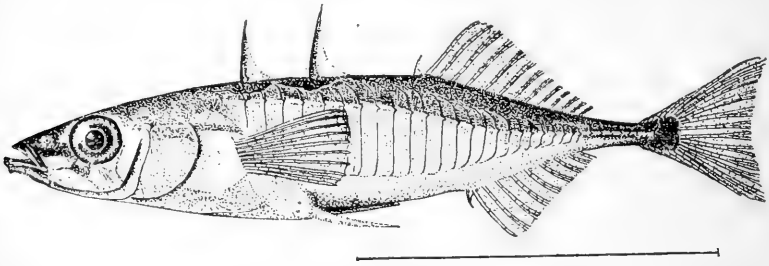


Fig. 33. A stickleback, fond of mosquito larvae.

wind, and the very small depressions above alluded to, too small to be observed in the grass, afford places for egg laying. It may be

too, that our mosquito, as does the salt marsh mosquito, lays its eggs in mud or elsewhere, where its instinct tells it water will come later.

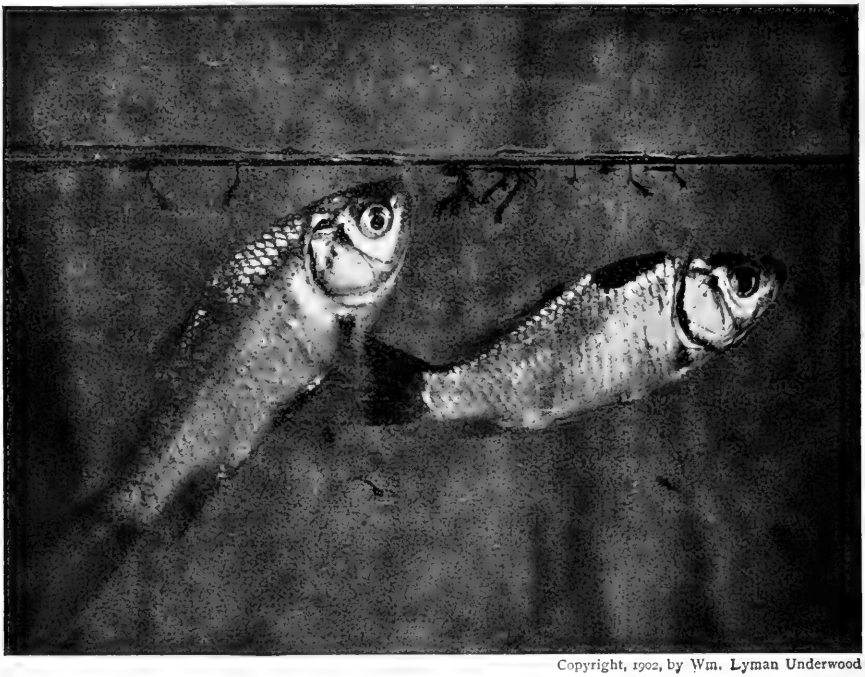
Every one is familiar with "wigglers," which are the larvae of mosquitoes, changing their appearance to become pupae, in which condition they exist for a short time before issuing from the water as perfect flies. Our illustrations show these stages, as also the appearance of the eggs. In a general way we may say the egg stage lasts from ten to twenty-four hours, the life of the "wiggler" from seven to ten days, sometimes longer, the pupal stage ordinarily from two to three days, sometimes longer, and the adult's life on an average, under natural conditions, probably from eight to twelve days. This statement is only a general one, since climatic conditions probably have great influence on duration of life. Mosquitoes have been kept alive in captivity for three weeks. Consideration of the above data shows that the duration of one generation is naturally, in round numbers, from 17½ to 26 days. Turning to the individual species, we can speak more in detail:

	Egg.	Larvae.	Pupae.	Total time required from laying of egg to emergence from pupal stage.
Anopheles maculipennis	1 to 4 days	16 days	4 to 5 ds.	21 to 25 days
C. pipiens	20 hours	2 to 4 wks.	2 to 8 ds.	17 to 37 "
C. pungens	10 to 12 hrs.	7 to 8 days.	2 days.	9½ to 10½ "

To show the enormous number of mosquitoes which may be found in a comparatively small amount of water, we quote from an experiment made by Dr. Lugger in 1896. By a careful estimate he found that one rainwater barrel contained 17,259 eggs, larvae and pupae, and in another barrel he found 19,110 eggs, larvae and pupae.

A curious person at once asks, "Well, where do they come from in the spring; does not the winter kill them all off?", and the answer is that many impregnated adult females hibernate, passing the winter under boards, under moss, in cellars and in garrets, in crevices of various sorts, in the woods, about the barns and out-buildings. They are often found in curtain hangings and in draperies indoors. These are sufficient to start them in the spring, and their rapid rate of increase does the rest. Even "wigglers" frozen solid in the ice in

late fall have been found to retain their vitality, and in the spring, when thawed out, to complete their changes and develop into full grown mosquitoes.



Goldfish feeding on mosquito larvae

Fig. 34. (From "How to Make A Flower Garden", Doubleday, Page & Co.)

ENEMIES OF MOSQUITOES.

Various birds eat large numbers of adult mosquitoes, notably the night hawk, 600 being found in one crop, swallows, martins, flycatchers, also bats. Dragon flies prey upon them in the air when adult, and the nymph of the dragon fly feeds upon the larval mosquito in the water. Many other aquatic insects are useful in the same way, and many small fish are instrumental in freeing shallow ponds of this pest. The adults are also attacked by one or two varieties of fungus, and by a small mite, resembling superficially the so-called "red-spider."

Remedies and Means of Prevention.

First, the filling in or draining of swampy marsh land in the vicinity of dwellings; the evening of shore lines of ponds and lakes, where possible, making the same regular, and thus doing away with the small, shallow inlets and wet depressions, which afford breeding places. Ponds, the surfaces of which are well covered with leaves of aquatic plants, are not so much infested as open shallow water, because the female mosquito is discouraged in trying to reach the surface of the water for egg laying. On the other hand, in ponds where there are large leafed plants growing beneath the surface, the wigglers above the leaves are more or less protected from the view of the fish below, which would otherwise prey upon them.

Kerosene is a good agent used against these pests upon ponds, drains and tanks where the use of it does not interfere with the legitimate use of the water. Even in tanks where the water is used for the needs of stock or man, if an arrangement is made to draw the water from below, a film of oil can be made to cover the surface without affecting the quality of the water. The use of oil is based upon the fact that the larval and pupal mosquito have to come to the surface for air, the air entering through certain tubes adapted to that end. The slightest contact with oil is fatal to them. One application every three weeks should be sufficient. It is preferably sprayed over the surface, though if it be simply poured on the surface, it will gradually cover the entire surface area. As long as a film is seen on the surface no treatment is necessary.

A quite important remedy is the introduction of fish, the sticklebacks, minnows, or common sun fish, into ponds and elsewhere, wherever kerosene cannot be used. These prey upon the wigglers, consuming large numbers.

The covering of cisterns and rain barrels, preventing adults from reaching the water and laying their eggs thereon, is a thought which would occur to any one knowing their habits.

Most compounds devised as preventives for application to the face and hands are either nauseating or ineffective or both. The writer in common with many others, has found, however, that oil of citronella, for sale at most drug stores, is the best preventive, and its odor not at all disagreeable. This should not be diluted, and should be applied to the face, neck and hands where one is exposed to the

attacks of these pests. One application is effective for from one-half to one hour, or as long as the surface of the skin remains moist with the oil, if not longer than that if the creatures are not very numerous or very hungry. Care should be observed not to get it into one's eyes. Every one to whom this has been recommended, and who has used it, speaks highly of its efficacy. When in camp in the woods, the writer uses a home made canopy, manufactured from mosquito bar, about six feet wide, by seven feet long and three feet high. The bough bed made six feet by seven, a post is driven at each corner to

How mosquitoes breed in the absence of the goldfish

Fig. 35. (From "How to Make a Flower Garden", Doubleday, Page & Co.)

project above the surface of the ground about two and one-half feet. Over this the canopy is thrown, the edges tucked under the bed, thus making an inverted box of netting, as it were, and under which one is secure from attack. As an auxiliary I have a curtain of netting over the door of the tent. Smudges are, of course, also effective, but disagreeable.

It has been observed that mosquitoes are attracted to people wearing dark clothing more than to those clothed in light colors or in white, and this suggests certain action as regards dress when in mosquito infested districts.

Mosquitoes instinctively seek shelter from a strong wind, and it is believed that the old theory that mosquitoes are borne long distances on the wind is erroneous, and that probably breeding places in such cases are much nearer than supposed.

Fig. 36. The Yellow Fever Mosquito, *Stegomyia fasciata,* female. L. O. Howard.

Various remedies have been suggested from time to time to relieve the itching and smarting caused by mosquito bites. Some sufferers find relief in one remedy, others in some other. Giles recommends a mixture of cologne and water, others favor weak ammonia, still others soda in water. However, with most people, the annoyance from these pests is caused before and at the time of biting and not afterwards.

Mosquitoes taken in Minnesota.

The following *Culicids* have been found in Minnesota: *Culex sylvestris,* Theob.; *C. consobrinus,* Desv.; *C. tarsalis,* Coq.; *C. impiger*

(syn. *nigripes,* according to Theobald); *C. nemorosus,* Meig.; *C. pungens* (*pipiens, fatigans*); *C. canadensis,* Theob.; *C. cantans,* Meig.; *C. triseriatus,* Say; *C. restuans,* Theob.; *C. dyari,* Coq.; *Grabhamia curriei,* Coq.; *Sayomyia plumicornis,* Fab.; *Aedes smithii,* Coq.; *Taeniorhynchus perturbans,* Walk.; *A punctipennis,* Say; *Anopheles maculipennis* (*quadrimaculata*), Meig.

The last is the malaria bearer, yet it must not be supposed that it is a menace in the state, for we have practically no malaria here, and this mosquito has to bite an organism affected with malaria before it can transmit the disease.

In 1903 the writer, when in camp on Basswood Lake, St. Louis county, allowed many of these insects(*A. maculipennis*) to bite him, in order to obtain some idea of the time required by this species to digest a full meal. After from 19 to 68 hours, showing great variation in individual cases, their abdomens had shrunk to their normal size, and they apparently were ready for business again, though they could not be induced to bite a second time. In this connection it may be stated as a fact, that the old idea that a mosquito can bite but once has been found to be wrong. *Anopheles* does not hurt in biting as much as *Culex*, at least, that has been the writer's experience, there being but little or no pain when the insect was operating.

Since 1880 it has been known that malaria is due to the presence of a small organism in the blood, a microscopic animal, not a plant, attacking the red corpuscles. In 1882 Dr. A. F. A. King of Washington read a paper before the Philosophical Society, advancing strong arguments as proof that this disease might be distributed by mosquitoes. Acting largely upon his ideas, many scientists at once began to work along the lines indicated in his suggestions. MacCullam, of Johns Hopkins University, Baltimore, was one of the most important contributors to our knowledge upon this point, but the work was by no means confined to that college nor to the United States. It was not, however, until several years after Dr. King's presentation in 1882 that the important fact, i. e., that malaria could not be transmitted naturally from one individual to another except through the bite of a mosquito was established, *Anopheles* being the only one, as far as we know, which transmits it.

The vital activities of the micro-organism referred to as attacking the red corpucles may be checked by quinine. If not checked by

this or by some other means, the spores in the corpuscles break out into the serum, and other corpuscles are attacked. The development to this point will take place, according to authors, anywhere, even on a glass slip under the microscope, in the stomach of the genus of mosquito known as *Culex*, and it is quite likely in the stomachs of various other biting insects. But as far as we know it is only in the stomach of *Anopheles* that the manner of development changes to a different form and finally penetrates to the duct of the salivary glands of the above mosquito; thence, when the insect is biting, through the proboscis these enter the blood of the victim, who is thus inoculated with the malarial germ, and shortly after shows the well known symptoms of the disease. It is now known that malaria is not caused by the air of swampy districts; that the swampy areas are only secondary in affording breeding grounds for mosquitoes; and that, as far as our knowledge goes at present, the only natural way by which the disease can be transmitted is through the bite of one, and only one insect, the mosquito we know as *Anopheles*.

In Italy, on the Campagna and elsewhere, a series of careful experiments were made to demonstrate that individuals had to be bitten by malaria-bearing mosquitoes in order to become infected. In 1900 certain experimenters lived in the most malarial infested region of the Campagna during the malarial period. They entered screened houses at sundown, and remained there until daylight, thus avoiding being bitten, while people all about them, not protected as they were, became affected with the disease, particularly at the advent of the rainy season. The doctors referred to, although they were frequently wet through by being exposed to the rain, showed not the slightest symptoms. Check experiments have been made by allowing specimens of *Anopheles* which had fed upon the blood of malarial patients at Rome to bite an individual not affected, and who had not since a boy, and was not at the time, living in a malarial district. In other words, the mosquitoes after biting the patient in Rome were sent to London. At the proper time malarial symptoms appeared in the individual, and the parasites were found in his blood.

Just as malaria is transmitted by the bite of a mosquito, so it is with the yellow fever. Most conclusive proofs are present to establish this fact. That the disease is not spread by contact was demonstrated to the whole scientific world by volunteer observers

wearing the clothes of and using the soiled bedding taken from the beds of patients who had died of this disease. The mosquitoes of the district were kept away, and these brave men passed through this trying ordeal safely. The transmitter of the yellow fever is the mosquito known as *Stegomyia fasciata.*

As stated above, we know also that the disease known as filariasis, giving rise to the condition known as "elephantiasis" (not *E. graccorum,*) in which a limb of a human individual becomes enormously enlarged, is caused indirectly by the bite of a mosquito, which forms one of the hosts of a tiny parasitic worm, *Filaria.* The writer will never forget seeing in the streets of Tangiers, Morocco, a sufferer from this loathsome, leprous-like disease, his right leg enormously swollen, keeping at bay a horde of heartless boys who were stoning him, and taunting him for his deformity. One could almost imagine he heard the biblical "Unclean!" "Unclean!" in the unintelligible tongue of the Moorish lads.

Considering the part that mosquitoes play in spreading disease, is it any wonder that this family *Culicidae,* is one of intense economic importance?

CHIRONOMIDAE.

The Midges.

These small, delicate, gnat-like flies, frequently called midges, might well be referred to as "Sunset Flies," since they are wont to appear in clouds just before or after sunset, preferably in damp places, about water in the woods, and elsewhere, though one meets with them in all localities. In the short days of autumn we frequently see the air full of them "dancing" as it were, in the warm afternoon sunshine. Williston has seen them in the Rocky Mountains at nightfall, rising in incredible numbers, so abundant as to produce a humming noise like that of a distant waterfall, audible for a long distance. Frequently they are mistaken for mosquitoes, resembling them somewhat superficially, but unlike mosquitoes, they are, with a few exceptions, harmless to man. One curious and distinguishing difference between them and mosquitoes is the fact that when resting they usually lift their fore legs in the air, whereas mosquitoes when resting generally have their hind legs raised. There are in all con-

siderbly over 1000 known species of *Chironomidae* in the entire world.

The larvae or maggots are delicate, frequently translucent, creatures, living for the most part in water, but also found in other places

Fig. 37. A Chironomid. Also antenna of male. (Original.)

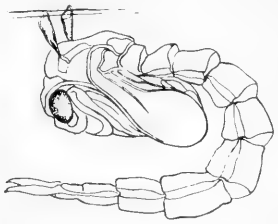


Fig. 38. Pupa of Chironomid, *Tanypus dyari*. Original. Note the resemblance to the pupa of a mosquito.

where there is moisture, such as under leaves in the soil, in decaying vegetables, in pitcher plants, in the sap under bark, etc. The larvae of some species are red, which color is due to haemaglobin, such as we have in our own blood, and which so easily unites and parts with oxygen. The aquatic larvae of some species form an important item in the food of trout. It is interesting to note that some of these larvæ are found in salt water, occasionally at great depths. The late Dr. Packard dredged live Chironomid larvæ in the harbor of Salem, Massachusetts, and in Lake Superior Chironomid larvæ have been dredged from 1,000 feet below the surface. They are found in salt lakes, and the larval form of one species has been discovered living at a depth of twenty fathoms at sea. The pupæ are found in water, and the pupæ of at least one species is said to produce eggs. We find in this family the celebrated "punkies" or "no-see-ums" (see illustration), those almost invisible pests, which are veritable blood suckers, and which go through almost any net, no matter how fine. When one is atacked by these creatures, scientific impulse upon the part of the victim is lost,

Fig. 38a. *Ceratopogon*, sp., "No-see-um," "Punkie," greatly enlarged. Lugger.

and instead of confining the specimen within a bottle, it is generally smashed, while the mind frames, but does not always give utterance to, a bad word. Aldrich (1904) lists 268 species of Chironomids in North America. Eighty-eight of these species belong to the genus Ceratopogon. In the June, 1905, issue of the Journal of the New York Entomological Society, Mr. Coquillette described twenty new North American species of Ceratopogon, the genus to which the "punkies" or "no-see-ums" belong.

Fig. 39. Wing of a Chironomid, *Chironomus.* After Comstock.

Species taken in Minnesota are as follows (see also Fig. 14, Plate II): *Diamesa waltlii,* Meig.; *Tanypus,* sp. (several *Chironomus* sp.); *Ceratopogon* (?); (?) *Tanytarsus,* sp., Coq.; *Tanypus annulatus,* Say; *Tanypus dyari,* Coq.; *Tanypus pinguis,* Loew.; *Chasmatonotus bimaculatus,* O. S.

MYCETOPHILIDAE.

The "Fungus Gnats" are extremely abundant over almost the entire globe, and they range from north of the arctic circle to within the tropics. They are, for the most part, small mosquito-like flies, and all have long antennae or "feelers" which, as a rule, are not hairy. The larva or maggot of the species of this family has a distinct head. With us they are found in greenhouses, on window panes in the house, and near and about decaying fungi; in fact, growers of mushrooms have sometimes to complain because of the fondness of these insects for the edible varieties they raise. The female fly lays her white eggs generally on the under surface of the fungus, and frequently the fungi, or varieties which are commonly spoken of as "toad stools," will be found in a decaying state, and riddled by the small active larvæ of these insects.

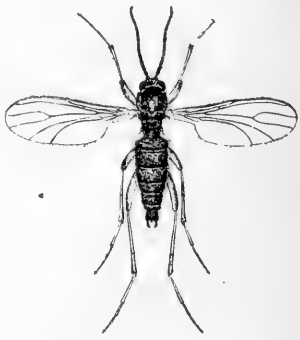


Fig. 40. A Mycetophilid. Original.

One genus in this family, *Sciara,* and perhaps the only one which does not live on fungi, preferring vegetable mould, cow dung, and the space under the loose bark of dead trees, has a peculiar habit of migrating in large numbers in the larval stage, forming in this process

a long band on the ground, two, three, four or more inches wide, nearly half an inch deep and sometimes ten feet or more long. Some observers claim to have seen bands from forty to one hundred feet long, five or six inches in width and one inch deep. This peculiar column advances, slowly, at the rate of about four inches in five minutes; those in the rear working toward the front over the tops of the others. On account of this peculiarity the species which have this habit are spoken of as the "Sciara Army Worm." The Germans refer to it as "Heerwurm." What is the purpose of these migrations in every case is not known; it cannot always be to obtain food, because they are frequently full grown when the journey is undertaken.

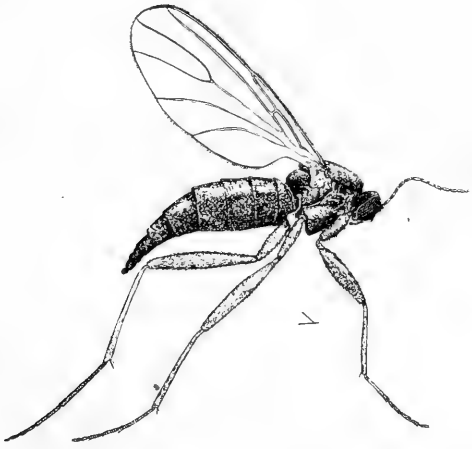


Fig. 41. *Sciara.* Original. The lines below fly indicate natural size.

Another peculiar trait of *Mycetophilids* is the luminosity, a rare thing amongst Diptera, shown by certain larval forms of the genus *Sciara.* Some members of this genus, too, are said to make galls on plants.

There are probably nearly 1,000 species of this family known, and others not described. Economically they are of some importance. Hopkins has shown that *Epidapus scabies* is the cause of potato scab; the larvæ of *Sciara mali* "destroy the interior of apples," particularly those that have already been injured by the Codling Moth. The fondness of some of the species for edible mushrooms has already been

referred to. At the same time we must acknowledge that the removal of rotting fungi from our woods and gardens, or the hastening of the decay of the same by the activity of these insects, is a most desirable thing. In the southern United States, from the fact that a species of *Sciara* or "Army Worm" appeared in large numbers contemporaneously with the appearance of yellow fever, it was erroneously supposed to have some connection with this dread disease, and hence was called the "yellow fever fly."

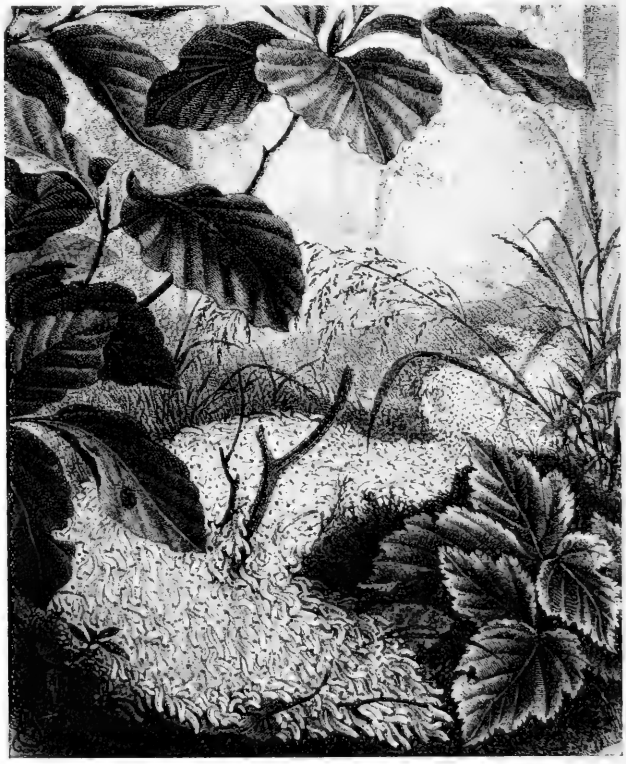


Fig. 42. A procession of Sciara larvae. From Brehm's "Thierleben."

We find in Minnesota the following species, and there are doubtless numerous others not yet met with: *Lasiosoma quadratula,* Loew.; *Mycetophila monochaeta,* Loew; *Mycetophila punctata,* Meig.; *M.* (?) *contigua,* Walker; *Neoglaphyroptera bivittata,* Say; *Sciara,* sp.; *Epicyta,* sp.; *Dynatosoma,* sp.

CECIDOMYIDAE.

Extremely minute and fragile flies, the maggots of many species causing galls upon plants or trees. Members of the family are therefore spoken of as "Gall Gnats." Before Malpighi's time, 200 years ago, it was believed that these galls were due primarily to the condition of the plant, and that the maggots therein arose spontaneously. Malpighi, however, advanced the theory, which is in part accepted to-day, that the abnormal growth was due to irritation in the plant tissue caused by a liquid deposited by a female fly at time of egg-laying. These small flies are found in most parts of the globe, from the far north to in or near the tropics, being more abundant in the warmer portions of the earth. There are probably at least 1,000 described

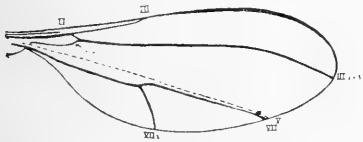


Fig. 43. A wing of a Cecidomyid. Much enlarged. After Comstock.

Fig. 44. Portion of antenna of *Xylodiplosis*, very much enlarged. After Janet.

forms, which are being added to each year. The antennae or "feelers" are long, and generally hairy, and there are fine hairs over the body and wings of the insects. The antennae are sometimes strikingly beautiful. We figure one peculiar form from a Cecidomyid known as *Xylodiplosis*. In this species the hairs on the antennae have no free extremities, but form loops, as indicated.

The tiny larvæ, or maggots, are of various colors, red or pink, or shades of yellow and orange. Their bodies consist of fourteen segments, which is apparently an exception to the rule that maggots have thirteen segments. A most striking structural peculiarity of almost every species of the family is the presence of a small forked horny piece, with the horns pointing forward, beneath the anterior end, between the second and third segments. It is called the "breast bone," in England the "anchor process," and its use evidently is not known, though it may be analogous with the mentum, the structure having to do with the under lip. Miss Ormerod regarded it as a scraper or digger, to assist in obtaining food from the stems of plants. It is shown in our illustration.

An extremely interesting point in the life history of insects in this family, according to Theobald, is their parthenogenetic development. In the larval stage parthenogenesis is not at all uncommon among insects in general, and is found to some extent in the order of Diptera, but nowhere so peculiarly interesting as in the larval life of the *Cecidomyidae*. The ovaries in the larvæ become fully developed and give off eggs; these eggs hatch into other larvæ, which in turn, give rise to further larvæ in the same way; "and so on," says Theobald, "until as many as five generations may be seen in an old larval skin." The discovery of this peculiar phenomenon in the *Cecidomyidae*, in 1860, is credited to a Russian naturalist named Wagner. The larvae of some species leap, being assisted in this act by processes upon the last segment. The pupal case or puparium made by individual mag-

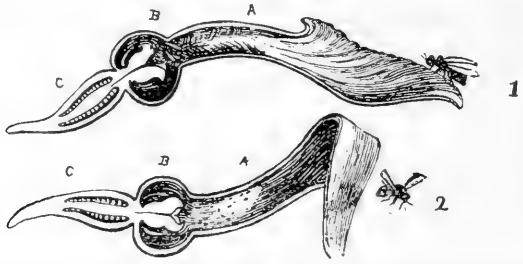


Fig. 45. Fertilization of *Aristolochia clematis* by Cecidomyiids. From Theobald's "British Flies."

gots in this family is brownish. In the case of the Hessian fly it has a slight resemblance to a flax seed, and is commonly thus referred to by wheat raisers.

Although the *Cecidomyids* represent a very injurious group of insects, they undoubtedly do good by bringing about cross-fertilization in minute plants, too small for most insects to enter. Theobald describes in the following words the fertilization of the European *Aristolochia clematis,* which is largely accomplished by Cecidomyids. He says that he has seen as many as five of these insects in a single blossom of this plant: "Each of these greenish blossoms commences with an expanded lip. This passes into a funnel or throat (A)" (see illustration), "which is lined by hairs, so placed that they allow the entrance of an insect, but not its exit. This long funnel opens into a flask-shaped enlargement (B), in which are placed the generative

organs. This cavity is also lined by hairs, especially at the base, around the anthers. The stigmas are placed above the anthers, and curve over them, the anthers being surrounded by the hairs of the flask.

"Fertilization takes place in the following way: The Cecidomyid enters the throat and passes down it, the hairs being placed so as to allow its free passage. As soon as it enters the flask it crawls about until its back, which is laden with pollen, comes in contact with the stigma, and thus fertilizes them. Upon this taking place, they spring up and assume an erect position. At the same time the hairs of the flask collapse and the anthers dehisce. The insect then crawling down, gets the pollen upon its back. While all this has been taking place the hairs of the funnel have withered up, and the Cecid or other insect, laden with fresh pollen, flies away to another blossom to repeat its experiences. But this is not all; as soon as the insects are free from the fertilized flower, the lip of the corolla bends over the entrance to the blossom, and thus effectually stops another fly from entering on a useless mission. The whole pedicel assumes a bent appearance, while the unfertilized ones are erect.

"This is, perhaps, one of the most curious adaptations that a plant has undergone for fertilization by insects, and has called forth a great deal of attention."

A few larvæ of this family are found in decaying wood, one species has been reared from decaying tulip and hyacinth bulbs. For the most part, one species will confine itself to a certain species of plant, or closely allied species of plants. Note, for instance, the much dreaded Hessian fly, which affects wheat almost entirely, although taken on barley, and on rye sparingly. One curious exception to this seeming rule is noted in the case of *C. sisymbrii,* which it is claimed forms a gall in the spring on the barberry, and later in the season on the nasturtium. It is to be noted also that the larvæ of some species live as guests or parasites in galls formed by other species, and some live parasitically amongst plant lice. Attempts have been made to classify the galls made by individuals of this family. No doubt all of our readers have observed the peculiar cone-like growth on the tips of branches of some of our willows (see illustrations). This is called the "Pine Cone Willow Gall" and is made by a *Cecidomyid* very common in Minnesota.

Some observers claim to have observed a great activity of Cecidomyid larvæ after a thunder storm, claiming that they leave their hiding places under ground, and crawl about restlessly for some time.

One of the prominent pests in this family is the Clover Leaf Midge, which folds the clover leaf lengthwise. We have also the Clover Seed Midge, which is exceedingly destructive to both red and white clover, preventing the maturity of the seed. But by far the

Fig. 46. Hessian Fly, female, reared in the laboratory, greatly enlarged. Original.

Fig. 47. Four puparia, "flaxseeds" of Hessian Fly, found in one volunteer wheat plant. Original.

most injurious of the family, indeed, at times, the worst of pests in wheat growing districts of the United States, is the Hessian fly, *Mayetiola destructor,* which gets its common name from a supposition that it was brought to America in the bedding of the Hessian soldiers. Much work has been bestowed upon this insect, and much written upon its ravages and treatment. It has been thoroughly discussed in various reports from this department, and perhaps needs

no further comment at this time; yet on account of its widespread distribution in Minnesota, and the importance of knowing the best way to handle it, we give here, in condensed form, the methods of its control:

1. Burn the stubble when, from any reason, shallow plowing is unavoidable, or when plowing is to be delayed in the spring until after emergence of flies. If the stubble is left long it will burn easier. Some farmers are willing to go to the trouble of spreading straw from threshing over the stubble, thus insuring the burning, and at the same

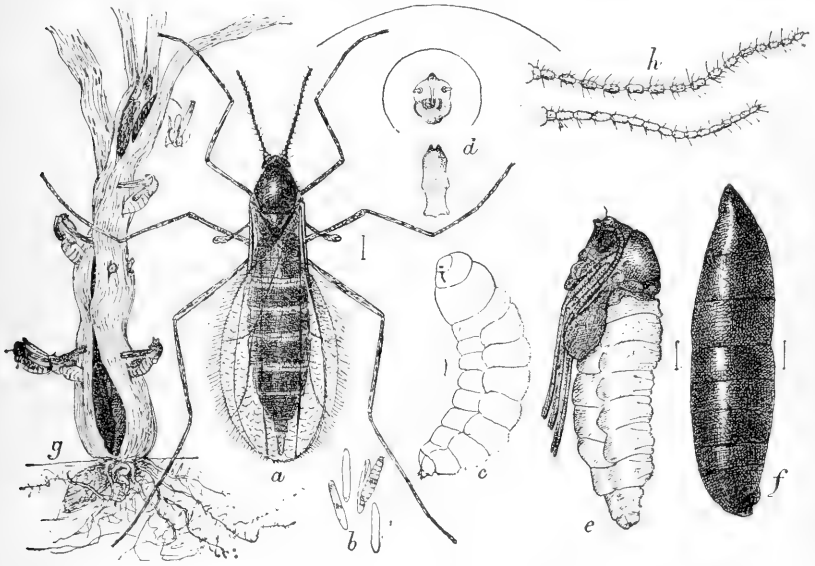


Fig. 48. Different stages of Hessian Fly; (a) female; (b) flaxseed pupa; (c) larva; (d) head and breast bone of same; (e) puparium; (f) cocoon; (g) infested wheat stem showing emergence of pupae and adults. From C. L. Marlatt, U. S. Dept. of Agriculture, Bureau of Entomology.

time the getting rid of some "flax seeds" which may have lodged on the surface of the straw pile at the time of threshing. It is well, however, to remember that repeated burnings, from the standpoint of our chemists, are not good for the soil.

2. Fall plowing of the stubble in such a way that the straw is completely turned under. In this connection we should not overlook the fact, made evident from the findings of 1903, that volunteer wheat, wherever found in the fall, may contain "flax seeds."

3. All screenings and litter about the threshing machine should be cleaned up, and either fed immediately or burned, leaving no litter from the threshing in the field. There is no absolute need of

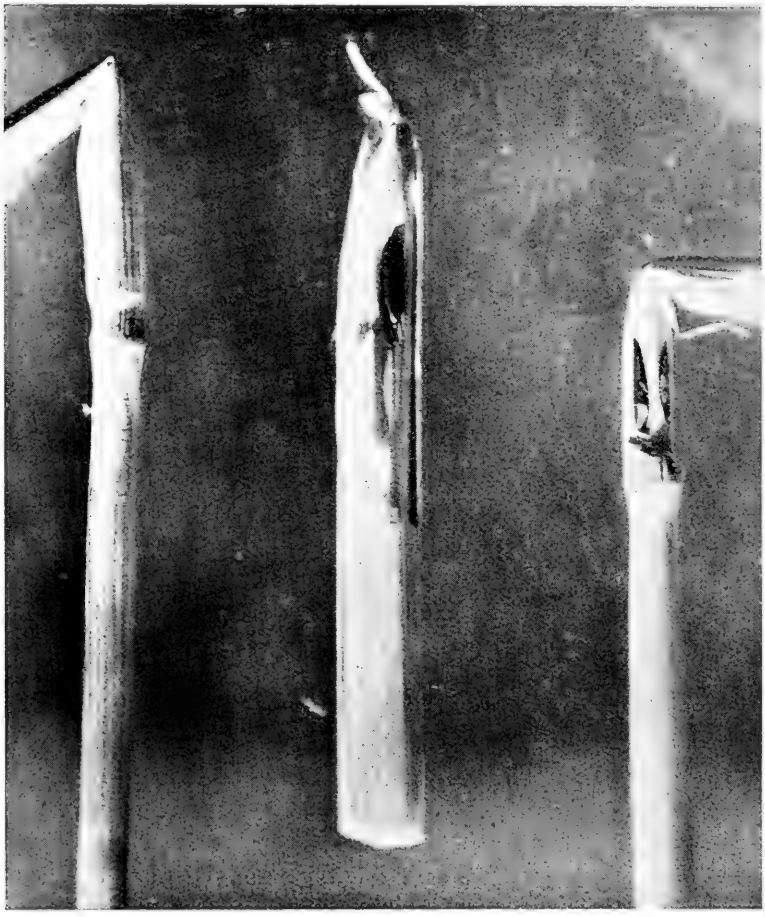


Fig. 49. Three straws showing work of the Hessian Fly; "flaxseeds" exposed in two straws at right. Original.

burning the straw pile. The flies emerging from "flax seed" in the center of the pile will never reach the surface.

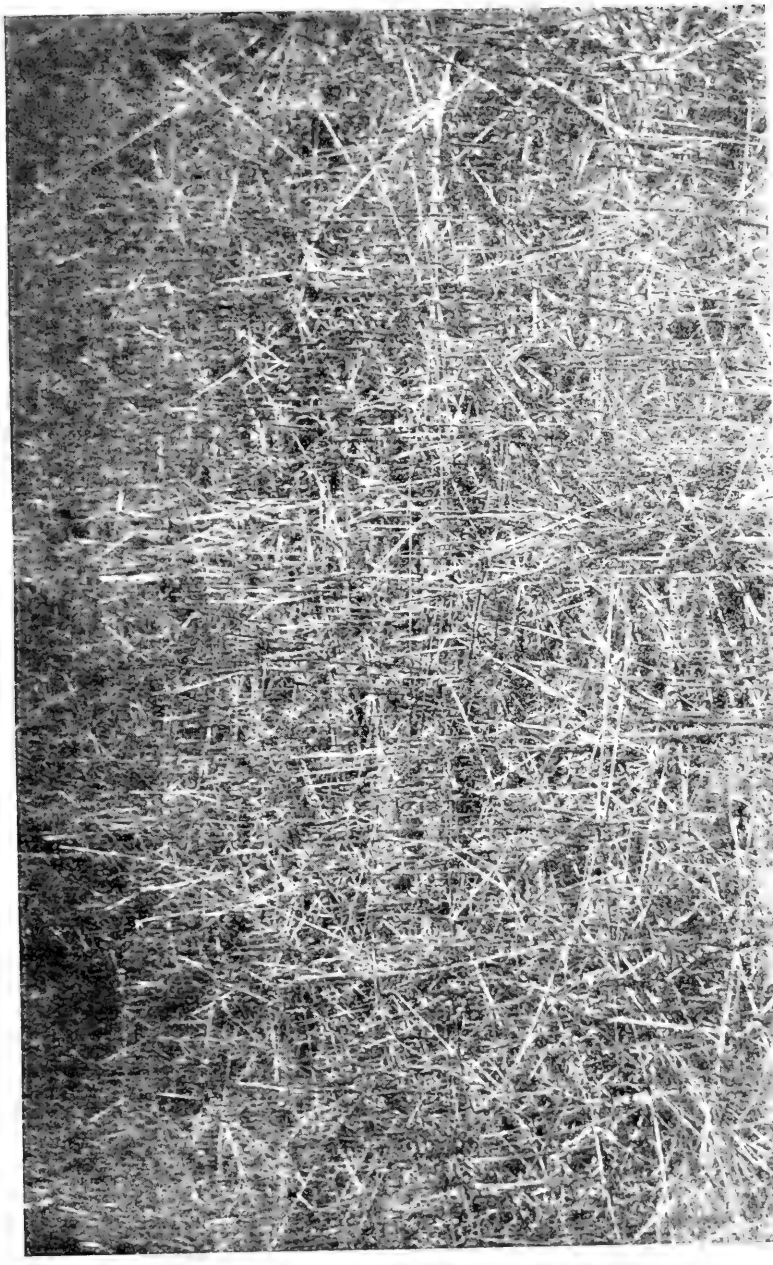


Fig. 50. The work of the Hessian Fly. A wheat field near Glyndon where 50 per cent of the wheat was down.

4. Since the fly lays its eggs, as a rule, near the locality where it emerges from the "flax seed," it is best not to plant wheat on the same ground two years in succession where rotation is possible. Varieties of wheat that produce a stout stalk are the least affected by this pest, and varieties of wheat should be selected and the soil handled to that end, remembering that a rank growth does not mean strong straw, but the contrary.

5. Co-operation is absolutely necessary, for however careful one may be, if his neighbor is not equally so, the latter's fields will afford a supply of this pest for the former. Since the pest issues from the "flax seed" early in May, a stubble field left for corn land not plowed up to the 10th of May or later has probably discharged its quota of flies, ready for mischief, before plowing.

Fig. 51. A Pine cone willow gall caused by a Cecidomyid. Original.

Fig. 52. The gall shown in Fig. 51 opened, showing maggots. Those in the center are the gall makers. Original.

As stated elsewhere, this pest will increase and decrease at regular intervals, due to the increase and decrease of its many parasites, which in turn are due to the abundance or the contrary of the fly. Regarding the number of broods of Hessian fly in Minnesota, bearing in mind the fact, as clamed, that the pupa may live many months in its case before emerging as a fly, we hardly feel justified in claiming a number of broods of this pest each season, until further observations have been made along this line.

The Wheat Midge, *Diplosis tritici,* another pest of this family, works in the flowers of the wheat. Another species of the same

genus, *D. violicola,* found in Minnesota, rolls up violet leaves and lives within. Still another, *D. resinicola,* or the "Resin Gnat," is found living as maggots in lumps of resin on various species of pine. This resin may have formed there as the result of injury by some caterpillar, or by abrasion of the bark; whatever its origin, it protects the maggots, which undergo their transformations in it. Our box elders, always a prey to insects, have been for three years or more disfigured by galls on their leaves, as shown in Fig. 55.

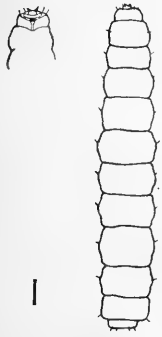


Fig. 53. A "skipping" Cecidomyii larva, bred from *Polyporus.* Much enlarged. Original.

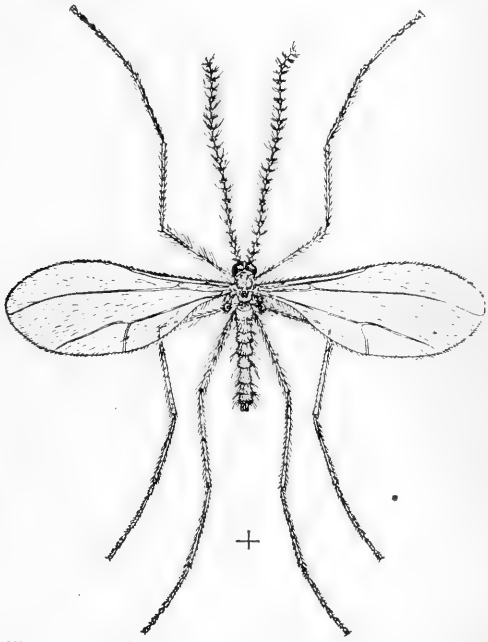


Fig. 54. The imago of the maggot shown in Fig. 53, much enlarged. The cross below shows actual size of insect.

Another tiny member of this family, *C. aceris,* also reared in our laboratory, causes a rolling of the leaves of the soft maple, in which very imperfect gall lives the maggot. We also have in Minnesota, in fact, we have reared them from the galls, *Cecidomyia robiniae,* working on the leaves of locusts. The leaves of our basswoods too frequently suffer from a Cecidomyid gall maker. We have also reared specimens of a Cecidomyid from the fungus known as *Polyporus.* The larvae found in this fungus had the power of leaping.

The imago and larvae of this insect are shown in Figs. 53 and 54.

The gall like growths caused by many flies in this, and by insects in other gall-making families, said growths being seen on willow, oak, goldenrod, sumac, maple and countless other trees and plants, are caused by the tissue of the plant in the immediate vicinity of the egg or larvae making an abnormal growth, due evidently to the presence of an irritating agent placed there by the parent insect, or by a secretion from the newly hatched larva, or in some other way not at this time thoroughly understood.

Fig. 55. Unsightly galls on box elder leaves. Caused by a Cecidomyid. Ruggles.

Species of this family collected in Minnesota are: *Contarinia violicola,* Coq.; *Mayetiola (Cecidomyia) destructor,* Say.; *C. aceris,* Shim.; *C. robiniae,* Hald; *C.* (?) *negundinis,* Gill.; *Asphondylia,* sp., "bred from cabbages in October;" a Cecidomyid bred from *Polyporus.* There are doubtless many others not yet encountered.

Fig. 55a. Cecidomyid galls on soft maple.

RHYPHIDAE.

False Crane Flies.

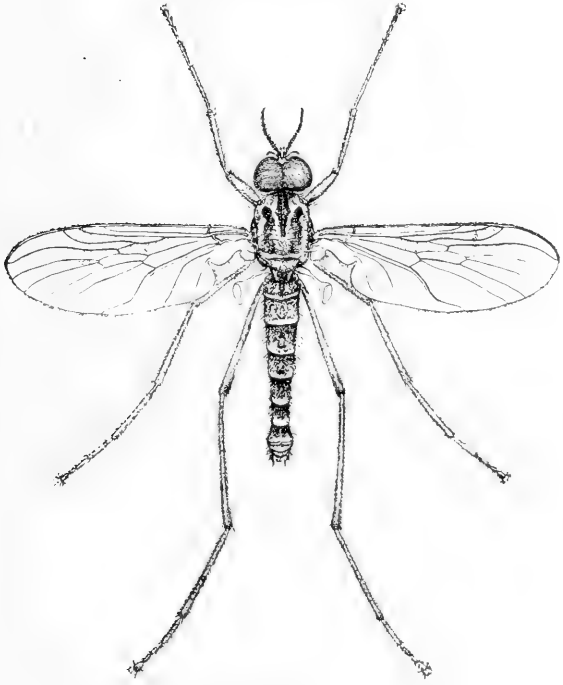


Fig. 56. ***Rhyphus punctatus,*** Fab., much enlarged. Original.

A very small family of flies, containing only a few species, possibly less than twelve in the United States. *Rhyphus fenestralis,* as its name indicates, is frequently found on windows. Comstock has observed species of this family feeding at night-fall on sugar, placed on trees to attract moths. They are also said to feed upon decaying fruit and other vegetable matter. The small larvae are worm-like, legless, and are found in pools of water, brooks, puddles, in decaying wood, rotten fruit and cow dung. Our illustration (Fig. 56), shows the appearance of *Rhyphus punctatus,* Fab., taken in Minnesota in May, and typifies the imagoes of this group. The flies are small, mosquito-like, and look like small editions of Crane Flies (*Tipulidae*), but lack the V-shaped suture on the thorax, which characterizes the latter family.

Minnesota species so far taken: *Rhyphus punctatus,* Fab.

ORPHNEPHILIDAE.

Solitary Midges.

The members of this family are very rare, and belong to one genus, *Orphnephila.* Very little, if anything, is known of their transformations. The flies are small, brownish or yellowish, and found in the neighborhood of streams. One species occurs in Great Britain, and but one, according to Comstock, 1895, *O. testacea,* in the United States.

BIBIONIDAE.

March Flies.

Perhaps "Spring Flies" would be a better appellation for these insects, since as far as Minnesota is concerned they rarely appear in March, some species being first observed when spring is quite well along, and a few do not appear until autumn. They are well illustrated in Figs. 57 and 58, and for the most part are dark colored, though the legs of the females of some of the species are brightly colored; some species are yellow, and a very common species, *Bibio albipennis* (see illustration), one of the earliest observed here, has

whitish, milky wings, contrasting with its black body. They all fly heavily, and are quite likely to be found among grass and other vegetation close to the ground. The sexual differences in coloration are striking, and oftentimes so marked as to lead one to think that he is looking at a different species. In this connection we might speak of another striking structural difference between males and females of many species, viz.: not only are the eyes of the males contiguous, but each eye is divided into a large upper portion and a small lower portion. The larvae or maggots feed upon vegetable matter, some

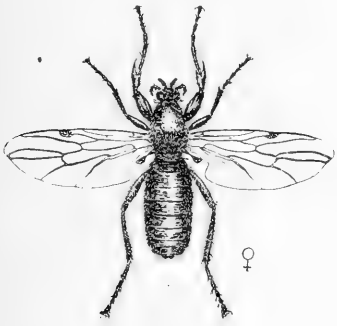


Fig. 57. *Bibio albipennis,* female. Original.

Fig. 58. *Bibio albipennis,* male. Original.

forms being particularly fond of roots of grasses. While they can hardly be regarded as pests, one species, *Dilophus febrilis,* the so-called Fever Fly, very common in Great Britain, causes serious injury to hops by feeding on the roots of the vines.

There are three hundred or more described species of the family, and they have a wide range, from Scandinavia to the tropics. Their range in time, or *geological* range, is not extensive, though they are more abundant in fossil form than any other insect. The writer has captured *B. albipennis,* Say, very commonly in Minnesota in May and June, and *B. pallipes,* Say, at Basswood Lake in June. *B. variabilis,*

NOTE.—In a few cases we have found specimens in the collection labeled South Dakota, not represented by species from this state. Since they are without doubt also found in Minnesota, though not yet taken here, we have included them with the Minnesota species; in every case, however, disignating them by the abbreviation, "So. Dak.," placed after the name.

Loew, has been captured at Lake Superior, and *Plecia heteroptera,* Say, is the fourth species recorded in this state. We also record *Dilophus breviceps,* Loew, So. Dak.; *Dilophus serraticollis,* Walk.; *Scatopse notata,* Linn. *Plecia heteroptera* is illustrated in color on Plate II.

SIMULIIDAE,

Black Flies, Buffalo Gnats.

These minute flies, belonging to the single genus, *Simulium,* are always more or less troublesome in summer to both stock and man in certain localities. Only the females "bite," but many of us can bear witness that each female can do enough mischief for two, and many a

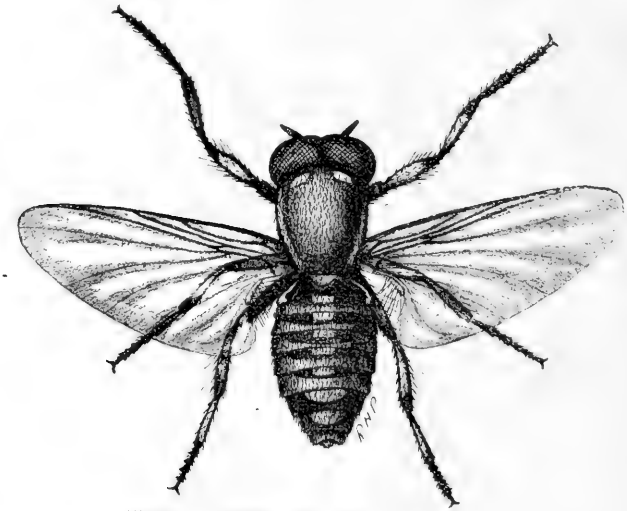


Fig. 59. *Simulium venustum,* male. Lugger.

would-be prospector, surveyor, or fisherman has returned in disgust from the woods, vanquished by the persevering hosts. A clot of blood generally marks the point of the creature's attack. Swarms of them frequently annoy horses during the spring plowing, and when, as sometimes occurs, they attack stock in enormous numbers, serious loss is occasioned. Cloudy weather discourages them, for, like the chinch bug, they want warm sunshine.

The perfect flies, that is, the imagoes or adult insects, are about one-eighth of an inch long, more or less downy or velvety, a "humped" thorax and the short antennae consisting of 11 joints. They breed in running water, hence they are particularly abundant in the northern part of Minnesota, where, for them, ideal summer conditions exist. The writer, in a trip to Labrador several years ago, found them unbearable a short distance from the coast, and was glad to flee back

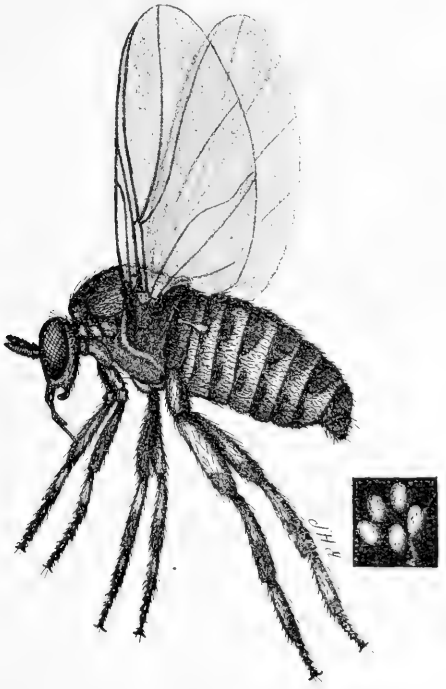


Fig. 60. *S. venustum*, female, and eggs. Lugger.

to the shore. They are nearly as bad, quite bad enough, in this state. In the northern part of Minnesota in ordinary seasons, they begin to be troublesome a little before the first of June. Oil of citronella, used as for mosquitoes, is effective as long as the skin is moist with the same. Louis Agassiz refers feelingly to their attacks, in "Lake Superior," and even such an enthusiastic coleopterist as E. A. Schwartz has been obliged to give up collecting insects in localities

where these pests abound. Countless other instances might be cited of man's inability to cope successfully with this tiny fly. It is not only a northern production, occurring often in Iceland, but is also found in the tropics of Africa and America. Through the southern part of the United States they are referred to as "Turkey Gnats" or "Sand Flies," and they sometimes cause very serious losses among stock, a fact which has already been referred to. The death of the afflicted animals is thought to be due to a poison left in the wound by the fly, said poison producing a disease which causes death very shortly. In 1884, in Franklin Parish, Louisiana, they killed 300 head of stock in a week. In 1874 the State of Tennessee alone lost as much as $500,000 worth of stock from attacks of these flies. Referring to their abundance in the South Dr. Lugger says, in one of his reports: "Nobody can realize the beauty of southern scenery who has not been there during plowing time and when the buffalo gnats were out in force. Just imagine a mule coated with stinking oil, or painted with mud or molasses, pulling a plow from which is suspended a tin pail containing a smudge, while the mule is further adorned by another tin pail suspended from his neck; the latter contains also glowing embers in which are produced such fine odors as can be made by burning leather and other similar substances." We have found *S. venustum,* fairly abundant and annoying stock in this State about the last of May (27th-30th).

My predecessor, in working up Minnesota forms, was evidently, according to his labels and his report for 1896, led into error, and multiplied the number of species occurring here. In other words, out of *S. venustum* he created *S. irritatum,* and *S. minutum,* and wrongly identified some specimens of *S. venustum* as *S. decorum,* Walker. This mistake was evidently first suspected by O. A. Johannsen of Ithaca, New York, and has been the subject of considerable correspondence between him and the writer. He has kindly cleared up the tangle, and unhesitatingly pronounces Lugger's specimens (imagoes) of *S. irritatum, S. decorum* and *S. minutum* to be *S. venustum.* His (Lugger's) *S. tribulatum* is *S. vittatum.* Therefore, in his Second Annual Report, 1896, Fig. 143 should be labeled *S. venustum* and not *S. minutum;* Fig. 144 is the same, not *decorum;* Fig. 145 is not *irritatum,* but *venustum,* as is Fig. 146, which Lugger also called *irritatum.* Fig. 147 on page 179 of his report is the larva of *S. vittatum,* not *tribulatum,*

as he has it. The same is true of Figs. 148, 149, 150, 151.

The following is a quotation from Dr. Lugger's Second Report. We omit references to his figures, which are, as we have said, erroneously labeled:

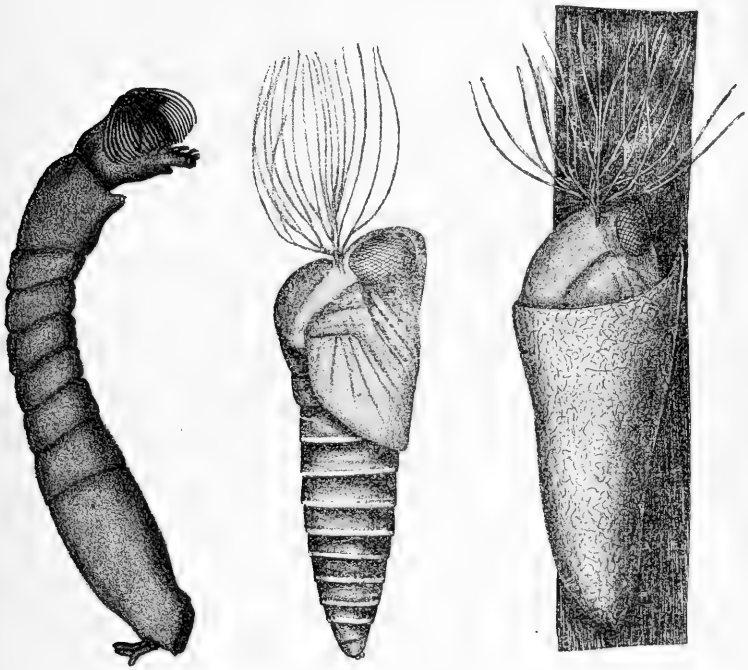


Fig. 61. *S. vittatum*, larva, pupa, and pupa in cocoon. Lugger.

"In our lake regions we find a large number of streams that flow over rocky bottoms, and are obstructed by floating grasses and other submerged plants. When we see a place in which the water flows more rapidly than in others, we can be certain to find there the early stages of buffalo-gnats. By investigating the plants that cause an obstruction, we find large numbers of larvæ and pupæ fastened to them. * * * This latter species (*S. vittatum*) is a great tormentor to humanity, and the proverbial patience of fishermen is severely taxed by their bites. In the northern part of Minnesota this species is called

the "black fly." Their bite is very severe, and the experience narrated by A. S. Packard would apply to this insect as well as to the one that tormented him in Labrador. In many places fishermen have to build smudges to drive away some of these tormentors. * * *

"All these insects have a very similar life history, and the one given will apply to all. Their peculiar larvae live in swift currents of creeks and rivers, where they feed upon very small aquatic animals, diatoms, desmids, etc. To obtain this food they are equipped with peculiar fans on their heads, which are constantly moving in the water, thus creating a current toward the mouth proper, and the material thus brought there is sorted by the other mouth-organs and either utilized or repelled. The larvae living in such a swift current anchor themselves by a peculiar sucking disk at the end of their body, and by a tough silken line, and are thus kept in position, which is an upright one, and one in which the face fronts the current. The larvae breathe by means of a peculiar organ situated near the tail, and the different species are distinguished by these breathing organs, which are either very simple or are quite complicated. Only one leg is found upon these strange looking beings, and this is found upon the first joint, yet by means of it and the sucking disk at the tail

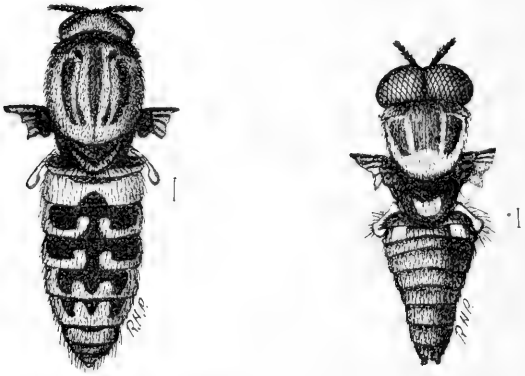


Fig. 62. *S. vittatum*, larger female, smaller male, to show markings. Lugger.

end of the larvae can move about like the well known measuring worms or geometers. Constantly feeding, these larvæ grow very rapidly, and are soon ready to transform into pupae. But before they can do so they have to construct some protection for the inactive pupae, otherwise this would be swept away by the current. They con-

struct for this purpose a neat little cradle-like house, made loosely of silk, and open at the top. This cradle is built against a stone, or upon submerged plants. In it the larva fastens itself by a little loose silk in the closed part, and now transforms to a pupa, and again removed from the cradle. But a great change has taken place, and the insect no longer breathes through an organ located near the tail, but by an entirely different one near the head. These breathing organs differ greatly in the different species, but are always composed of a number of fine threadlike tubes closed at the end, and which unite near the base in a larger tube that communicates with the interior tracheal system. Gradually the fly forms inside the pupa, and when ready to issue it leaves its old quarters, and popping to the surface like a cork runs over it, and flies off to the shore to harden its chitinous covering. Such larvae and pupae abound in all our northern streams, but only in places where there is a swift current. Here the eggs are also deposited, and mose frequently upon stones near enough to the surface of the water to be kept moist, or upon the projecting parts of submerged objects. The female is, in fact, able to dive, and can deposit her eggs even under water. These eggs are arranged in a very neat manner, and are usually white."

In 1822 Verdat wrote an interesting account of the escape of this delicate fly from the pupal case, below the surface of the water. According to this observer the pupal skin during the latter part of the pupal life becomes inflated with air, probably through the spiracles. It finally splits along the back, as is usual among insects, and the contained air emerges as a bubble. This bubble rises quickly to the surface, with the contained fly, which later escapes dry and uninjured. The body of the fly is covered with fine hairs, amongst which the air is imprisoned, the surface film of water pressing against the hairs, but not entering the spaces between.

Methods of Prevention:

Animals which have not shed their winter coats suffer more than those whose skin is smooth, since the flies can apparently get a better hold where long hair exists. Horses clipped in the early spring, therefore would not suffer as much as unclipped animals. Horses and cattle in darkened stables are not attacked. If a preventive is called for on a working team, fish oil or fish oil with a little kerosene

added (one part kerosene to three of fish oil) applied about once a day, would be of benefit; or grease with a few drops of carbolic acid mixed with it. Many repellants are devised and sold, the application of many of them being almost as bad as the attack of the insect, and almost none of them effective where the flies are very numerous. Fishers and hunters sometimes use a mixture of kerosene oil and mutton tallow, greasing the exposed parts with the same. Oil of tar is also used, and a number of others too numerous to mention. One repellant sold some years ago under the name of "Black Fly Cream," and made in Portland, Maine, is said to be good. In anointing animals with the various strong smelling oils, one must use care not to use machine oil or other strong oils, the repeated applications of which are apt to remove the hair. Smudges are resorted to, not only for stock, but also in tents in the woods, and even in houses in localities where black flies are bad. The Hudson Bay Company used to burn pyrethrum powder (Persian or Dalmatian insect powder) in houses and stores, and Dr. Lugger claims to have used this successfully in his trips into the timber.

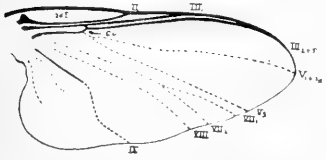


Fig. 63. Wing of Simulum, much enlarged. After Comstock.

Minnesota species as far as collected are as follows: *S. vittatum*, Zett.; *S. venustum*, Say; *S. irritatum*, Lugger; Lugger; *S.* (?) *invenustum*, Walker; *S.* (?) *pecuarum*, Riley. Williston in 1896 stated that this family was represented by about 75 species. At least one of these, *S. innoxium*, is not known to suck blood. There are about 25 species of this interesting family in North America.

TABANIDAE.

Variously known as Horse Flies, Breeze Flies and Gad Flies; these two latter terms being also applied to *Oestridae*. Some, which are found particularly in the timber, affecting deer and moose, are called "deer flies"; some of them we refer to as "green heads".

To fit these flies for their parasitic habit of preying upon quadrupeds, Nature has equipped them with powers for extremely rapid flight, and they can easily overtake the fastest deer or horse. It

has even been said of them that some can fly faster than an express train at full speed.

Fig. 64. *Tabanus lineola,* Fab., "Green Head", Lugger.

Both males and females are found on flowers, the males confining themselves to a diet of nectar, and never biting, the females only resorting to the sweets offered by flowers when blood cannot be obtained. They not only infest quadrupeds, but many of them do not scruple to attack man, as many of us know to our cost. Warm weather and bright sunshine appear to be the conditions most conducive to their activity, and they are, as a rule, more numerous in the vicinity of low and marshy places, prairie country for instance, because the adults appear to be especially fond of water, and their brownish or

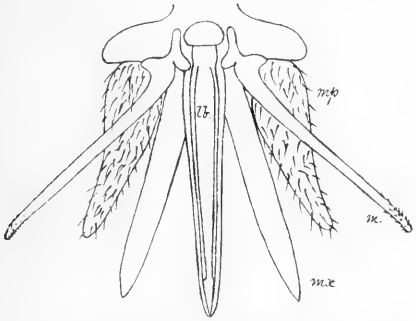


Fig. 65. Mouth parts of *Tabanus,* greatly enlarged. Lugger.

Fig. 66. Larva of *T. atratus.* After Riley.

black eggs are deposited either on stems or leaves, in the case of those whose larval life is passed on land; or upon reeds in the water

in the case of aquatic forms. Pine woods, too, seem to attract them. Some forms of larvae are said to live in rotten wood. The larvae are always carnivorous, feeding on snails, or the early stages of insects, thus offering something of a compensation for the mischief caused by them as adults. Not only are the attacks of *Tabanids* exasperating to both man and beast, but it is quite possible, even probable, that they may transmit disease, by biting a well animal after having fed upon the blood of some infested creature. They are probably active agents in distributing the disease known as "anthrax."

The writer was appealed to for help last summer by a mail carrier in the northern part of the state, who had to discontinue carrying mail on account of the attacks of *Tabanidae* upon his horses. Nets or light covers are, of course, a protection, particularly the latter.

There are in the entire world, according to Williston, about 1,400 or over (probably at least 1,500) known species belonging to this family. Over 150 of these are American. Tabanus alone, a very common genus, has more than 100 species in America, and there are at least 50 North American species of the genus *Chrysops*. Reinwardt's Breeze Fly (see illustration) is very common in our prairie country. Dr. Lugger speaks of them as so numerous on a window

Fig. 67. *Chrysops aestuans*. Lugger.

pane in a small rural station on the prairie as to obscure the light, and upon the bench below the window he counted 2,117 flies.

Where nets or light coverings cannot be used, anointing the horses with repulsive ointments, such as fish oil, or fish oil and tar, would be of benefit. Care should be taken never to use machine oil for this purpose, as the results of its use are disastrous to the hair.

Tabanus atratus is parasitized by a tiny four-winged fly, known as *Phanurus tabanivorous*, Ashm.

Some members of the genus *Chrysops* (see Fig. 67 and also Plate I) appear to direct their attacks to the region about the eyes and ears of stock. Horses' ears may be protected by nets, or the ears and skin about the eyes may be smeared with the following solution: Pine tar one gallon, kerosene or fish oil, or crude carbolic acid one quart; powdered sulphur two pounds. This mixture, also, applied to wounds made by barbed wire or otherwise, will keep off flies which might otherwise lay their eggs in same.

Fig. 68. *Tabanus reinwardtei*. Lugger.

The larva of one species of *Chrysops* is said to eat plant lice.

Species taken in Minnesota are: *Chrysops obsoletus*, Wied.; *C. celer*, O. S.; *C. aestuans*, V. d W.; *C. univittatus*, Macq.; *C. vittatus*, Wied; *C. pilaris*, O. S.; *Tabanus giganteus*, De G. Plate II; *T. atratus*, Fab.; *T. reinwardtii*, Wied.; *T. lineola*, Fab.; *T. lasiophthalmus*, Macq.: *T. trispulis*, Wied.; *T. phaenops*, O. S.; *T. orion* O. S.; *T. centron*, Mart.; *T. costalis*, Wied., Plate I, and *T. rhombicus*, O. S.; *Silvius quadrivittatus*, Say So. Dak. *Pangonia tranquilla*, O. S.; *Chrysops sordidus*, O. S.

STRATIOMYIDAE.

Soldier-Flies.

As children, and the same is, in a measure, true of us as adults, we always ran to obtain a glimpse of the bright uniforms of soldiery. Some such thought must have inspired the naturalist who first called the members of this family "Soldier-Flies," for while some are of modest colors, many show most brilliant and striking features in this direction—yellow and black, or black and green being the most striking combinations, while uniform metallic greens and blues are extremely common. While the smaller species are active, the larger varieties are noticeably slow. They can be picked from flowers by the hand, and make no effort to escape. On June 12th, at St. Anthony Park, within half an hour the writes collected from the flowers a Ninebark bush, *Physocapus opulifolius* which stood in the hot sun, over fifty specimens of this family, representing nine different species. They were exceedingly abundant, and twice that number could readily have been obtained. This bush, a near relative of the golden leaved Spirea, has apparently a great attraction for many flies, as well as Hymenoptera, since member of other families, *Muscids, Sarcophagids, Syrphids* and *Stratiomyids*, were swarming about the newly opened flowers.

Fig. 69. A characteristic Stratiomyid wing. After Comstock.

This family is a large one, about 1,000 or more species being known. In the more typical forms the abdomen is broad, and more or less flattened. The venation of the wing is a most striking characteristic (see illustration). The adults are flower lovers. They lay their eggs on the ground, on aquatic plants, and possibly on the water. The larvae feed either upon small animals or upon vegetable matter. The larvæ of one species has been found in cow dung and under stones, and another larval form occurs in the sap of elm trees, still another

Fig. 70. Flies attracted to "Nine Bark" bush. Original.

in privies; two others in decaying wood and in moss respectively. Many, however, both in the larval and pupal stages occur in water, some even being found in water that is salty or alkaline. Some have even been discovered in a hot spring in Wyoming, where the water was so warm as to render it impossible to keep one's hand in it. We figure the larva of one species in two positions, to show the method of locomotion in water, and also the coronet of filaments at the posterior end

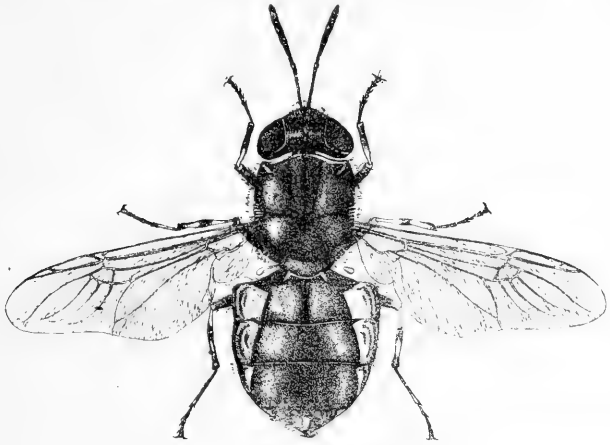


Fig. 71. *Stratiomyia discalis.* Lugger.

of the body, which is in part at least, of use in respiration, in that it can include in its mesh a bubble of air, and take this bubble below the surface. The larva figured can creep on earth, or on mud. Limbs are not present. One larval form, *Hermetia illucens*, has been found in the intestine of man, and has also been bred in Irish potatoes. Doubtless its occurrence in the human intestine is due to the eating of uncooked vegetables, such as lettuce, upon which the larva may be living. Maggots of this form are also found in catsup exposed to the air, and their occurence in barrels of catsup has been explained on the ground that the females lay their eggs in the material oozing through the cracks in the barrel, and the small

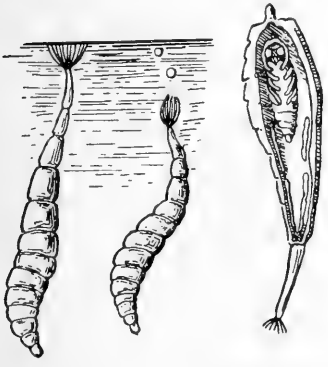


Fig. 72. A Stratiomyid larva, on left, floating at surface of water. Middle figure, larva descending. On right, larva within pupal skin. After Swammerdam.

maggots can work their way through these cracks. Such material is best kept in sealed bottles. Several members of this interesting family occur in Minnesota. The writer has taken the following species in this state.

Stratiomyia barbata, Loew; *S. badia,* Walker; *S. discalis,* Loew, Fig. 8, Colored Plate II; *S. limbata,* Loew; *S. meigenii,* Wied.; *S. picipes,* Loew; *S. normula,* Loew; *Sargus viridis,* Say, Fig. 1, Colored Plate I; *Allognosta fuscitarsis,* Say; *Nemotelus unicolor,* Loew; *N. nigrinis,* Fall.; *N. uliginosus,* Linn.; *Actina (Beris) viridis,* Say, Fig. 73; *Microchysa polita,* Linn.; *Odontomyia cincta,* Oliv., Fig. 7, Colored Plate I; *O. vertebrata,* Say; *O. truquii,* Bell; *O. flavicornis,* Oliv. There also occur in Minnesota as shown by labels on specimens in our collection *Odontomyia binotata,* Loew, female shown in Fig. 3, Plate I; *O. inaequalis,* Loew.; *O. nigrirostis,* Loew.; *O. interrupta,* Oliv.; *O. pilimana,* Loew.; *O. intermedia,* Wied.; *Sargus decorus,* Say, Fig. 4, Colored Plate II; *Euparyphus bellus,* Loew; *Hylomyia pallipes,* Loew.

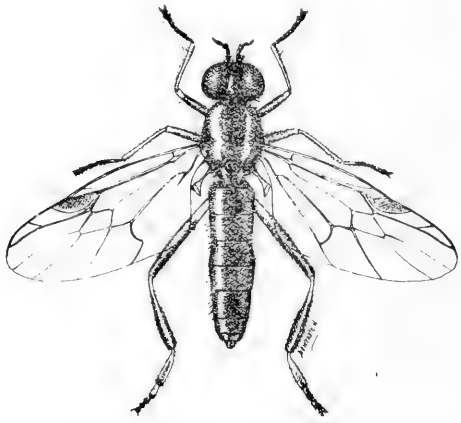


Fig. 73. *Actina (Beris) viridis.* Original.

ACANTHOMERIDAE.

A small family containing only fifteen or sixteen species, about five of which occur in North America, contained in two genera found only

in America, including the largest representatives of the Diptera, some of them being nearly two inches long. Most of these flies live in Central and South America, where it is said they are found in forests, on trunks of trees. But little is known of their habits.

As might be expected, we have not met with any representatives of this family in Minnesota.

LEPTIDAE,

Snipe-Flies.

The name "Snipe-Flies" is given to this family on account of the somewhat long legs, tapering abdomen, and occasionally a long proboscis or "beak" pointing downward, suggesting a fanciful resem-

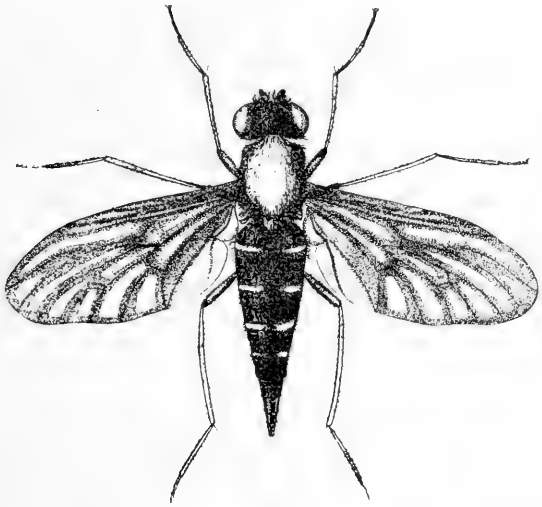


Fig. 74. *Chrysophila thoracica.* Lugger.

blance to the birds of this name. They do not all, however, have these somewhat superficial characters. Some of these flies are quite large, *Coenomyia ferruginea*, for instance, Fig. 2, Colored Plate II, is from three-quarters of an inch to one and one-half inches in length; *Chrysopila thoracica*, a strikingly handsome fly, shown in color Fig.

4, Plate I, and in Fig. 74 is at least an inch long. The old families *Xylophagidae* and *Coenomyidae* are now included here.

Fig. 75. *Leptis mystacea,* female. Lugger.

The snipe flies are found in fields, on tall grass or bushes, and in woody places, generally when resting having the head down. In

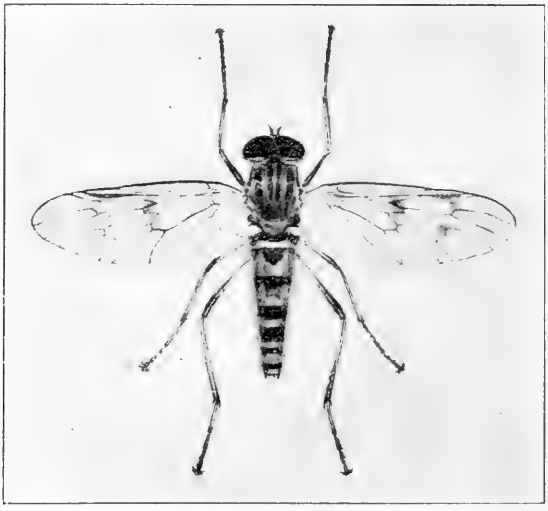


Fig. 75a. *Leptis mystacea,* male. Original.

the adult form some are predaceous, and the larvæ of all species live in the earth and in decaying vegetation or in water, and prey upon

other animal organisms. One form, according to Williston, lays its eggs on the sand, and the larvæ form conical pits therein for the purpose of capturing other insects. Aldrich (1905) gives about 120 species as occurring in North America. The females of an exotic species, *Atherix ibis,* lay their eggs in a common mass on a twig over water, die as they do so, until, according to Sharp, the mass may include thousands of individuals; ultimately it falls into the water.

Minnesota species as far as collected by this department are: *Chrysopila quadrata,* Say; *C. fasciata,* Say; *C. ornata,* Say; *C. proxima,* Walk.; *C. thoracica,* Fab., shown in color as Fig. 4, Plate I, and also in text; *Xylophagus rufipes,* Loew; *Atherix variegata,* Walk.; *Coenomyia ferruginea,* Scop., Colored Plate II, Fig. 2; *Xylomyia farcus,* Will.; *Leptis ochracea,* Loew; *L. punctipennis,* Say; *Leptis mystacea,* Macq., Fig. 17, Plate I, also shown in text. There are doubtless others not yet met with.

ACROCERIDAE=CYRTIDAE,

Small-headed Flies.

The writer has not met with these flies in this state. They have a strikingly small head, a prominent humped thorax, and a large

Fig. 76 and 77. *Opsebius pterodontinus,* dorsal and side view. Lugger.

abdomen. Some have very large proboscids, sometimes longer than the body. These feed upon flowers, others take no food in the adult

stage. Williston states that the larvæ, so far as known, are parasitic upon spiders and their cocoons. Aldrich, who, by the way, retains the name *Cyrtidae* for this family, lists forty-two species for North America. We figure *Opsebius pterodontinus,* O. S., to illustrate the family.

NEMISTRINIDAE,

Tangle-Vein Flies.

Not met with in Minnesota. Sharp and Williston state that about 100 species occur in this family, widely distributed. Aldrich, in his catalogue for 1905, mentions only six species as occurring in North America. The veins of the wings of these flies unite in such a complex manner as to give to the group the name "Tangle-Vein Flies."

ASILIDAE,

Robber-Flies.

These rapacious and really useful flies prey upon insects weaker than themselves, carrying off bodily flies, wasps, and even beetles and

Fig. 78. *Cyrtopogon bimacula.* Original.

large grasshoppers, to be killed and devoured. Williston reports having observed a female seize and carry off a pair of her own species.

Their prey is always taken upon the wing, and their appetite is evidently hard to satiate, one individual having been observed to kill eight moths one after the other.

They vary in size from one-third of an inch or smaller to species two inches or more in length. Our illustrations give an idea of the difference in appearance between some of the species. *Cyrtopogon bimacula,* Walk., Fig. 78, is nearly an inch long, the general color being black, the wings clear with black markings; *Dasyllis thoracica,* Fab., Fig. 79, is shiny black, with a profusion of yellow hairs on the thorax, and on the head between the eyes. Fig. 80 illustrates one of the more delicate forms, *Stichopogon trifasciatus,* about two-thirds of an inch long, head and thorax pearl, abdomen black with pearl colored lines where the segments meet, and a broad band of the same color on the fourth abdominal segment. *Promachus vertebratus,* Say, Fig. 81, one of our largest species, and very common, the writer has seen flying off over a wheat field with a good sized grasshopper in its grasp. *Laphria sericea,* Say, is shown in color, natural size, as Fig. 21, Plate II; *Dasyllis sacrator,* Walk., Fig. 10, Colored Plate II, looks something like a large bumble bee. All the above species occur in

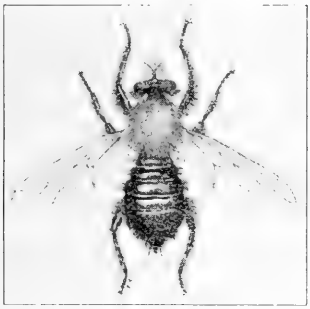


Fig. 79. *Dasyllis thoracica.* Original.

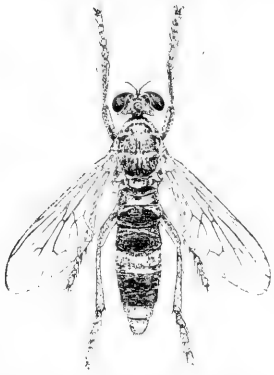


Fig. 80. *Stichopogon trifasciatus.* Original.

Minnesota, as does also *Proctocanthus brevipennis,* Wied., which looks something like a small edition of *P. vertebrata; P. milbertii,* Macq.; *Tolmerus notatus,* Wied.; *Erax rufibarbis,* Macq., and *E. aestuans,* Linn.; *Cyrtopogon falto,* Walk.; *Taracticus octopunctatus,* Say; *Leptogaster incisuralis,* Loew.; *L. flavipes,* Loew. Several other species belonging to the genus *Asilus* are yet to be named.

The larvæ, also carnivorous, occur in rotten wood and other vegetable matter, such as decomposing leaves and in the soil. Eggs are laid in the soil or in rotting trees, the latter place doubtless being chosen because such a locality abounds in the larvæ of other insects. Aldrich (1905) lists 552 species in North America alone, a very few of them being of doubtful authenticity, while Williston and Sharp state that there are something like 3,000 described species of Robber Flies in the world.

Fig. 81. *Promachus vertebratus.* Original.

These insects may be seen upon the ground or upon the foliage of trees. When disturbed in the former position they rise quickly, making a sharp buzzing sound, and light again a short distance beyond. The members of this family unite in having a firm, horny proboscis, adapted for piercing their victims, either pointing forward or directed downward.

MYDAIDAE.

Mydas-Flies.

Large flies, the largest of the North American Diptera, resembling the Robber Flies superficially. The adults, like those of the preceding family, are predaceous. The larvæ live in decaying wood, and some, like the larvæ of the *Asilids*, prey upon the larvæ of beetles. About 100 species are known, many of which occur in Australia and Africa. *Mydas clavatus,* Drury, a striking species (see Fig. 15, Colored Plate II), has been taken in Minnesota. The colored drawing represents the natural size of the fly.

APIOCERIDAE,

Apiocerids.

Not found in Minnesota; only about twelve species known in the entire world. A small family; the species found in the far West and in Australia and Chili. They are flies of considerable size, elongated, and frequent flowers. Aldrich lists seven species as occurring in North America.

BOMBYLIIDAE,

The Bee Flies.

A populous family, many of the individuals common in Minnesota, and striking, in that they have a habit of hovering before blossoms, darting from one to the other with characteristic quickness, inserting their long proboscids (the *Bombyliides* division) into the flowers for the nectar and pollen contained therein. They are fond of bright sunshine, and are frequently seen resting on the ground in sunny places. They are, for the most part, medium sized, but some are small and some quite large. Some resemble in coloration small bees, the body being fringed with down, or partly covered with hair. Others, unlike these, are characterized by striking markings on their wings. One rather peculiar form found in Minnesota, *Systropus macer* (Fig. 82), resembles somewhat a delicate wasp.

Fig. 82. *Systropus macer.* About three times enlarged. Original.

The family is, to a certain extent, a useful one, in that the larvæ of some species are parasitic in the egg sacks of grasshoppers and locusts, and in the larvæ and pupæ of butterflies and moths, as well as some hymenopterous insects. Out of 1,500 or more species occurring in this populous and widely distributed family, about 460 are natives of North America.

The following is a list of those met with so far in this state: *Bombylius major,* Linn., Fig. 85; *B. pulchellus,* Loew; *B.* (?) *validus,* Loew; *B. varius,* Fab.; *B. atriceps,* Loew; *Spogostylum oedipus,* Fab.;

S. limatulus, Say; *S. simson,* Fab.; *Systoechus vulgaris,* Loew.; *Sparnopolius fulvus,* Wied.; *Systropus macer,* Loew; *Exoprosopa decora,* Loew, Fig. 17, Colored Plate II; *E. capucina,* Fab.; *E. fasciata,* Macq.; *Anthrax alternata,* Say; *A. ceyx,* Loew; *A. halcyon,* Say; *A. sinuosa,* Wied.; *A. tegminipennis,* Say; *A. agrippina,* O. S.; *A. fulviana,* Say; *A. lateralis,* Say; *A. consessor,* Coq.; *A. hypomelas,* Macq.; *A. costata,* Say; *A. fulvorhirta,* Wied.; *A. fenestratoides,* Coq.; *Argyramoeba oedipus,* Fab.; *Systoechus candidulus,* Loew.; So. Dak.; *Phthethiria sulphurea,* Loew; Lugger speaks also of *Systoechus oreas,* Fig. 83 in text, occurring in Minnesota among the egg masses of locusts, though we find no specimens in the collection. It is believed by many

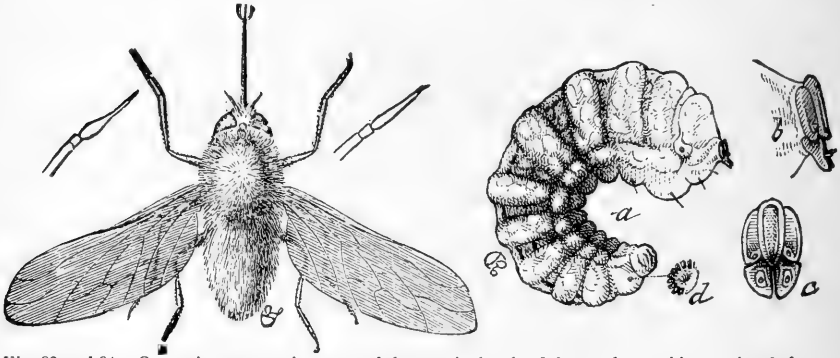


Fig. 83 and 84. *Systoechus oreas,* imago and larva; *b,* head of larva from side; *c,* head from front; *d,* preanal spiracle. After Riley.

that *Bombyliids* do not use their proboscids for anything but sipping nectar or gathering pollen, but the writer has been quite severely "bitten" by them, and his experience was duplicated by Dr. Lugger, who says, in discussing this useful parasite, on page 43 of the Third Annual Report, speaking of the above species: "This proboscis can be used for other purposes than sipping nectar, as the writer found out to his sorrow, when he attempted to catch some of them with his hand and succeeded. Violent pain, a swollen finger and added knowledge were other results of the catch not bargained for." He further says in the same connection: "Early in August these flies (*S. oreas*) were exceedingly numerous, hovering in the air, and keeping their wings in such rapid motion that they cannot be distinguished, and appear like a haze surrounding the body of the insects.

When disturbed these flies will dart away with wonderful speed, to remain stationary in the air in another spot. These bee-flies, although possessing a blackish grey ground color, are so densely covered with pale yellow hairs that this color is entirely hidden. This hair is so long that the outlines of the insects are obscured, and they resemble on this account, very small bumble-bees."

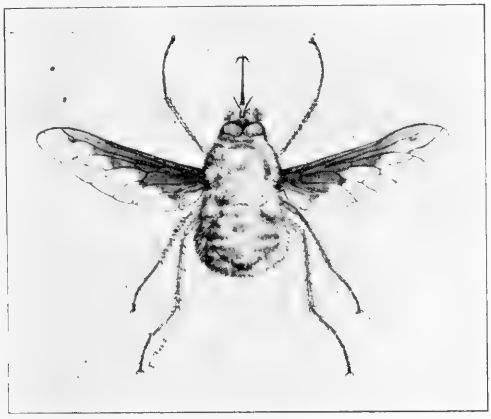


Fig. 85. *Bombylius major.* Original.

Systropus macer, Loew, Lugger has reared from Limacodes in Minn.

THEREVIDAE.

Stiletto-Flies.

Possibly named from a fanciful resemblance to a stiletto; the head is somewhat broad and the abdomen long and tapering. They resemble somewhat some *Asilids.* We illustrate *Thereva senex,* Fig. 86, and *T. frontalis,* Fig 15, Colored Plate I, both taken in Minnesota.

The family is a small one, predaceous in the adult and larval forms upon insects in the young stage, probably feeding upon vegetable matter also; the larvæ of some species found in rotten wood.

There are not more than 200 species of this family known over the entire world; of these 71 species occur in North America.

Minnesota species so far captured: *Thereva frontalis,* Coq.; *T. senex,* Walk.; *T. duplicis,* Coq.; *Thereva,* sp.; *Psilocephala haemorrhoidalis,* Macq.; *P. limata,* Coq.; *P. munda,* Loew.

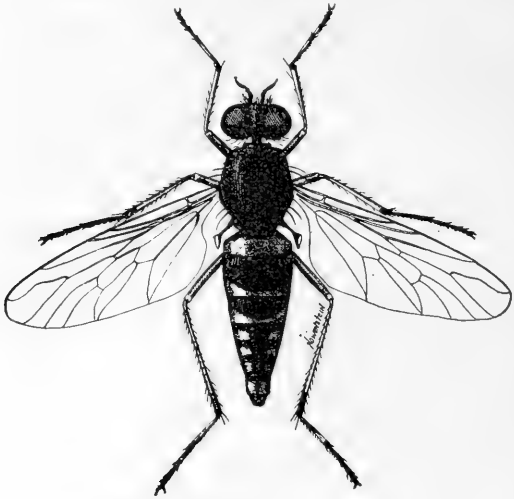


Fig. 86. *Thereva senex.* Lugger.

SCENOPINIDAE.

The Window Flies.

So called because very frequently found in windows, but, as Comstock very well puts it in his Manual, "the conclusion that these are

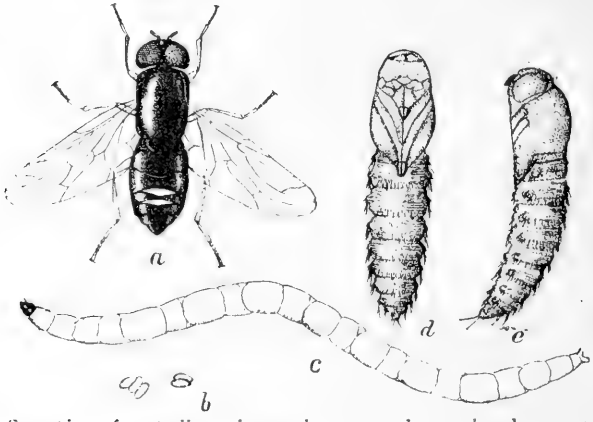


Fig. 86a. *Scenopinus fenestralis, a,* imago; *b,* eggs; *c,* larva; *d* and *e,* pupa. Lugger.

the most common flies found on windows should not be drawn from the name." House flies, various *Anthomyiids, Sarcophagids,* and members of various other families, are commonly seen on windows, many of them, to the uninitiated, looking as though they belonged to the same species, although they may be representatives of different families. We only have about ten *Scenopinid* species in North America.

The adult flies of this family are black; the long, slender larvæ are found in decaying fungi and in wood. They are supposed to be carnivorous.

Scenopinus fenestralis, Linn., is found in Minnesota.

EMPIDAE or EMPIDIDAE,

Dance-Flies.

This is a large family, Aldrich giving 432 species as occurring in North America alone, and about 200 species are known in Great Britain. They are medium sized flies of dull colors, brown, gray or black. The legs are long, sometimes hairy, and most of the species have a pointed beak. They are predaceous, preying upon smaller flies and other insects, the female being particularly savage, and using her rostrum, or beak, for piercing and sucking her victims. They are also found on flowers.

In one genus, *Hemerodromia,* the femurs of the front legs have spines against which the fore tibiæ close. This contrivance evidently serves the purpose of a trap. The flies of this family are well referred to as "Dance Flies," since some species perform quite extensive ærial gymnastics, and are often seen in this act near shrubbery or over brooks. In these dances some are said to carry silken veils or nets. These webs or nets may assist in capturing other insects, and may also be of use in courtships.

The following clipping from the Elgin (Minn.) *Monitor* probably refers to flies of this family.

A SINGULAR PHENOMENON.

A singular phenomenon was witnessed about town Tuesday afternoon when Frank Adams, who was sitting in his wheel chair on the lawn at his home, discovered that the air was literally full of delicate white silvery webs. He called the attention of a number of our citizens to it, who witnessed the same

phenomenon. The tops of buildings and trees were literally covered, and fleecy white masses were seen floating in the air, hundreds of feet above the highest trees.

By constant observation, Frank discovered that the air was infested by myriads of little flies, but with bodies much smaller than the bee, and of an exquisite pure downy white, and that these little insects were spinning millions of delicate silvery white webs, not only enveloping the earth, but filling the air as far as eye could reach with a silvery sheen. Frank captured a number of the flies, but could find no one who could tell him anything about them. It is not infrequent to find the plants, trees and shrubbery, of a morning, covered with tiny spiders' webs, but to see the myriads of little flies spreading their delicate laces over the surface of the earth, is at least an interesting experience.

The maggots are found in decaying vegetable matter, though it is possible they feed upon other animal matter found there.

We have found the following species in Minnesota, which list, however, probably only represents a fraction of what occurs here: *Hybos,* sp.; *Rhamphomyia,* sp.; *Hilara,* sp.; *Rhamphomyia luteiventris,* Loew.; *R. debilis,* Loew.; *R. irregularis,* Loew.; *R. priapulus,* Loew.; *R. pulla,* Loew.; *R. limbata,* Loew.; *Hilara macroptera,* Loew.; *Syneches thoracicus,* Say; *S. pusillus,* Loew; *Euhybus,* sp.; *Syndyas polita,* Loew.; *Empis nuda,* Loew.; *E. otiosa,* Coq.; *Platypalpus crassifemoris,* Fitch; *Platypalpus,* sp.; *Hemerodromia empiformis,* Say; *H. rogatoris,* Coq.

DOLICHOPODIDAE,

The Long-legged Flies.

Another large family, 380 North American species being listed by Aldrich. Great Britain claims over 200 species. Referring to the above scientific name, Comstock fittingly remarks: "It must be remembered, however, that these flies are long-legged only in comparison with the allied families, and not in comparison with crane flies and midges. They are rather delicate, slender insects, for the most part, with metallic coloring, golden or green, and the males of some of the genera characterized by the expansion of the feet, or antennæ or other organs, which are probably to be regarded as ornaments used in courtship."

Aldrich, in speaking of this family, and referring to the great variety and complexity of the sexual adornments of the males, says

that "probably three-fourths of the species offer well marked peculiarities that distinguish the males at a glance." In the *American Naturalist*

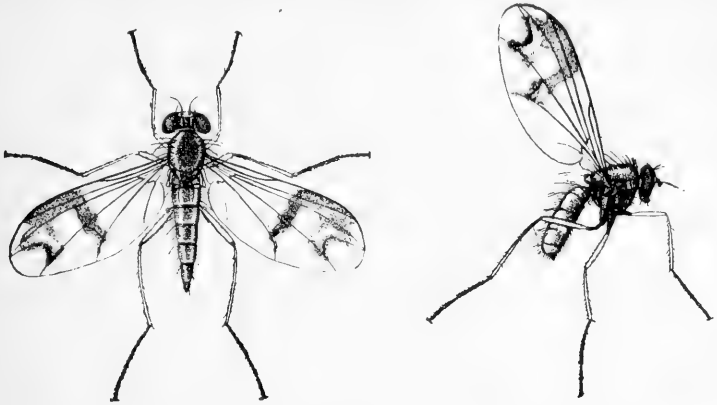


Fig. 87 and 88. *Psilopodinus sipho*, male and female. Lugger.

for 1894 he describes the courtship of a species of Dolichopus, which he observed. It is so interesting, as throwing some light on the habits of this large family, and possibly upon the use of the adornments above mentioned, that we quote him in full:

"I observed in September the maneuvers of the male in courting the female. He would place himself directly in front of her, at a distance of about half an inch, with his face toward her. He would then rapidly vibrate his wings, holding them horizontally, at right angles to the body, and at the same time would give these fore feet an up-and-down motion, raising them simultaneously above the level of the head and bringing them down with a slight force upon the ground, the movement recurring in a measured way in about half a second. This he would continue for some ten seconds; then, rising on the wing, he would swiftly make a small semicircle in the air and attempt to alight upon the female. In the large number of cases that I observed, he was always unsuccessful, the female hastily moving away a few inches, when the male would usually alight before her and repeat the movements just described. On account of the numbers engaged in this occupation on the same small area, I could not be certain that the same male always attended upon a given female; but there can be no doubt that the females are exceedingly slow to accept the males, for I saw the above maneuver repeated hundreds of times with the same result.

"In company with the species just mentioned occurred considerable numbers of a species of Hygroceleuthus, which I have referred to (Kans. Univ. Quarterly, II., 24) as a variety of *H. crenatus*, O. S. These were engaged in

a similar occupation. The male of this species has only plain tarsi, but differs from the female in having the antennal joints longer, the first two with coarse black hair, and the arista of the third short and heavily covered with black pubescence; the face is also longer, the wings broader, and the cilia of the

Fig. 89. Ornamented tarsus of a Dolichopod. Original.

tegulae, instead of being coarse and chiefly black, are fine and white. The male hovers in the air before the female at a distance of one or two inches occasionally making a slight darting motion toward her. In this position the peculiarities of his face and antennae are shown to the best advantage. The breadth of the wings is probably an advantage only in facilitating this hovering process, and the structure of the tegular cilia may possibly be accounted for by supposing that it is simply in compensation for the increased growth of the wings. This male, after hovering a few seconds, describes a semicircle in flight and attempts to alight upon the female as in the foregoing species, and with the same results. I observed the copulation only once, and then did not see the preliminaries.

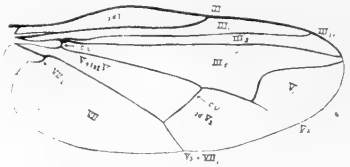


Fig. 89a. Wing of Dolichopod. After Comstock.

"In this connection the observations of Fr. Dahl (Zool. Anzeig., April, 1889) on another species of Dolichopus are of interest. I translate from a quotation in an article by Dr. W. M. Wheeler (Proc. Wis. Nat. Hist. Soc., April, 1889, p. 209), which mentions a somewhat similar habit in a gall-gnat (*Asynapta antennariae*, Wheeler).

" 'The male species of fly, *Dolichopus plumipes*, possesses on first tarsal joint of the middle legs a beautiful, regular fringe, the purpose of which is not immediately perceptible, as the flattened hairs could not possibly serve to grasp the female. I have now observed the pairing of these insects, and am convinced that the structure serves as an actual ornament to the male, like the highly developed tail-feathers, etc., of a male bird. The male came flying up, and hovered for a time so close over the quietly resting female that the fringed tarsi hung down immediately before her eyes. After some time copulation was attempted, but the female at once showed unwillingness. Only after repeated attempts did he succeed in gaining her acceptance.' "

Individuals of this family are extremely abundant in this state, and offer an interesting group for study. Our species range in size from

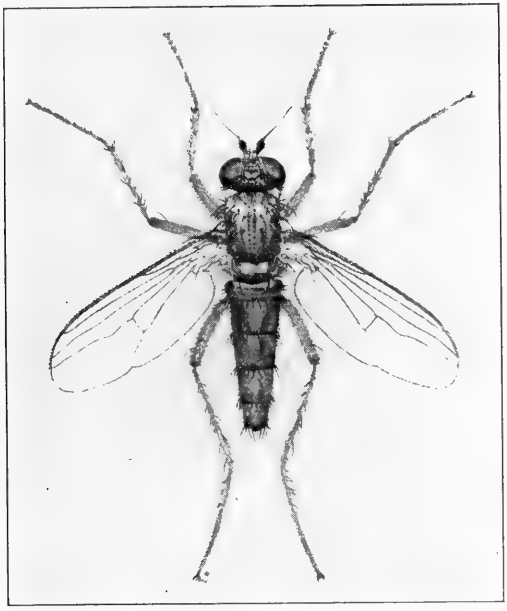


Fig. 90. *Dolichopus flagellitenens.* Original.

one-fifth to three-quarters of an inch in length. They are predaceous, usually found more abundantly in damp places where rank growth occurs, although many species are found in dry places, in flower gardens and elsewhere. The larvæ live in putrifying vegetable matter or in earth; some are found in sap under the bark of trees. Some of the larvæ may be carnivorous.

The following species have been taken in Minnesota: *Dolichopus ovatus,* Loew; *D. flagellitenens,* Wheeler; *Psilopodinus patibulatus,* Say, Fig. 19, Colored Plate I; *P. scobinator,* Loew.; *Dolichopus splendidus,* Loew.; *D. cuprinus,* Wied.; *D. lobatus,* Loew.; *D. bifractus,* Loew; *D. ramifer,* Loew; *Psilopodinus caudatus,* Wied.; *P. sipho,* Say; *Agonosoma filipes,* Loew; *A. scintillans,* Loew; *Dolichopus latipes,* Loew, So. Dak.; *D. dakotensis,* Ald.; *D. longimanus,* Loew;

Pelastoneurus vagans, Loew, So. Dak.; *Liancalus hydrophilus,* Ald., So. Dak.; *L. genualis,* Loew; *Scellus, sp.; Neurigona carbonifer,* Loew.

LONCHOPTERIDAE,

Spear-winged Flies.

Very minute, brownish flies, with apex of the wings pointed, suggesting a spear head. There are no cross veins in the wings. Although there is but one genus in this family, the individuals are common, and to be seen all summer in damp places, along shady brooks and elsewhere. The maggots live on the ground under vegetable matter. Three species only occur in North America.

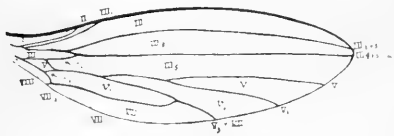


Fig. 91. Wing of a Spear-winged Fly. After Comstock.

SYRPHIDAE,

Syrphus-Flies.

This is an enormous and most interesting family; over 700 known species occur in North America, and we list 56 species in Minnesota. There are probably at least 3,000 species over the entire world. For the most part they are of moderate or large size, some of the Minnesota species being an inch or more long, while on the other hand some are quite small. Some are thickly covered with hair, and so marked as to bear a close resemblance to bumble bees; others so cleverly imitate honey bees or wasps, barring the absence of the second pair of wings, that the tyro is completely deceived. Black and yellow are the predominating colors, the abdomen being frequently banded with the latter color.

They are found everywhere, in garden, field and wood, frequently seen darting from flower to flower or leaf to leaf, ready to oviposit amongst the plant lice found thereon, which lice later afford food for the Syrphus maggots hatching from the eggs. Or, as in the case of some species, they frequent the neighborhood of filthy water, their

larvæ living in the filth of the barn yard or privy. Particularly is this true of *Eristalis tenax*, whose larva is commonly known as the Rat-tailed Maggot, a name proposed by Reaumur years ago, and still retained. This species lives in foul pools wherever decaying organic

Fig. 92. *Syrphus ribesii*. Original.

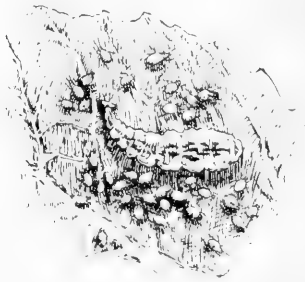


Fig. 93. A Syrphid larva feeding on plant lice. Original.

matter is present. In this maggot the so-called "tail" is a tube used in respiration, and capable of being extended to the surface of the water for that purpose. The adult *Eristalis* resembles a bee so closely that the ancients, seeing swarms of this genus coming from the putrifying carcasses of oxen, believed that bees could be produced from such dead bodies. Ovid, Virgil and other ancient writers, by their works, gave color to this belief, but Florentinus, a Byzantine author of about the tenth century A. D., gave the most explicit directions for producing bees from such sources, and Osten Sacken translates his statements as follows:

"Build a house, ten cubits high, with all the sides of equal dimensions, with one door and four windows, one on each side; put an ox into it, thirty months old, very fat and fleshy; let a number of young men kill him by beating him violently with clubs, so as to mangle both flesh and bones, but taking care not to shed any blood; let all the orifices, mouth, eyes, nose, etc., be stopped up with clean and fine linen, impregnated with pitch; let a quantity of thyme be strewed under the reclining animal, and then let windows and doors be closed and covered with a thick coating of clay, to prevent the access of air or wind. Three weeks later let the house be opened, and let light and fresh air get access to it, except from the side from which the wind blows strongest. After eleven days you will find the house full of bees, hanging together in clusters, and nothing left of the ox but horns, bones and hair. When the shed is opened, small white animalcules are seen, resembling each other, motionless; then they are observed to grow little by little, to develop wings,

and to take the color of bees; the wings are at first short and tremulous, unfit for flight; the limbs are weak; finally, desirous of flight, the insects start and knock against the windows, pushing each other."

Virgil's description of the process is very similar. The chamber to be built must have four windows; a young ox is to be slain and his flesh pounded without shedding of blood; thyme and cassia are to be strewed. The words "trunca pedum primo" (with stumps of feet) apply exactly to the larva of Eristalis. Wasps and hornets were similarly supposed to proceed from the carcasses of horses. Osten Sacken attributes this belief to the swarming of the bee-like bot-fly of the horse (*Gastrophilus equi*) about horses. The belief would be strengthened by the occasional productions of the wasp-like Helophilus (a close relative of Eristalis) from carcasses of the horse, though any other dead body would do as well.

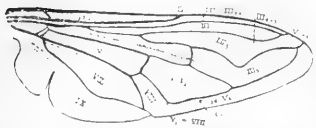


Fig. 94. Wing of Syrphid, showing spurious vein, which characterizes this family. After Comstock.

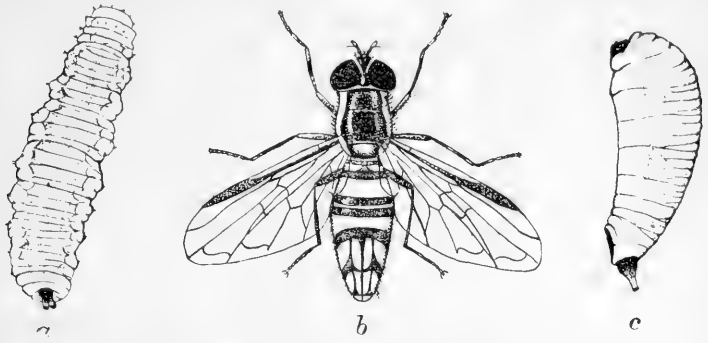
Fig. 95 and 96. *Microdon tristis* and pupal case. Original.

And yet even these species, when adult, are frequently found upon flowers. The maggots of one species live in the nests of bees and wasps, possibly, it is thought, living upon the excrement of the larvæ of bees and wasps, and thus rendering the latter a service. The maggots of the genus *Merodon* live in the bulbs of narcissus. The larvæ of the genus *Microdon* live in ants' nests. These maggots (*Microdon*) are so unlike other dipterous larvæ in their appearance that when first discovered they were supposed to be little molluscs.

We have illustrated freely in this interesting family, and reference to Colored Plates I and II, and to the various figures in the text will give one a good idea of the appearance of these useful flies, useful in that the larvæ of very many of the species consume large numbers of plant lice, one of the worst enemies of the agriculturist and gardener.

The larvæ are soft-bodied creatures, sometimes green or brown, or variously marked, seen lying amongst a colony of aphids, or plant lice, on rose bush, spirea, turnip, cabbage, or a host of other useful and ornamental plants, and with the anterior part of their bodies so

constructed that they spear their prey, as it were, sucking their body juices and thereby destroying hundreds of these troublesome pests.



a *b* *c*

Fig. 97. *Allograpta obliqua,* imago, larva and pupa. Lugger. Not collected in Minnesota.

We have at the Experiment Station a large number of pinned specimens of this family, so common in this state, representing the following Minnesota species: *Chrysochlamys croesus,* O. S.; *Criorhina intersistens,* Walk.; *C. verbosa,* Walk., Fig. 18, Plate II; *Brachypalpus frontosus,* Loew; *Syritta pipiens,* Linn.; *Sericomyia,* sp.; *Eristalis dimidiatus,* Wied.; *E. aeneus,* Scop.; *E. tenax,* Linn., Fig. 9, Plate I; *E. meigenii;* Wied.; *E. inornatus,* Loew, Fig. 9, Plate II; *E. occidentalis,* Will.; *E. montanus,* Will.; *E. hirtus,* Loew; *E. bastardii,* Macq.; *E. flavipes,* Walk., Fig. 16, Plate I; *E. transversus, Wied.; E. latifrons,* Loew., So. Dak.; *Helophilus similis,* Macq.; *H. conostoma,* Will.; *H. chrysostoma,* Wied.; *H. latifrons,* Loew., Fig. 11, Plate I; *Microdon tristis,* Loew.; *M. fuscipennis,* Macq.; *Chilosia tristis,* Loew.; *Chilosia,* sp.; *Paragus bicolor,* Fab.; *P. tibialis,* Fall.; *Chrysogaster pulchella,* Will.; *Melanastoma mellinum,* Linn.; *M. coerulescens,* Will.; *Platychirus quadratus,* Say; *P. hyperboreus,* Staeg.; *Syrphus arcuatus,* Fall.; *S. ribesii,* Linn.; *S. grossulariae,* Meig.; *S. amalopis,* O. S. *S. americanus,* Wied.; *S. diversipes,* Macq.; *S. xanthostoma,* Will., So. Dak.; *Sphaerphoria,* sp.; *S. cylindrica,* Say, on cabbage aphis; *Mesogramma marginata,* Say.; *M. geminata,* Say.; *Xylota ejuncida,* Say.; *X. pigra,* Fab.; *X. vecors,* Loew; *Chrysotoxum derivatum,* Walk.; *Chrysotoxum,* sp.; *Temnostoma alternans,* Loew; Fig. 11, Plate I; *T. aequalis,* Loew; *Spilomyia quadrifasciata,* Say; *Trophidia quadrata,* Say, So. Dak.; *Pipeza pulchella,* Will.; *Neoascia globosa,* Walk.; *Rhingia nasica,* Say; *Triodonta curvipes,* Wied.; *Spilomyia fusca,* Loew; *Mallota posticata,* Fab.

PIPUNCULIDAE,

Big-eyed Flies.

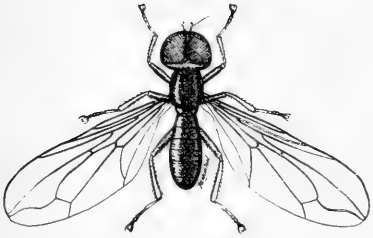


Fig. 98. A Big-eyed Fly, *Pipunculus fuscus.* Lugger. Not collected in Minnesota.

These are very small flies which frequent shady places. The more common forms measure about one-eighth of an inch in length. They have large heads, mostly composed of the large approximated eyes. The head is broader than the thorax, and the wings project beyond the posterior end of the abdomen. They can be collected upon low plants. Aldrich lists only 25 species as occurring in North America, all contained in three genera. In Great Britain there are about twelve species. The larvæ, as far as they have been studied, are parasitic upon bugs.

Pipunculus elegantulus, Will.; has been taken in Minnesota.

PLATYPEZIDAE,

Flat-footed Flies.

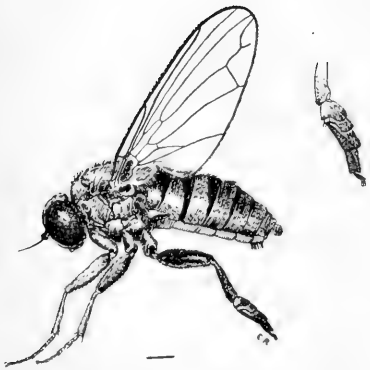


Fig. 99. *Platypeza,* sp. and view of tarsus, much enlarged. Original.

Our illustration shows why these flies have the above name. We have reared the imago from larvæ found in decaying mushrooms.

The adults are seen flying about in shady places, and on the leaves of plants in such situations. The family is not rich in species. Aldrich lists nineteen for North America (1904), and Great Britain claims four genera and nearly a score of species.

Platypeza, sp., occurs in Minnesota.

PHORIDAE.

Hump-backed Flies.

The appearance of these small dark flies is well shown in Fig. 100. They are particularly striking on account of their rounded thorax— "hump-back" —and peculiar venation of their wings. This hump-backed appearance is in part due to the fact that the head is lower than the rest of the body, being almost under the anterior part of the thorax, as shown in our illustration. They are observed in swarms in the air, upon fallen leaves, and occasionally on windows, though on account of their minute size they are not readily observed by other than an entomologist. We found them in large numbers in gardens in June on the so-called "Ash-leaf spirea." The larvæ live in decaying animal and vegetable matter, and are said to attack even living insects.

Sixty-four species are credited to North America (Aldrich, 1904). Members of the family are said to be abundant in Europe.

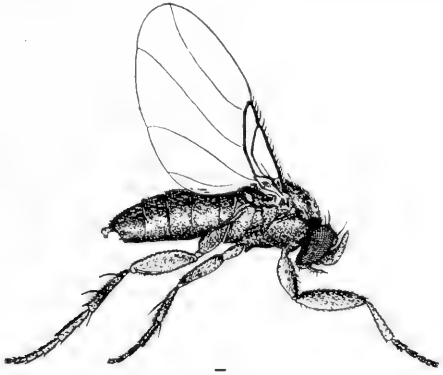


Fig. 100. A Phorid, *Conicera atra.* Original.

We have taken in this state: *Conicera atra,* Meig.; *Aphiochaeta nigriceps,* Loew.

CONOPIDAE,

Thick-headed Flies.

The flies in one division of this family have slender abdomens, and head broad transversely, resembling petioled wasps quite decidedly.

There are at this writing only about 78 known North American species in the entire group. The family is especially interesting on account of the peculiar habits of the larvæ of some of the species, regarding which there is much to be learned. These larvæ live parasitically in the interior of wasps, bees and locusts. One observer claims that he has seen the adult flies follow bumble bees and alight upon them for the purpose of oviposition, and it is supposed that the larva, upon hatching, bores its way into the body of the bee. Some naturalists have believed that it is in the nests of the bees and upon the larvæ and pupæ that the eggs are laid. This theory, however, is hardly to be entertained, since they have never been reared from the larvæ or pupæ, though frequently bred from the imago. Members of the genus *Conops* have emerged from the body of a bumble bee several months after the death of the latter. The larvæ of those which infest bees are large, one, when full grown, occupying almost all of the space in the abdomen of the bee parasitized.

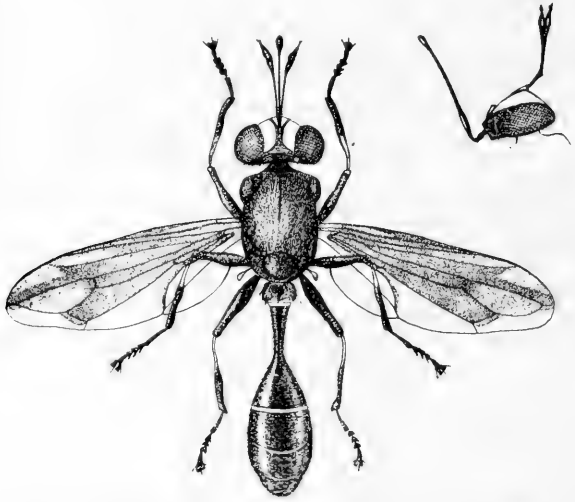


Fig. 101. A Thick-headed Fly, *Physocephala tibialis,* not taken in Minnesota. Lugger.

We have taken in this state: *Myopa clausa,* Loew., Fig. 5, Plate II; *M. vesiculosa,* Say.; *M. pilosa,* Will.; *Physocephala affinis,* Will. *P. furcillata,* Will.; *P. marginata,* Say; *Oncomyia abbreviata,* Loew.

MUSCIDEA.

The families of flies in the following pages, while they agree in certain characteristics which formerly united them in one family, *Muscidae,* at which time many of them were regarded as sub-families, have latterly been given family rank. While they differ from each other in certain characteristics, which present-day entomologists for the most part regard as sufficient to establish the separate families, they agree in the following common character: The antennae are always three-jointed, and always (with the exception of one genus,where it is absent) with an arista, the palpi are never jointed; pulvilli always present; empodia wanting; alulets well developed.

BORBORIDAE.

A family of about twenty-four North American species. The smallest one in our collection, *Limosina,* whose larva lives in algæ, fungi, diseased potatoes, etc., is extremely minute, while *Borborus* is nearly or quite half an inch in length.

These are brownish flies, found frequently in swarms about decomposing organic matter, the larvæ of some of the species living in such material; sewage, or dung, for example.

We have taken in Minnesota: *Borborus equina,* Fall.; *B. geniculata,* Meig.; *Limosina,* sp.

AGROMYZIDAE.

Very small flies, about 92 species in North America, the larvæ of some of the species feeding on plant lice. Other larvæ have been found in galls.

Species taken in this state are: *Agromyza neptis,* Loew.; *Ochthiphila polystigma,* Meig.

GEOMYZIDAE.

A small family of small sized species. Sixteen are known in North America (1904). As far as known the larvæ live in the stems of plants, and the adults are sometimes captured when using the beating net upon plants and shrubbery.

OSCINIDAE.

Minnesota has occasion to know these flies, for in the family are two wheat pests, which at times make their presence unpleasantly known within the confines of our state, and which have long been injurious to wheat, rye and barley in Europe. I refer to the Frit Fly,

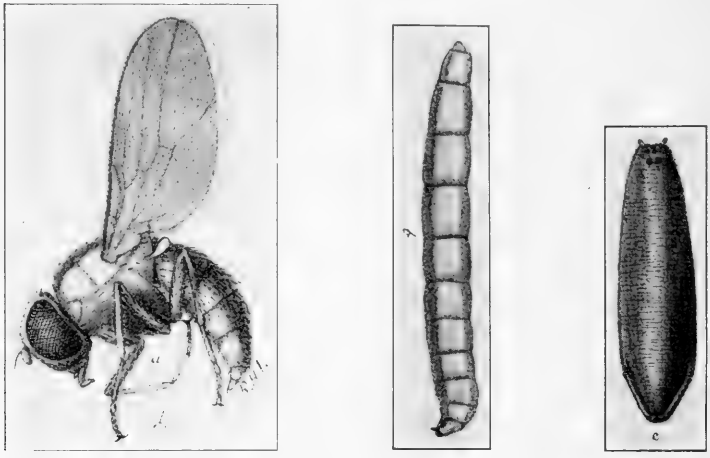


Fig. 102. Frit Fly, *Oscinis soror*, imago, larva and puparium. Lugger.

Oscinis soror, Macq., Fig. 102, and the Wheat Stem Maggot, *Meromyza americana*, Fitch, Fig. 103. The first of these, well shown in the illustration, and quite troublesome here in 1892, prevents the filling of the heads, and by working in the stem in the maggot stage so weakens it as to allow it to bend, thus bringing the heads upon or near the ground. This injury is first seen about the time the head begins to form. The part of the stem above the first or second joint generally wilts at that time, if affected, and bends over. Minute worms may be found in the early stage of the trouble, causing this weakening by their presence in the straw just above a joint. These are the larvæ of the Frit Fly, and are shown in the illustration at (b). If, however, the examination of these stems be delayed until late, one finds not the larva, but the puparium (c), which is the hardened and browned skin of the larva, and contains the pupa or larva (October). Sometimes three or more of these puparia are found together. They are

brownish and much resemble the puparia of the Hessian Fly, treated of elsewhere in this report. For this reason, but more particularly from the fact of the bending or breaking of the stem, this insect's work is sometimes mistaken for that of the Hessian Fly. However, it has been the observation of the writer that the Hessian Fly in Minnesota out-numbers the Frit Fly 10,000 to 1, and hence this mistake is not often made. As far as we know, this pest passes the winter as a pupa in the stem in the stubble field, and hence the same remedies would apply here as in the case of the Hessian Fly. If a farmer has reason to suspect the presence of this pest in his stubble field, by noting bent straws left by the reaper, he need only split the straw with a penknife to the joint just below the bending to settle the doubt, for if this insect has caused the bending, the puparium will be seen at the joint and inside the stem, the interior of the stem being generally discolored also. Whereas, in the case of the Hessian Fly, which causes the same injury, the puparium, or "flax seed," will be found outside the stem, between it and the sheath.

The name "Frit Fly" is given to this insect because Swedish farmers apply the term "frits" to wheat rendered worthless by its attacks.

As mentioned above, this fly caused considerable damage in Minnesota in 1892. Like other pests of similar habits, it appears in increasing numbers at one period, and then almost disappears, to occur again later.

The second wheat pest referred to, *Meromyza americana*, is reported to the Experiment Station from time to time. In 1895 it was reported numerous in the Red River Valley, and at points in central and eastern Minnesota. In 1896 it was also present in considerable numbers. In that year, too, it was common in the wheat at the Experiment Station farm. On affected grain, the heads, instead of filling normally, turn white, and are called "white heads" or "bald heads."

Fitch described this insect in America as early as 1855, but existing records indicate that it was known as a wheat pest in Pennsylvania as early as 1821. Webster and Forbes worked up this insect a number of years ago, in Ohio and Illinois, and claimed at that time three annual broods for each state, with the probability of more in states farther south. In Minnesota where we have but little fall

sown wheat, practically none, its life history may vary from that given for the two above-named states. Prof. Lugger, in his First Annual Report, handles the subject so nicely that we quote him in full:

"According to the accounts given by the above-named entomologists, the flies found in the wheat fields in September and October deposit their eggs upon the young plants of winter wheat; the young maggots make their way downwards, feeding upon the central part of the stem near the surface of the ground, and cutting this off entirely, cause it to die. In these positions the maggots hibernate, appearing again as adults in spring. These flies of the first brood again deposit eggs, the maggots of which in time destroy the stems just above the upper joints. After killing this upper part of the plants, another brood of flies, the second generation, appears, which emerge in July and deposit eggs in volunteer wheat or grass. From these maggots a third brood is produced, which develop into flies the same autumn, and deposit eggs upon the young plants of winter wheat. How many broods of this insect may be produced in Minnesota is not known. Only one thing is certain, and that is that their life history must be quite different in a region where volunteer wheat is a very uncommon thing and where winter wheat is never grown. It is true we have in such regions a number of grasses that might possibly give this insect a shelter, as it is known to attack elsewhere, besides wheat, such grasses as wild rye, blue-stem, poa and even green pigeon grass. Perhaps this may be the case, though none of the wheat stem maggots have thus far been found here in such grasses. Here, at the Experiment Station, the flies issued from material kept in breeding cages from July 22d till August 4th.

"The illustration shows three straws of wheat infested by the maggot. It shows also the pupa resting inside an open stem, and the injury caused by the maggot. A fly, natural size, is resting upon one of the straws. Larva, pupa and adult, greatly enlarged, are also shown. From many of the stems, instead of flies, parasites issued, showing that, notwithstanding the hidden life led by these maggots, their enemies can find them.

"The adult flies, about one-eighteenth of an inch long, are of a pale yellowish-green color. The large head is marked with a triangular black spot at base, inside of which are located the three simple eyes. The large compound eyes possess in life a beautiful bronze color. The thorax is marked with three longitudinal bands. The abdomen is also ornamented with three longitudinal bands, which are interrupted at the sutures, but more or less confluent toward the posterior end. The color of the under side of the fly is uniformly yellowish green, excepting two triangular spots on each side above the posterior and middle coxae. The legs partake of the same general color; the thighs are slightly darker, and the tibiae and tarsi dusky. The hind pair of thighs are very much swollen, and are provided on the under surface with two rows of small spines. The hind tibiae are very strongly curved. The two large basal joints of the antennae are yellowish.

"The eggs of the American Meromyza are glistening white, with longitudinal ridges, the space between the ridges is faintly recticulated. They are

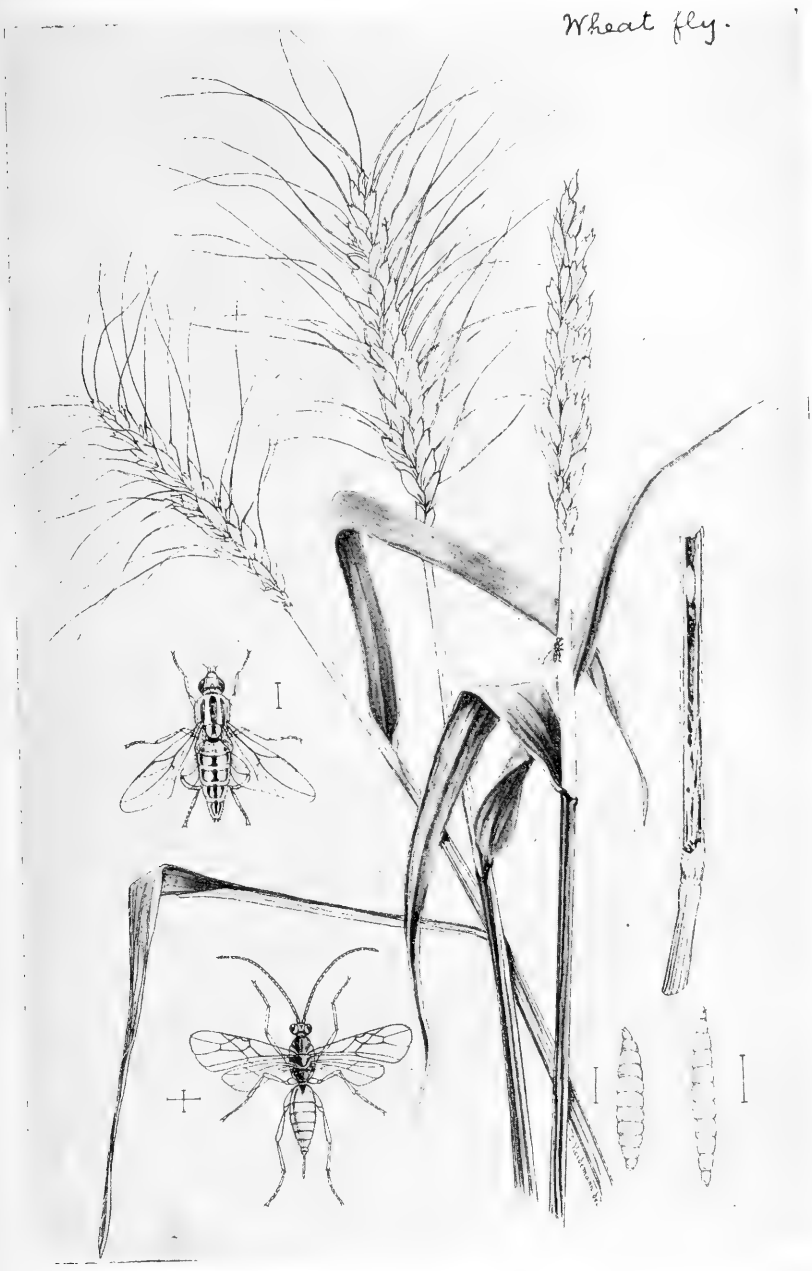


Fig. 103. Wheat infested with Wheat Stem Maggot. Pupa also shown inside stem. Maggot, pupa and imago enlarged. A parasite of the Wheat Stem Maggot shown on left near bottom. Lugger.

very elongated, being .023 of an inch long and .005 of an inch broad.

"The larva or maggot is very pale green and very slender, being about one-quarter of an inch long by one-thirty-second of an inch wide. Its head is provided with a pair of black toothed hooks. The covering of the apparent pupa is simply the shrunken larval skin, which protects the true pupa forming inside. As soon as the real pupa is formed it becomes visible through the transparent larval skin, and is seen to be also of a pale green color. It is about one-sixth of an inch long and about one-thirteenth of an inch broad. As the imago is formed inside the pupa, the eyes, wing-pads and legs become apparent.

"A careful comparison has convinced me that the insects bred from Minnesota wheat straw are identical with those bred from eastern and southern straws, and that the flies vary among themselves to a sufficient extent to account for extreme differences that may occur."

The reader must not suppose that these are the only flies found in this family, nor that all the flies occuring therein are wheat pests. Such is by no means the case. Aldrich in 1904 lists about 135 species of Oscinids in North America, the locality from which specimens were secured indicating a wide range over this country.

They are all small flies and quite common. A locally abundant fly of this family, *Oscinis pallipes*, Loew., commonly known as "The

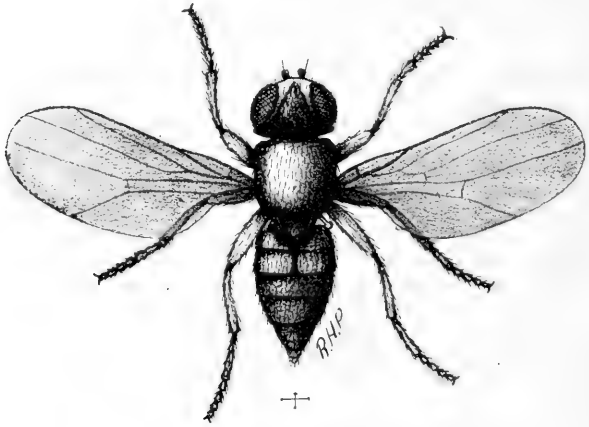


Fig. 101. *Oscinis pallipes*, Blood-sucking Oscinis. Lugger.

Blood-sucking Oscinis," is curious, in that it so markedly departs, in its adult stage, at least, from the habits of its vegetarian congeners as well as its other family relatives. It is very small, black, with yellow face and legs (see Fig. 104,) where the line below the insect shows the exact size of the fly, and its expanded wings. This fly in

June, July and August is sometimes very abundant in localities, and attacks horses, cattle, dogs and man, sometimes causing large sore spots on stock as a result of its work. In all the drawings in this report where hair lines occur, these lines indicate the natural size of the insect.

Hippelates flavipes, Loew., which Aldrich regards as the same as the above described *Oscinis pallipes,* Loew, is dealt with at some length in entomological literature. Schwarz writes ("Insect Life," Vol. VII) of "The Hippelates Plague in Florida," mentioning the fact that the adults annoy people, dogs, etc. Howard, in "Proceedings of Washington Academy of Science," Vol. II, page 590, says they occur on human excrement, and perhaps carry putrefactive germs to open wounds, inducing blood poisoning.

We have taken in Minnesota: *Oscinis soror,* Macq.; *O. pallipes,* Loew.; *Meromyza americana,* Fitch; *O. carbonaria,* Loew.; *O. trigramma,* Loew.; *O. coxendix,* Fitch; *O. dorsata,* Loew.; *Hippelates convexus,* Loew.; *Chlorops assimilis,* Macq.; *Siphonella cinerea,* Loew., S. Dak.

DROSOPHILIDAE

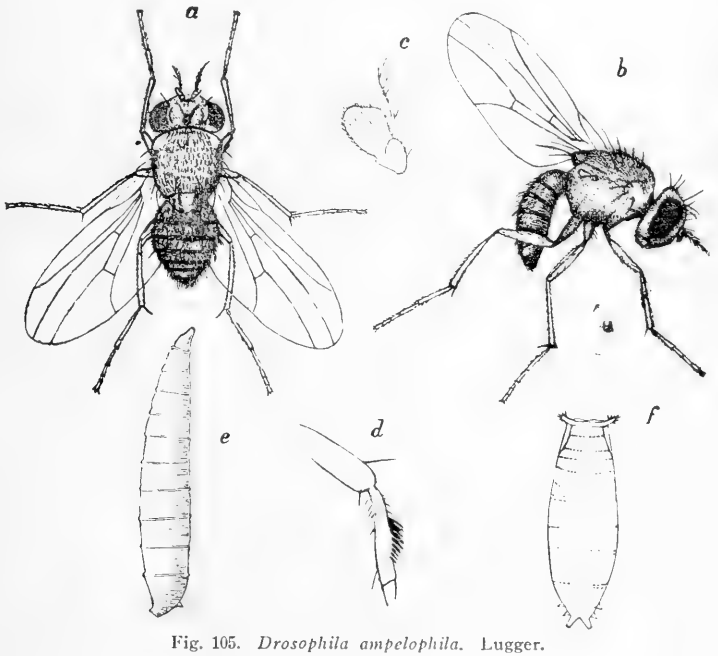


Fig. 105. *Drosophila ampelophila.* Lugger.

Tiny plump flies, many of the species appearing in large numbers about decaying or fermenting fruit. The pomace about cider mills attracts these flies; in fact, some writers speak of the family as "Pomace Flies." The larvæ of many of the species live in decaying fruit. One of the largest in our collection is *Drosophila busckii.* It is of a smoky color, and about one-sixth of an inch in length.

Seventy-nine species, according to Aldrich, are found in North America. *Drosophila sigmoides,* Loew; *D. ampelophila,* Loew; *D. funebris,* Fab.; and *D. busckii,* Coq.; have been taken in this state, the first being reared from pupæ found in the froth of *Clastoptera,* on hazel leaves, according to C. N. Ainslie. *D. busckii* was reared from rotten potatoes.

EPHYDRIDAE.

Of moderate size, dark colored flies, some quite small. Minnesota species in the collection range from one-fourth to one-half inch. The family, for the most part, is found in wet, marshy places. Some of the adults are characterized by having strikingly large heads. "Rat-tailed" larvae are found among some of the species of this family, as among the Syrphids, and the larvae generally are found in water, in the stems of aquatic plants, in the sap of trees, amongst the cells of the leaves of *Lemna, Alisma,* etc. The genus *Ephydra* is particularly interesting from the fact that its larvæ are

Fig. 106. *Ochthera mantis.* Lugger.

Fig. 107. *Ephydra hians.* Original.

aquatic, frequently found in enormous numbers, and are useful from an economic standpoint. An account by Prof. W. H. Brewer,

given S. W. Williston, and published by the latter in his "North American Diptera," is well worth repeating here:

"The waters of Lake Mona are clear, very heavy, have a nauseous taste, and when the lake is still has a look as of oil and is not easily disturbed. The water feels slippery to the touch, and will wash grease from the hands or from clothes cold more readily than common soapsuds will when hot. It is said that no fish or reptile lives in it, but it swarms with countless millions of larvae that develop in flies which rest upon the surface of the water, as well as cover everything on the immediate shore. The numbers and quantities of these flies and larvae are absolutely incredible. They drift up in heaps along the shore and hundreds of bushels could be collected. They only grow at certain seasons of the year, and then Indians come from far and near to gather them for food. The larvae or pupa are dried in the sun, the shell rubbed off by hand, when a yellowish kernel (pupa) like a small yellowish grain of rice appears. This is oily, very nutritious, and not unpleasant to the taste, and under the name of koo-cha-bee (so pronounced) forms a very important article of food. The Indians gave me some of it. It does not taste badly, and if one were ignorant of its origin, it would make nice soup."

Of another species, *Ephydra hians,* which is abundant in Lake Texcoco near the City of Mexico, Prof. Penafiel has the following to say, also published in the work above cited:

"It is of the eggs of this insect that the greater part of what is known as Ahuatle is composed, and which is now used by the natives who have preserved the customs of the ancient Aztecs. The eggs are cleaned and pounded into flour, and are prepared by mixing with hens' eggs, and fried with fat into small cakes. The larvae are also used for food under the name of Puxi."

We have specimens of the above species, *Ephydra hians,* Say, taken in the Red River Valley, Minnesota. Aldrich lists 145 species of *Ephydridae* as belonging to North America. The following are Minnesota species: *Ephydra hians, Say.; Parydra bituberculata,* Loew.; *Paralimna appendiculata,* Loew., So. Dak.

DIOPSIDAE.

Only one species known in this country, and none in Europe. The adult presents a most peculiar appearance, in that the sides of the head are produced to form a long process on either side, bearing eyes and antennae. Our illustration is that of a South African species, where

apparently these bizarre looking creatures are more common than with us.

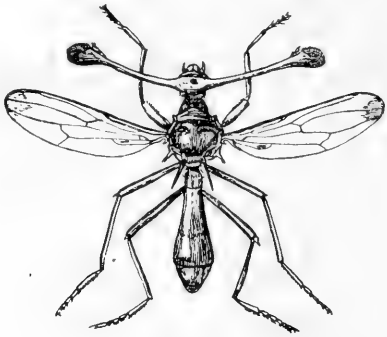


Fig. 108. *Diopsis apicalis*, a striking form from South Africa. From Sharp.

Aldrich, in speaking of the only species known to occur in North America, *Sphyracephala brevicornis*, Say, says that in the midsummer of 1901 he found it by the hundreds upon foliage in one of the shady glens adjoining the campus of Cornell University, Ithaca, N. Y. He further states that there is nothing to show that the larva has anything to do with the skunk cabbage, as intimated by Comstock, Kellogg, and possibly other American writers.

Sphyracephala brevicornis is found in Minnesota.

SEPSIDAE.

Small, blackish flies with irridescent wings. They live in decaying cheese, ham, vegetables, or excrement, about which the adults are frequently seen. Aldrich refers to the adults of *Themira putris*, attending plant lice on cottonwood in abundance. A correspondent in Olmstead county, Minnesota, referring to observations made last summer, writes us as follows: "Flies of this family were very numerous in corn fields, especially in the vicinity of hills that were infested with aphis. They are very active and are continually doing a 'cake walk,' as they promenade up and down the corn leaves, pluming themselves occasionally, and they showed little fear, allowing themselves to be taken by inverting a vial over them."

The "Cheese Mite" or "skipper," of which we show an illustration of the adult, Fig. 109 is a good illustration of this group. The act

Fig. 109. *Piophila casei*, fly which produces the Cheese Mite or "Skipper." Original.

of "skipping" which characterizes the cheese mite larva is performed by the maggot seizing the posterior part of its body, with its mouth armature, pulling hard and suddenly releasing its hold. In this way it can "jump" quite a distance. This insect has caused packers pecuniary loss by infesting bacon and ham. The adults of this family are active flies, both when using their legs and in flight. Aldrich (1904) gives 29 species as occurring in North America.

Taken in Minnesota: *Sepsis violacea*, Meig.; *Themira putris*, Linne.; *Piophila casei*, Linn., So. Dak.

MICROPEZIDAE.

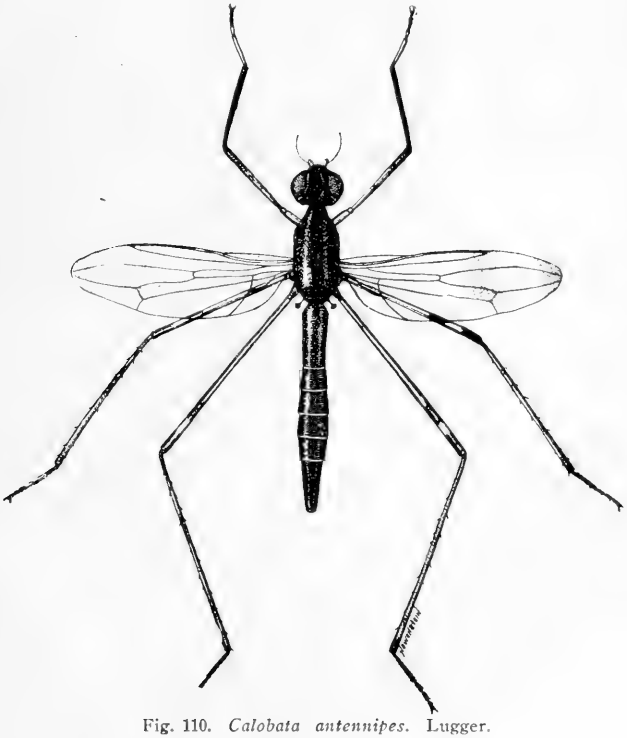


Fig. 110. *Calobata antennipes*. Lugger.

Fairly good sized flies, with long, very slender legs, the latter characteristic seemingly implied in the family name. Aldrich, in his "North American Diptera" (1904), lists nine genera, containing sixty-four species, but of this number several are of doubtful occurrence.

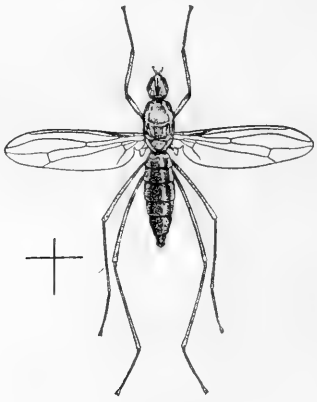


Fig. 111. *Calobata univitta.* Original.

Calobata univitta, Walk.; and *C. antennipes,* Say; are the only species so far secured by us in this state. We give two typical illustrations of members of this family. *C. antennipes* waves its fore feet about like antennae.

PSILIDAE.

Moderate sized flies whose larvæ, as far as known, live in the roots or galls of different plants. Twenty-four species occur in North America (1904).

ORTALIDAE.

A family of about 150 species in North America, characterized in many instances by their grotesque form and by striking wing markings. Minnesota specimens in our collection are brown or gray, with mottled wings. *Pyrgota* is nearly an inch long, while *Rivellia* is much smaller. The adult flies are generally found in the long grass of meadows. But little is known of the larvæ.

We have taken in Minnesota: *Rivellia pallida,* Loew.; *R. viridulans,* Desv.; *R. boscii,* Desv.; *Tetanops integra,* Loew.; *Chaetopsis aenea,*

Fig. 112. *Pyrgota valida.* Original.

Wied.; *Pyrgota undata,* Wied., Fig. 1, Plate II; *P. valida,* Harris; *Seoptera vibrans,* Linn.

TRYPETIDAE.

This family contains some gall makers, notably *Eurosta* (*Trypeta*) *solidaginis,* Fig. 2 Plate I, which produces the familiar round gall (not

Fig. 113. *Rhagolitis* (*Trypeta*) *pomonella,* The Apple-Maggot Fly. Original.

the elongated gall, which is made by a moth) on the stems of the golden rod. The larvæ of other species, according to Williston, mine in the leaves of *Rumex, Senecio, Arctium,* or live in the berries

of *Solanum carolinensis;* in the fruit of *Prunus, Lonicera,* etc.; other larvæ in the blossoms and in galls on the stems or roots of various *Compositæ;* others in the galls and roots of *Achillea* the flowers of *Hieracium,* etc. The larvæ of one genus live in oranges and lemons.

There are over 200 species of this family in North America. They are very numerous, for the most part small, brownish, with markedly mottled, or curiously marked wings. The largest species in our collection is *Trypeta diffusa,* about two-thirds of an inch long.

Minnesota species so far taken: *Straussia longipennis,* Wied., Fig. 5, Plate I; *Oedaspis polita,* Loew; *Rhagoletis pomonella,* Walsh; *Camptoneura picta,* Fab.; *Oedaspis atra,* Loew.; *Euaresta festiva,* Loew.; *E. bella,* Loew.; *Acidia suavis,* Loew.; *Euaresta aequalis,* Loew.; *Carphotricha (Paracantha) culta,* Wied.; *Spilographa flavonotata,* Macq.; *S. diffusa,* Snow; *Eurosta solidaginis,* Fitch. We illustrate (Fig. 113) the fly whose maggots tunnel in apples.

SAPROMYZIDAE.

For the most part small flies, though *Palloptera superba,* Loew., a yellowish species, with wings strikingly marked with black, taken in this state, is nearly half an inch long. As the name indicates, these flies frequent decaying vegetable matter, in which the larvæ breed. One species was bred from the flower stem of an orchid; one was reared from human excrement; the larvæ and pupæ of another was found

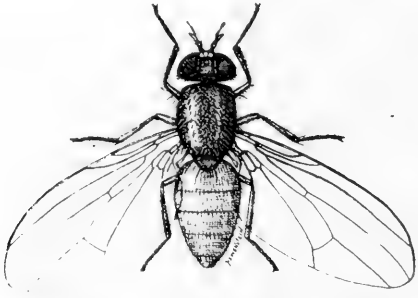


Fig. 114. *Sapromyza lupulina.* Lugger.

in decayed wood. Aldrich lists 103 North American species. We have secured in this state: *Lauxiania cylindricornis,* Fab.; *Sapromyza vulgaris,* Fitch; *Palloptera superba,* Loew.

RHOPALOMERIDAE.

This very rare and little known family probably does not occur in North America, though Williston, in *Entomological News,* Vol.. VII, page 185, reports a genus belonging to this family from this country. Aldrich, in his "North American Diptera" (1904), gives three species, but one is from Yucatan and two others from Mexico. Members of the family probably frequent damp places in regions where they are found.

HELOMYZIDAE.

Fig. 115. *Leria pubescens.* Original.

Specimens of this family in our collection are dark colored, measuring about one-half inch in length. We have found the following in Minnesota. *Leria pubescens,* Loew.; *L. serrata,* Linn.

Larvæ have been reared from bat and rabbit dung, and one species from decaying wood. Some maggots are found under the bark of trees. Some species of this family are said to live in burrows.

Aldrich gives forty North American species, coming from Hudson Bay, Nova Scotia, White Mountains, Mexico, California, Missouri River, Montreal, etc.

HETERONEURIDAE.

No representatives in Minnesota, as far as known to the writer.

The larvæ are found in decaying wood, under the bark of trees, etc. They, like cheese skippers, have the power of leaping.

Aldrich lists fourteen North American species, but six of these are from the West Indies, and at least four others are of doubtful authenticity.

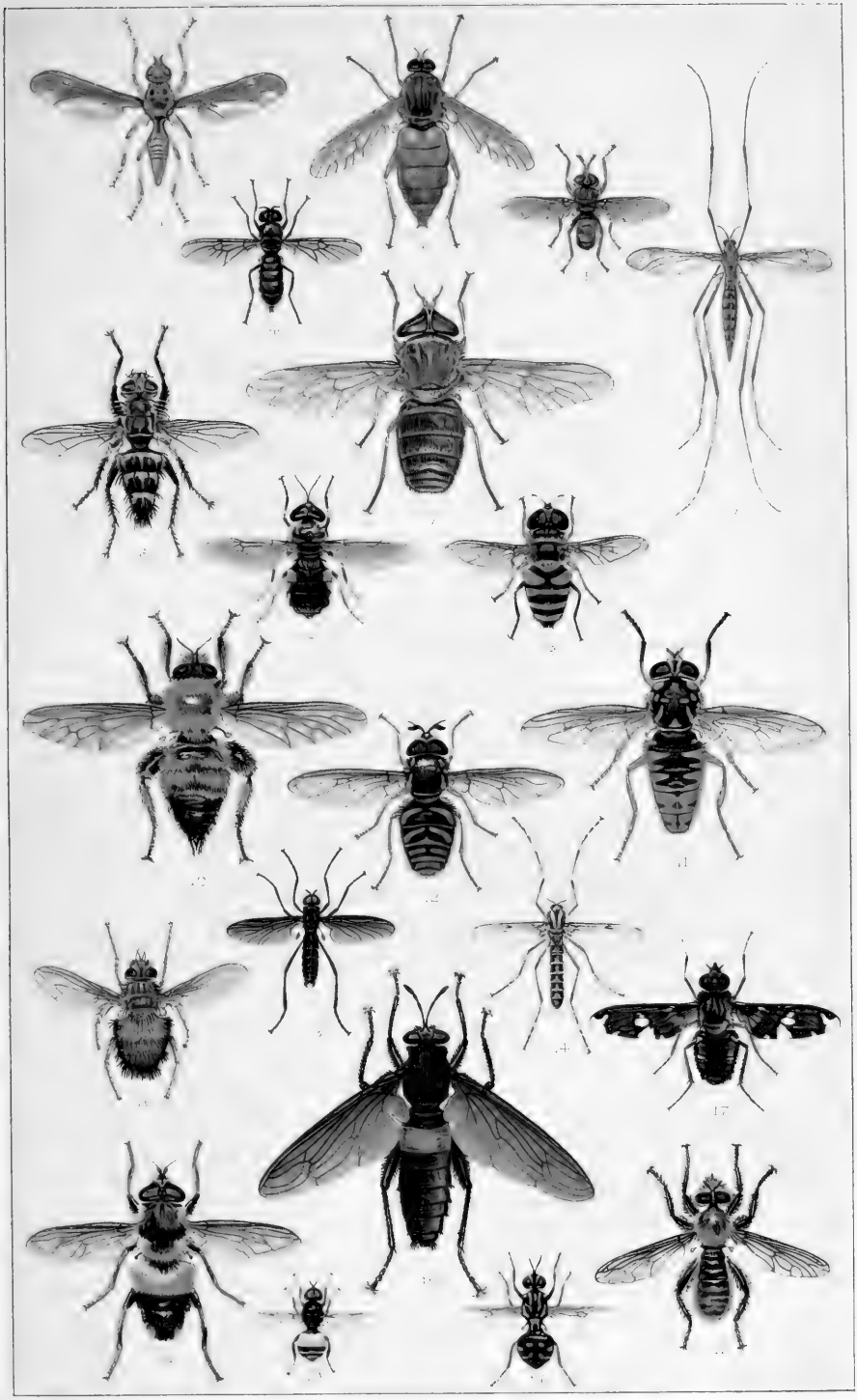
SCIOMYZIDAE.

These are brownish black or yellowish flies, sometimes with strikingly marked wings, found in moist localities, such as meadows or along the banks of streams. The larvæ are aquatic. Some of the species are minute in size, and others, like *Tetanocera plumosa,* are at least two-thirds of an inch long. Aldrich lists 64 species in North America, secured in the White Mountains, Canada, Alaska, Middle States, Texas, Nova Scotia, New Mexico, New York State, Connecticut and elsewhere, showing the family to be of general distribution.

EXPLANATION OF PLATE II.

(Figures are natural size unless otherwise stated.)

1. Pyrgota undata, Wied., *Ortalidæ.*
2. Coenomyia ferruginea, Scop., *Leptidæ.*
3. Pachyrhina ferruginea, Fab., *Tipulidæ.*
4. Sargus decorus, Say, slightly enlarged, *Stratiomyidæ.*
5. Myopa clausa, Loew, slightly enlarged, *Conopidæ.*
6. Tachina robusta, Town., slightly enlarged, *Tachinidæ.*
7. Tabanus giganteus, De G., *Tabanidæ.*
8. Stratiomyia discalis, Loew, slightly enlarged, *Stratiomyidæ.*
9. Eristalis inornatus, Loew, slightly enlarged, *Syrphidæ.*
10. Dasyllis sacrator, Walk., slightly enlarged, *Asilidæ.*
11. Temnostoma alternans, Loew, slightly enlarged, *Syrphidæ.*
12. Chrysotoxum sp., slightly enlarged, *Syrphidæ.*
13. Plecia heteroptera, Say, slightly enlarged, *Bibionidæ.*
14. Chironomus sp., slightly enlarged, *Chironomidæ.*
15. Mydas clavatus, Drury, *Mydaidæ.*
16. Bombyliomyia (Hystricia) abrupta, Wied., *Tachinidæ.*
17. Exoprosopa decora, Loew, slightly enlarged, *Bombyliidæ.*
18. Criorhina verbosa, Walk., *Syrphidæ.*
19. Nemotelus uliginosus, Linn., twice enlarged, *Stratiomyidæ.*
20. Euparyphus bellus, Loew, twice enlarged, *Stratiomyidæ.*
21. Laphria sericea, Say, *Asilidæ.*



EDITH REED, Del.

PLATE [illegible] SOME MINNESOTA FLIES

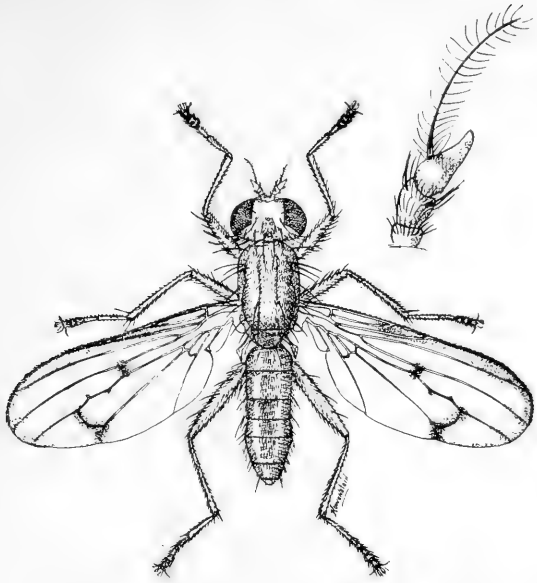


Fig. 116. *Tetanocera plumosa,* with one antenna enlarged. Lugger.

Minnesota species so far secured are as follows: *Tetanocera umbrarum,* Linn.; *T. plumosa,* Loew.; *Sciomyza nana,* Fall., So. Dak.; *Sepedon armipes,* Loew.; So. Dak.; S. *fuscipennis,* Loew.

PHYCODROMIDAE.

Of rare occurrence in North America. Members of the only genus we have here are said to be found abundantly in seaweed and other algæ thrown up by the waves along the sea coast. The two species given by Aldrich as occurring in North America were secured in Massachusetts and in Alaska.

SCATOPHAGIDAE=SCATOMYZIDAE.

Dung Flies.

These are the brownish or yellowish flies seen commonly in pastures and elsewhere about cow dung, though they are also said to feed upon insects which they capture. As might be supposed, the larvæ of

some of the species are found in cow dung, some, *S. furcata,* in the excrement of swine, and others in the stems of plants. The larva of

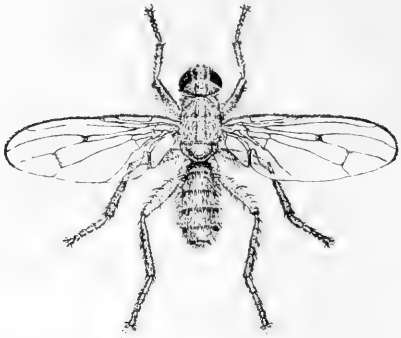


Fig. 117. *Scatophaga furcata,* one of the Dung Flies. Original.

S. stercoraria, a practically cosmopolitan species, "lives everywhere in the excrement of human beings, in that of the horse and of cows."

Aldrich lists 118 species as having been taken in North America. Minnesota species as far as secured are: *Cordylura confusa,* Loew.; *C. varipes,* Walk.; *C. variabilis,* Loew.; *Scatophaga furcata,* Say; *S. stercoraria,* Linn.

ANTHOMYIDAE.

A large family (over 300 species in North America) of very common flies, blackish or grayish for the most part, containing, by the way, some important pests, notably the Cabbage Maggot Fly, the Onion Fly, etc. One variety mines the leaves of beets. Many species of this family resemble superficially the common house fly, and are frequently mistaken for them. The student, however, can readily tell them from house flies with the use of a lense, for in Anthomyids the first posterior cell is widely open near the apex of the wing, while in the house fly the same cell in much narrowed, almost closed.

Anthomyids are not at all uncommon inside of the house on windows. They are among our most abundant flies, found almost everywhere, in garden, field, woods and meadows.

The Cabbage Maggot, which is the larva of *Phorbia brassicae,* mines in the roots of cabbages, cauliflower and radishes, and has caused

a loss of thousands of dollars to market gardeners in this state alone. The fly has the characteristics of others of this family, and can be found abundantly during parts of the summer in fields of cauliflower

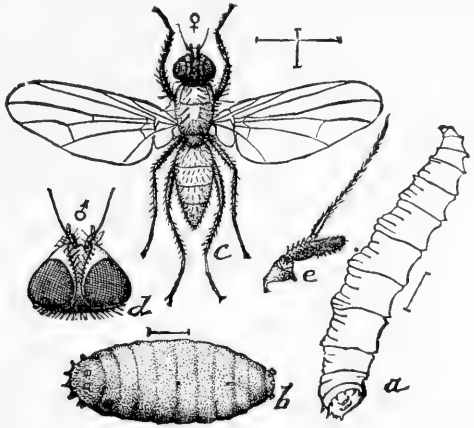


Fig. 118. Cabbage Maggot; *a*, larva, *b*, pupa; *c*, adult; *d*, head; *e*, antenna. After Riley.

and cabbage. The leaves of a plant seriously affected wilt down, and examination of the roots at this time will disclose the presence of numerous maggots. We have been working with this pest during the past summer, and find that an emulsion made of crude carbolic acid, together with certain cultural precautions, promises well as a means of prevention. This pest is of such importance that a special publication regarding it and remedies for it will be issued by this department later.

The maggot boring in radishes is identical with the cabbage maggot, as is the maggot found "in turnip, winter cress, hedge mustard, celery and doubtless other plants" (Chittenden). The Onion Maggott we have not found in Minnesota as yet. It is a close relation to the cabbage maggot, and the work of this maggot causes a yellowing and wilting of the leaves of the onion plant.

The Bean Maggot, the larva of another *Anthomyid* fly (see Fig. 119), is also sometimes troublesome here. It works in the stems as well as in the seed, as shown in our illustration. Its work is so readily recognized that no detailed description seems necessary.

The great majority of these flies are vegetable feeders in the larval stage, being found either in living or decaying plants. However,

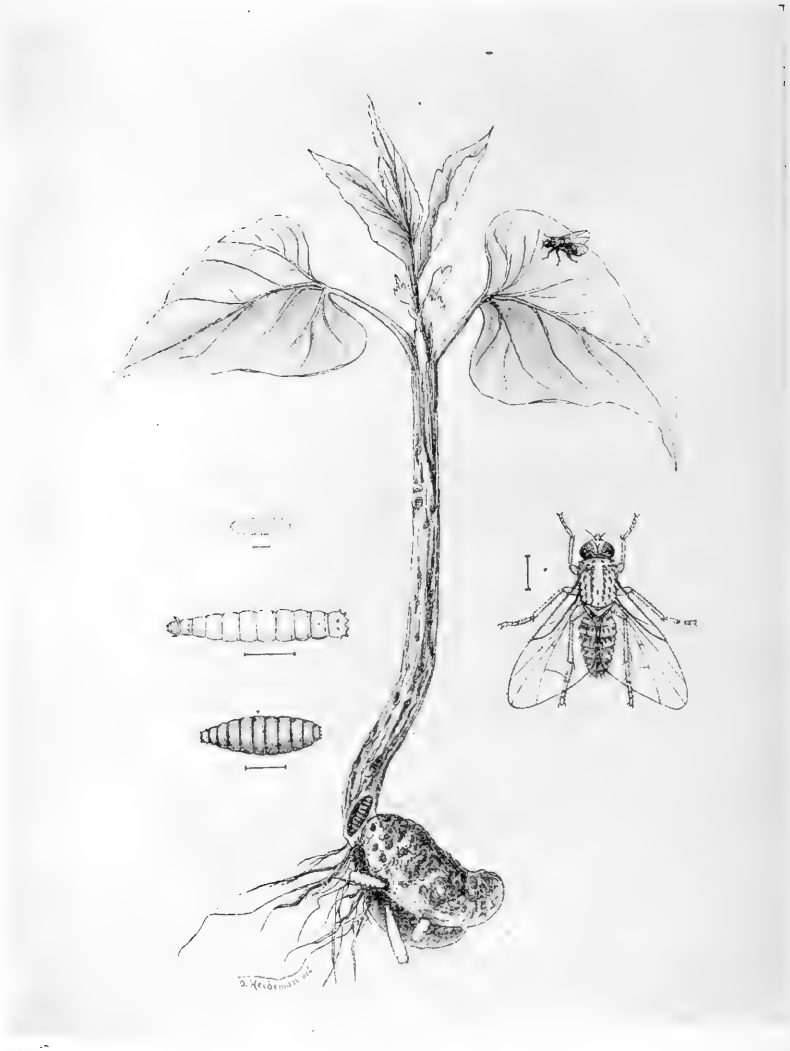


Fig. 119. The Bean Maggot. Lugger.

some species are found in decaying animal matter, in dung, and in human excrement; some in the nests of various Hymenoptera; some produce mines in leaves; some affect young birds, and some befriend us by eating grasshopper eggs.

The family is world-wide in its distribution.

The following Minnesota species are in our collection: *Anthomyia radicum,* Linn.; *Caricea nana,* Zett.; *Dialyta,* sp.; *Homalomyia canicularis,* Linn.; *H. incisurata,* Zett.; *H.* sp.; *Hylemya lipsia,* Walk.; *Hyetodesia proxima,* Wulp.; *Phorbia brassicae,* Bouche; *P. fusciceps,* Zett.; *Pegomyia,* sp.; *Spilogaster nitens,* Stein.; *Ophyra leucostoma,* Wied.; *Hylephila,* sp.

OESTRIDAE.

"Bot Flies," "Gad Flies" or "Breeze Flies."

This is one of the most important families from an economic standpoint. The flies are medium size, some quite large; without exception the larvæ live in or upon quadrupeds, such as horses, cows, sheep, rabbits and gophers. Some few are known to attack man. The bot fly which attacks sheep, places its living young in the nasal passages.

The adults, like the horse fly, are fond of sunny localities, and in this stage take little or no food.

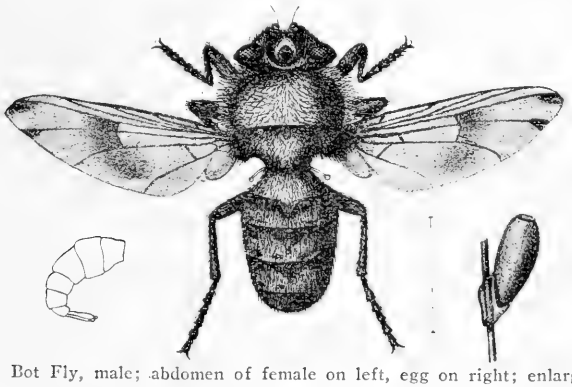


Fig. 120. Horse Bot Fly, male; abdomen of female on left, egg on right; enlarged. Lugger.

One of the most interesting and injurious is the Horse Bot Fly, *Gastrophilus equi.* Clark (see Colored Plate I, Fig. 10). The female horse bot fly lays from 400 to 500 eggs, all of which may be placed, under favorable circumstances, upon one horse. These eggs are fastened to the hairs, generally of the fore legs, shoulders or chest. A horse instinctively fears this pest, and it will be seen, if in the pasture,

to start and strike with the fore feet, although the cause of its nervousness is not visible. The adult fly is brownish, more or less hairy, looking a little like a small honey bee. It is most skillful in depositing its yellowish eggs, "nits" we sometimes call them, on the animal's

Fig. 121. Eggs of Horse Bot Fly, as seen under the microscope. Original.

hairs. The moisture and friction which these receive from the animal licking its hair cause them to hatch, and further licking, occasioned possibly by the irritation caused the skin by the presence of the tiny larvæ, carries the maggot into the mouth, whence it finds its way into the horse's stomach, and there completes its larval life, attached to the lining of the stomach, and sometimes so abundant as to completely cover a portion of it, as shown in our illustration.

Normally the egg stage lasts about fifteen days. Evidently if the eggs go four weeks without being licked, a very small percentage, if any of them will hatch. The bots live in the stomach or intestines eight or ten months, moulting twice during that period, and naturally, when numerous, sapping the vitality of the horse. They also cause great irritation by attaching themselves to the lining of the small intestine and rectum. In the spring these bots lose their hold and pass out with the droppings; working their way into the soil an inch or two, or into some protected locality; each "bot" or larva changes to a pupa, lying within a pupal case, from which the adult fly emerges after about thirty days.

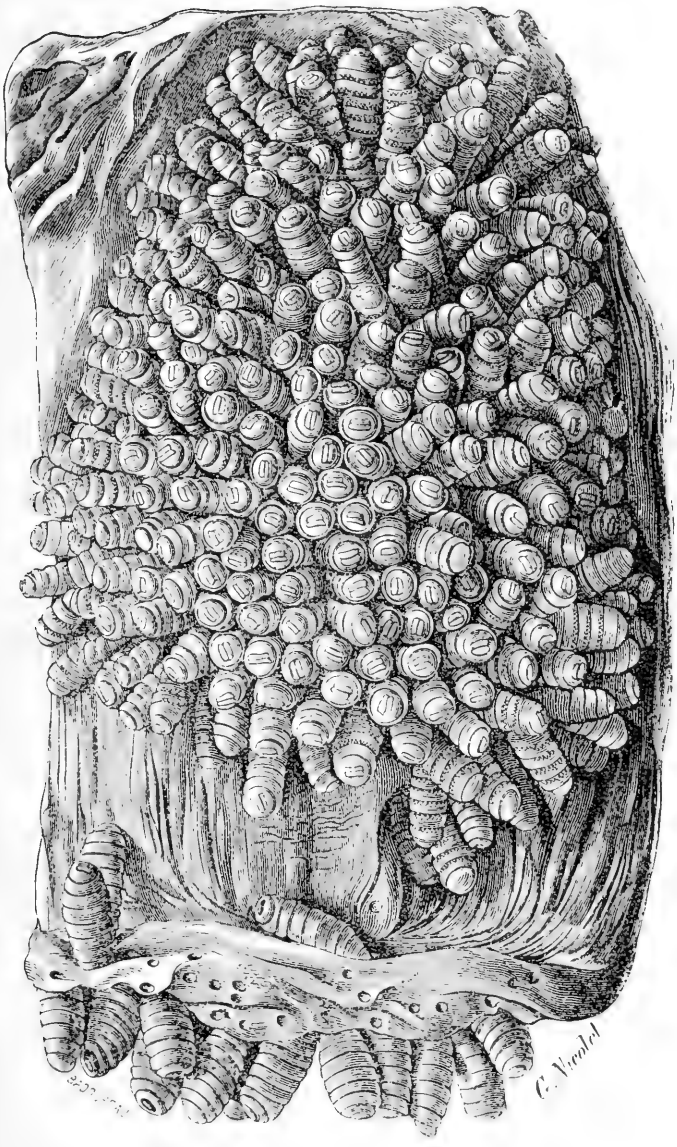


Fig. 122. Bots in stomach of horse, natural size. After Heller.

We have at least three species of bot flies belonging to this genus, *Gastrophilus,* in Minnesota: *Gastrophilus equi,* just described, and *G. haemorroidalis* and *G. nasalis,* which will be described later.

Remedies and Means of Prevention:

A horse will not be attacked as long as it is in the stable. Ordinarily a stable horse can be kept free from what "nits" it gets while out of doors by proper currying, and no careful man in charge of horses is going to allow the eggs to remain on the animal or animals in his charge. Horses in pasture, not being groomed frequently, become covered with eggs during the summer and early fall, and such animals should be carefully examined every two weeks, and all "nits" removed. The eggs can be cut off or killed by a trace of kerosene, just brushing them over with a feather wet in the oil, and not using enough kerosene to injure the hide. Or they may be killed by the use of a wash consisting of one part of carbolic acid in thirty parts of water. Further, we can resort to clipping, when eggs are deposited in numbers, or to the use of a sharp razor, destroying the eggs with the latter, without cutting much of the hair. A thoughtful teamster in a field or elsewhere, if he observes a bot fly disturbing his horses, is going to try to kill the fly with his hat or otherwise, and thus prevent further trouble.

City horses, whose droppings fall mostly on pavements, and in other places unfavorable for the further development of the bots, are not so subject to the pest as are the animals in the country.

The United States Department of Agriculture has in the past suggested the advisability of treating piles of dung by some process which will destroy the fly. It is very evident that as long as the horse is kept from licking his coat where the eggs or larvæ are no harm can befall him other than the irritation caused by the attacks of the fly. A horse in poor condition, in whose droppings the owner occasionally notices bots, is probably so badly affected as to call for treatment, and a veterinarian should be consulted. Sometimes turpentine is used internally, but it is a dangerous remedy in the hands of the uninitiated. Four ounce doses of turpentine, four hours apart, until three or four doses have been given, the last dose followed by one ounce of powered aloes, has been recommended. Carbon bisulphide has also been used in Italy with marked success. Six gelatine capsules, each containing 15 grams of C S 2 were given to two horses at intervals of two hours.

During the four following days the first horse passed 497 bots, the second, in five days, 571 bots. Another party gave one horse 32 grams in five hours, and the animal later passed 203 bots. Horses so treated should be carefully watched, and if any bad effects upon the animals appear, treatment should be stopped. We are not aware of this treatment being used in this country. The old and absurd "molasses and milk" remedy has long since been found to be absolutely of no use.

THE RED-TAILED BOT FLY,

G. haemorroidalis, Linn.

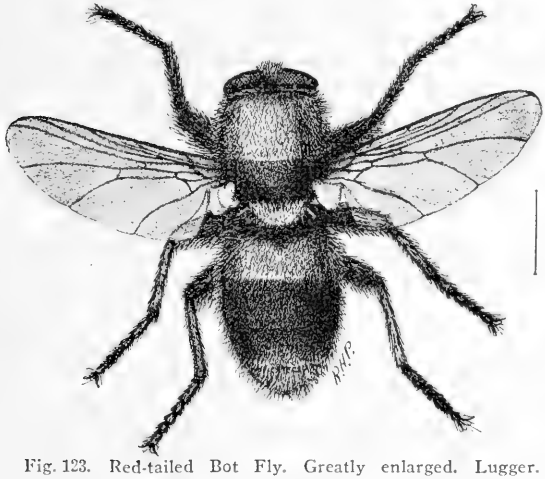


Fig. 123. Red-tailed Bot Fly. Greatly enlarged. Lugger.

This is another bot fly (see Fig. 123), which evidently occurs in this state, also attacking horses. Its habits are much like those of the species just described, and the same remedial measures will apply. It is claimed that the female deposits her eggs on the mouth, instead of the shoulders and the fore legs.

NASAL BOT FLY,

G. nasalis.

With habits somewhat like the two preceding, as its name implies, however, preferring the region near the nose on "chin" for egg laying. Horses seriously affected with this bot should receive the

attention of a good veterinarian. The means of prevention are practically the same as in the first described species, *G. equi.* Painting

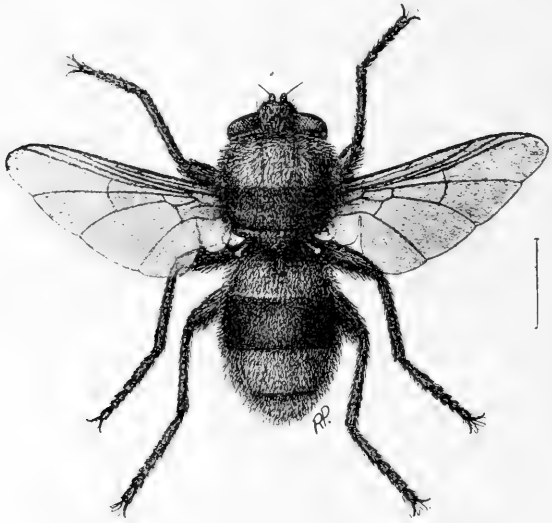


Fig. 124. Nasal Bot Fly. Greatly enlarged. Lugger.

the eggs every few days, when a horse has been exposed, with pure kerosene, would probably prove sufficient, but a mere combing or use of a brush is not sufficient with the bot, or with any other laying eggs on the hairs. Repulsive ointments on lip or nose would be of service where the animals are running in pasture.

THE SHEEP BOT FLY, SHEEP GAD FLY, "GRUB-IN-THE-HEAD," "FALSE GID."

Oestrus ovis.

This bot fly, dull yellow in color, looking a little like a large house fly, and having no mouth, places its living young (the eggs having been hatched in the body of the parent) in the nostrils of sheep. The attempts of the female fly to reach this point drive the poor animals frantic. They lie down, bury their noses in the dust, throw dust in the air, huddle together, etc. The young larva, once in the nose, works its way upward, occasionally gaining lodgment in the frontal sinuses, cavities between plates of bone over the eyes. Ten months

are required for the maggots to mature, at which time they crawl back to near the anterior opening of the nose, and are sneezed out. They remain in the pupal stage, one or two inches below the surface of the ground, from four to six weeks. This upward migration of the larva, and its subsequent activity, causes serious symptoms in the affected animal, which occasionally result disastrously. This, however, according to Neumann, only occurs when the bots are quite

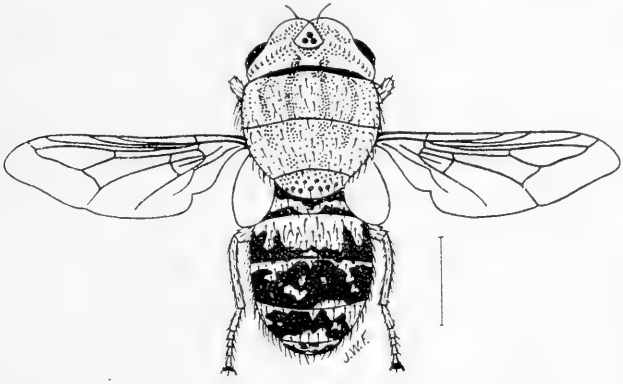


Fig. 125. Sheep Gad-Fly, from a Cambridge specimen. Enlarged. Lugger.

numerous in the animal, and are well advanced in their development early in the season. Animals seriously affected lose their appetite, become emaciated, discharge thick mucous matter from the nose, sometimes throw their heads back, or, hanging their heads, lift their feet high in the air when walking, grate their teeth and froth at the mouth. This is followed by convulsions and finally death within six or eight days after the appearance of the first symptoms. This fly, like most allied pests, is fond of hot sunshine, and flies on warm and sunny days between May and October.

The above symptoms are sometimes wrongly ascribed to the attacks of worms which cause the sickness known as "gid", or "turn sick". The presence of the bot fly, however, does not cause the animal to turn in a circle, as in a case of "turn-sick". The presence of the bot, too, nearly always causes nasal discharges and snortings which symptoms are absent in a case of "gid".

Remedies and Means of Prevention:

In the case of common stock destined for the market, a very

general and serious attack can perhaps best be met by sending the sheep to the slaughter house. On the other hand, there are a few remedies or methods of preventing an attack, or of relieving the sufferers. If the bots have penetrated into the frontal sinuses, it is apparent that it would be very difficult, if not impossible to reach them. Certainly one should never use a wire, or any compound which would injure or cause great suffering to the patient. When the bots are in the nostrils simply, they may be removed sometimes by dipping a feather in turpentine or very weak carbolic acid (one part of acid to thirty parts of water), or creosote or zenoleum. An injection of salt water, or diluted carbolic acid into the nostrils, with a syringe is claimed to be good. Fine air-slaked lime is used by some, the animals being forced to breathe it, to induce sneezing. Dr. Lugger states in one of his reports that he met with success by blowing pyrethrum up the nostrils. But, as intimated above, all these remedies would avail little or nothing if the bots were safely housed in the bones of the forehead. Anything which will induce sneezing is good; tobacco snuff shaken into the nostrils, the burning of horns, leather or feathers in a closed shed where sheep are confined, etc. It is claimed also that equal parts of turpentine and sweet oil poured into the nostrils carefully, the head being held up, is excellent, care having to be observed in order that the sheep may not be choked.

Some sheep raisers in infested localities maintain in pasture or yard logs, along which at intervals of five or six inches two inch holes are bored, from May to October. These holes are kept about half filled with salt, and the edges or the mouths of the holes are frequently smeared with fresh tar. The sheep, in endeavoring to reach the salt, involuntarily smear their noses with the tar, and this tends to keep off the flies. As an auxiliary to this, for they will not all get a liberal allowance of tar on their noses, one may rub into the nostrils

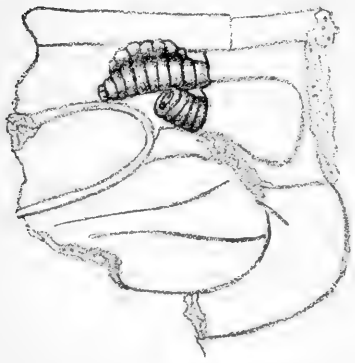


Fig. 126. Three larvae of Sheep Gad-fly in frontal sinuses of sheep. Enlarged. Lugger.

and about the nose the following compound: Pine tar, two parts, fish oil or cotton seed oil, one part, powdered sulphur one part. Some, instead of using salt logs, plow a few furrows across the pasture, into which the sheep may stick their noses when attacked. Some breeders keep deep dust in a portion of the sheep yard, into which the animals instinctively thrust their noses when attacked by the fly. This, however, only affords temporary protection, since the fly returns to the attack as soon as the animals leave the furrow. All modern books on sheep raising undoubtedly contain the latest and best remedies for all parasites of sheep. One or more good books of this kind should be in the hands of every sheep raiser.

OX BOT FLIES, WARBLE FLIES.

The genus *Hypoderma* includes species of bot flies which make tumors on cattle, and while not very abundant in Minnesota, their presence on our dairy cows or beef stock, even in limited numbers, makes them of special interest. Like other bot flies, they lay eggs on the hairs in spring and summer, and these eggs are either hatched by the moist friction of the tongue of the animal, the tiny maggots finding their way into the mouth by subsequent licking, or the eggs themselves are carried into the mouth and hatched there. In this event the young maggots migrate down the gullet, through its walls and other tissues of the victim, until they reach the skin, where (generally some time after Christmas) they appear, forming the swellings known as "warbles". Here, in tumors caused by their own activities, they mature, their anterior end, with its mouth, being at the bottom of the tumor, where the mucus upon which they feed gathers, and the posterior end, through which most of the breathing takes place, is directed upward, and is near the small opening in the hide, apparently made for the purpose of respiration, discharge of excrementious matter, and the escape of the bot. These holes are also called "warbles".

This bot stage or larval stage lasts for nine or ten months, and the vital activities of the bot, if abundant, cause the victim to lose flesh, to fall off in milk, if it is a milch cow, and imparts to the flesh in the vicinity of their work a slimy greenish appearance. This abnormal flesh is called by butchers "licked beef". When mature the bots force their way through the hide, and dropping to the ground, bore an inch

or so below the surface, turn into pupæ, and after about four weeks in this stage, emerge as perfect flies. Until 1890 it was supposed that the eggs were laid on the back, and that the maggots penetrated the skin directly at that place.

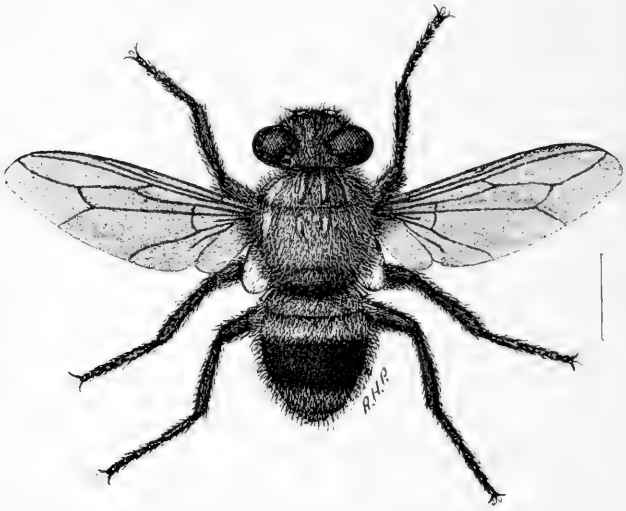


Fig. 127. The Striped Warble-fly or Heel Fly. Enlarged. Lugger.

Hypoderma bovis, De Geer, is the most commonly described ox warble fly, but it is doubtful whether this species is found in the United States, and probably the injury to stock in this direction should be ascribed to the Striped Warble Fly, or Heel Fly, *Hypoderma lineata,* Villers, shown in Fig. 127. This is a hairy fly, looking a little like a dark colored bee. There are yellowish white hairs on the thorax, while above the abdomen is banded with black and whitish. Four lines on the thorax give its name, the Striped Warble Fly. The name "Heel Fly" comes from the fact, according to the statement of cattle men in the Southwest, that it lays many eggs on the heels of the cattle above the hoofs. The eggs are attached to the hairs by a peculiar clasping apparatus at one end.

It would appear from a report appearing in the *Farmers' Review* for 1889 that at that date this parasite was practically unknown in Minnesota and Dakota. But that we have it now to some extent is an undisputed fact, and doubtless it will increase in time, as more stock

is raised here. In the same year (1889) seventy-three per cent of cattle marketed in Chicago from Illinois during the bot season (January to June) were infested; 71 per cent of Iowa shipments showed infestation, and 48 per cent of the cattle from Indiana; 33 per cent of the cattle from our neighboring state, Wisconsin; 56 per cent of Ohio cattle; 57 per cent of Missouri cattle; 60 per cent of the cattle from Kansas, and 57 per cent of the Kentucky cattle. In each case the loss on the hide was one-third; that is, "grubby" hides were docked one-third their value. In summing up it may be said that the loss from warble flies during that year, on cattle shipped to the Chicago market alone, was $3,337,565.00.

Remedial Measures:

The bot may be squeezed out of the tumors on the back of milch cows, and killed, enlarging the opening a trifle with a clean knife, if necessary, or a drop of kerosene, or a little mercurial ointment may be introduced through the opening of each tumor. This squeezng out of the bots causes some pain, it must be confessed, as is evidenced by the cattle wincing during the operation. After the bots have been removed or killed within the tumors, the latter should be dressed a few times with vaseline in which carbolic acid has been mixed, or with some other healing and sterilizing ointment.

These tumors can be easily detected, when present, by running the hand over the back of the animal. A mixture of one part of powdered sulphur and four parts lard rubbed into and over openings of tumors will kill the bots.

If the eggs on the hairs are moistened with kerosene when first observed they will not hatch. Repellent materials which are persistently sticky, such as fish oil, or a compound of pine tar and kerosene (it is not safe to use too much kerosene) and fish oil, may be frequently smeared over the back, sides, belly, fore legs and roots of the tail of stock running in pasture, and will in a great measure reduce the evil. This is not always practicable. Of course, the flies will find some animal poorly protected, and this animal will suffer all the more on account of the protected condition of its mates. Fish oil emulsion, first used against the horn fly, might well be used on stock running in pasture, both for the ox warble and the horse bot fly. It is inexpensive and easily applied, and those who have worked with it claim its effects

last four or five days. If the stock is inclosed, and a knapsack sprayer used, a large number of cattle may be treated in an hour. The emulsion is made as follows: Dissolve one-half pound of common hard soap in one gallon of boiling water; add gradually two gallons of fish oil, churning the liquid through a force pump for several minutes, and when wanted for use dilute by adding 15 or 20 parts of water to one part of stock solution. The Department of Agriculture has recommended tar, or the following mixture: Sulphur four ounces, spirits of tar one gill, whale oil one quart; one application each week.

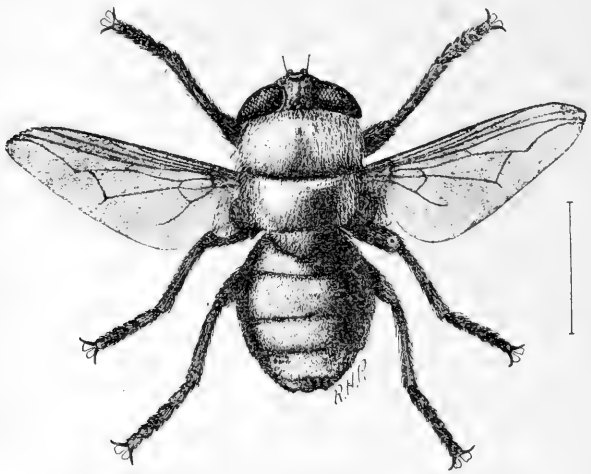


Fig. 128. Emasculating Bot-fly. Enlarged. Lugger.

Naturally, housed animals are not so subject to attack, and if animals in the pasture can resort to a shed, to deep shade, or to water, they are much less troubled than those not so protected. Those in charge of milk cows or other cattle kept in barns should be on the lookout at the proper time for bots along the back or eggs on hairs, and when seen take prompt measures. Co-operation is absolutely essential in this, as in other farm practices, to insure the best results. In Texas, on the ranges, where the attacks of the ox warble fly are felt very severely, cattle are said to be driven frantic at the approach of the pest, running for the nearest body of water, there to remain for several hours. Animals are frequently mired in this way. This species is said to sometimes, though rarely, attack man, the cattle tender, the odor of whose garments deceives the flies.

The genus *Cutebra* contains a number of bot flies, some of them common in Minnesota, of special interest, although not of decidedly economic importance. These are the flies whose larvæ we find on rabbits, generally on the neck, and frequently on gophers and squirrels. Unidentified bots, possibly belonging to this genus, have been taken from beneath the jaws of kittens. *C. cuniculi* is a common bot found

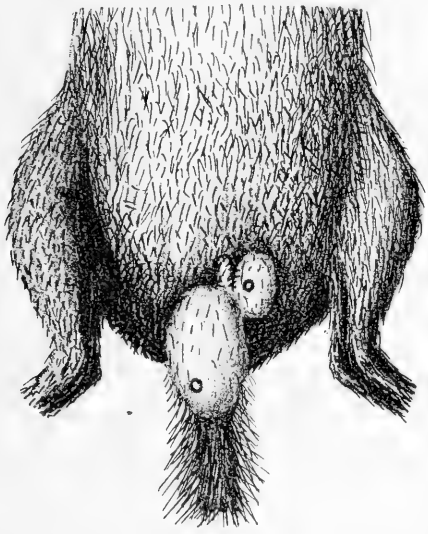


Fig. 129. Larvae of Emasculating Bot-fly in Striped Gopher, natural size. Lugger.

on the rabbit, and *C. fontinella,* Clark, has been taken from the rabbit in New Mexico. Squirrels are sometimes found emasculated, which is undoubtedly the work of the emasculating bot fly, which may be the species shown in our illustration, and not the work of other squirrels, as was at one time generally supposed. Fig. 129 shows a portion of a striped gopher with larvæ of the emasculating bot fly in the scrotal region. There is much to be learned regarding the species of this genus in Minnesota, but such knowledge is not of special value to the farmer. We have here, to our certain knowledge, two or three species, *C. baccata, C. horriphilum,* and probably others. These are large flies, as shown by the hair lines on the side of the figures. They are more or less hairy, with large eyes. One species has red eyes, and is marked with yellow, white and black. Another has dense, brownish fur on the thorax, and another is entirely black.

This important family, *Oestridae*, contains about seventy or more species, and it is claimed that for the most part each species is confined to one species of mammal. Williston states that seven species of

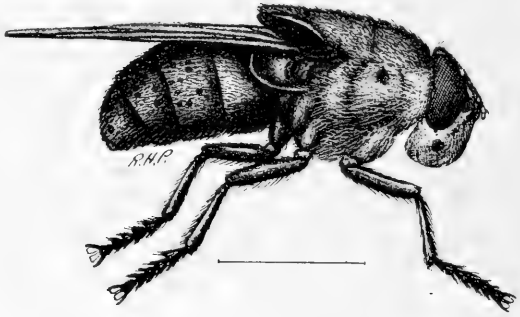


Fig. 130. *Cuterebra buccata.* Enlarged. Lugger.

Gastrophilus are found in the stomach and intestine of the horse and ass. Thirteen species of *Hypoderma* are known to live under the skin of the horse, the ox, the buffalo, the sheep and the goat; four species are found on the antelope and the musk deer. A species is also found on the reindeer, and bots have been found in the neck of a hog, possibly *Cephenomyia,* which infests deer. We have no proof of members of this family attacking birds or reptiles. That some of its members at times, in common with certain *Muscidæ,* attack man, we have undisputed evidence. As mentioned above, the ox warble has been known to attack parties taking care of cattle, *lineata* having been positively identified in a human host, and *bovis* in Europe is said to have been also identified in man.

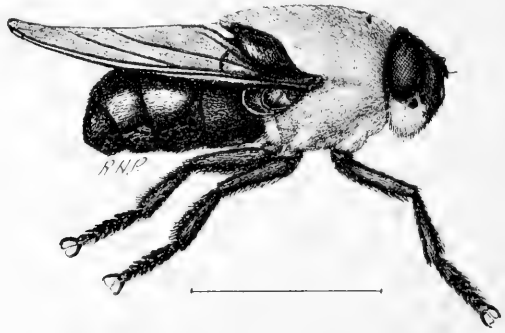


Fig. 131. *C. horripilum.* Enlarged. Lugger.

Mr. Logan reported to the editor of *Insect Life,* some years ago, that while in the forests of the United States of Colombia looking for mahogany, far from cattle or the habitations of men, he was much troubled by bots living under the skin of his back and shoulders.

Mr. John Hamilton, in the *Entomological News* Vol. 4, claims that in South America the bot fly, which he at the time recorded as *Oestrus hominis,* deposited eggs under the skin of the bellies of the natives, and the larvæ sometimes produced in them fatal ulcers. This may have been *Hypoderma bovis,* or more probably *Dermatobia noxialis.*

Fig. 132. Bot of Man, *Dermatobia noxialis.* After Brauer.

There are many examples of the occurrence of this latter species in man. The same physician also reports a case which came under his attention of a six-year-old boy who had been on a farm in Illinois the fall before his attack. He says: "Several years ago I saw, professionally, a boy, six years of age, who had been suffering for some months from the glands of one side of his neck being swollen, and a fetid ulceration around the back teeth of the lower jaw of the same side. Three months' treatment was of no avail, and the end seemed near. One day a white object was seen to move in the ulcer at the root of the tongue, which, on being carefully extracted, proved to be a large grub, which, from having frequently seen them, I recognized as a full grown larva of *Hypoderma.* It was of the usual tawny color, about half an inch long when extracted, and about one-third that thickness, and quite lively. The case ended fatally."

The supposition was that, in some way, when on the farm, an egg was taken to the boy's mouth, and the larva found between the base of the tongue and jaw suitable tissue in which to develop, coming to maturity at the same time as though it had gone into an ox.

The writer wishes in this connection to refer to a case which came under his own notice in 1903. Dr. Foster of St. Paul sent to the entomologist two or three dead larvæ, looking like the illustration shown in Fig. 133. These were taken from a female infant

three weeks of age, born prematurely at seven months, and bottle fed from birth, and came from pustules on the palm of the hand, back of the neck, and between the great and second toes of the right foot. These "worms" were about one-fifth of an inch long. The infant had slept in its carriage out of doors for many hours nearly every day since its birth. The larvæ were sent to a specialist in Washington, who identified them as *Gastrophilus epilepsalis,* French. Banks, however, Canadian Entomologist, December, 1903, claims that it is wrongly named. This same specialist identified French's original larvæ and doubtless had the type with which he compared my specimen. A case somewhat similar to this was reported in 1899 by Dr. H. C. Adderly of Illinois. In this case a boy, ten years of age, had been suffering for four years from epileptic spasms, sometimes having twenty spasms in twenty-four hours. The patient was constipated, and upon the use of a cathartic, hundreds of maggots were seen in the excreta. These were sent to Prof. French, and he named them *Gastrophilus epilepsalis,* as above, and this species sent me by the Minnesota physician is claimed to be identical with the one named by French. It is to be regretted that the larvæ were not sent alive, so that they might have been reared to the adult stage, in which stage they could have been identified absolutely.

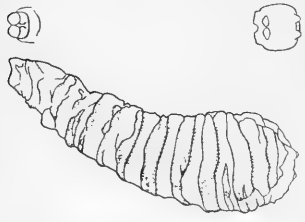


Fig. 133. Maggot taken from under the skin of a three-weeks old infant. Original.

In this connection it may be said that this department would thoroughly appreciate specimens of this kind coming to the notice of physicians over the state. They should be sent to the office of the entomologist, securely packed in some moist cotton, or in moist earth, and upon their arrival would be so cared for that they would undoubtedly complete their transformations. The writer would be very glad to give any one sending such maggots the benefit of any and all information obtained from rearing them.

Minnesota species: *Gastrophilus equi,* Clark; *G. haemorrhoidalis,* Linn.; *G. nasalis,* Linn., from sheep; *G. epilepsalis,* French (doubtful; probably not an *Oestrid*); *Hypoderma lineata,* De Vill.; *Cuterebra buccata,* Fab., from throat of Neotoma; *C. grisea,* Coq., from Gopher; *C. horripilum,* Clark.

SARCOPHAGIDAE,
The Flesh-Flies.

As their English name intimates, these flies, for the most part, seek flesh, not only for food, but also to deposit their eggs, thereon,

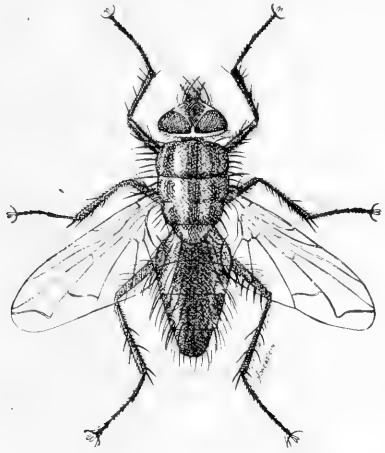


Fig. 134. A Sarcophagid. Lugger.

and carcasses of dead animals attract them in large numbers, as well as the blow fly, which latter species belongs to the family *Muscidæ*. Some species of Sarcophagids seek dung or rotting vegetable matter or fruit for feeding and oviposition. The larvæ of some attack the nasal cavities or ulcers on man and other animals. It is claimed that 20,000 eggs have been found in the ovaries of one Sarcophagid.

Some species of the genus *Sarcophaga* give birth to living larvæ and, according to Williston and other writers, have been found under the skin of turtles, in the stomach of frogs, etc. Still other species of this genus destroy locusts, attack the army worm, etc. The larvæ of several species are known to occur in snails, in beetles, in pupæ of moths, etc.

Aldrich lists about 118 species as North American (1904), and of these 102 *belong to the genus Sarcophaga.* The habits of some of these latter are interesting. *S. assidua,* Walker, has been reared from human excrement, also bred from a destructive "grasshopper" or

locust. *S. carnaria,* Linn., it is interesting to note, does not occur in the United States, though frequently figured and referred to as found in this country by Riley, Lugger and others. In fact, this is a very common error to be found in older publications on Entomology. All references, therefore, to this species as occurring in North America, undoubtedly refer to some other or several others. Riley found what he supposed was this species parasitic on eggs of Rocky Mountain locusts, and also on the growing insects. Dr. Hugo Summa records (*St. Louis Medical & Surgical Journal,* May, 1889) a case of nasal myiasis in man, due to a species of *Sarcophaga,* which he supposed was *carnaria.* Dr. Walter B. Johnson, in *Ophthalmic Record,* 1892, gives an account of a larva referred to this species, in the ear of man.

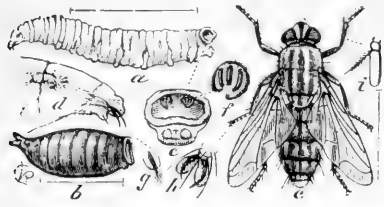


Fig. 135. *Sarcophaga,* sp., which preys upon the eggs of "grasshoppers" or locusts. After Riley.

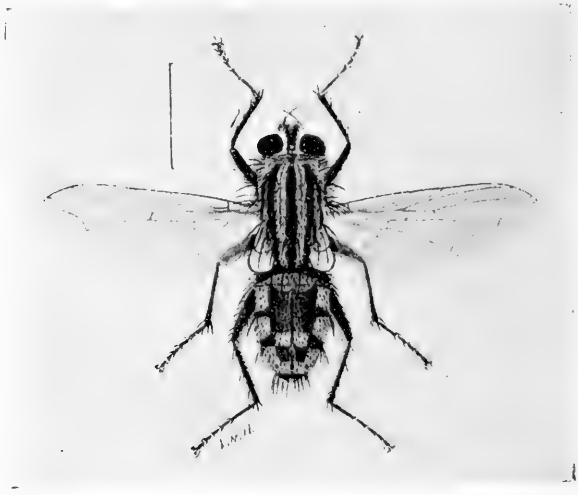


Fig. 136. *Sarcophaga sarracenia.* Lugger.

S. davidsonii, Coq., is claimed to prey upon the eggs of spiders. *S. helicis,* Townsend, has been reared from a May beetle or "June Bug". *Lachnosterna,* sp., and from "grasshoppers," from the cabbage worm

and from the army worm. *S. incerta,* Walker, has been bred from cow dung; *S. quadrisetosa,* Coq., breeds in the excrement of man and cattle; *S. sarracenia,* Riley, a very common species in Minnesota, has been reared from human excrement as well as from "grasshoppers."

Enough species have been cited to give an idea of the habits of the family, useful in many things, but a menace in others. How people can tolerate in their dwellings the presence of house flies and others which are found with them, after knowing their habits, is beyond the comprehension of an entomologist.

We list the following species from Minnesota: *Sarcophaga helicis,* Town., parasitic on *M. atlanis; S. sarracenia,* Riley; *S.* sp.

MUSCIDAE.

(*In Strictest Sense.*)

House Flies, Blue Bottles, Horn Flies, Stable Flies, etc.

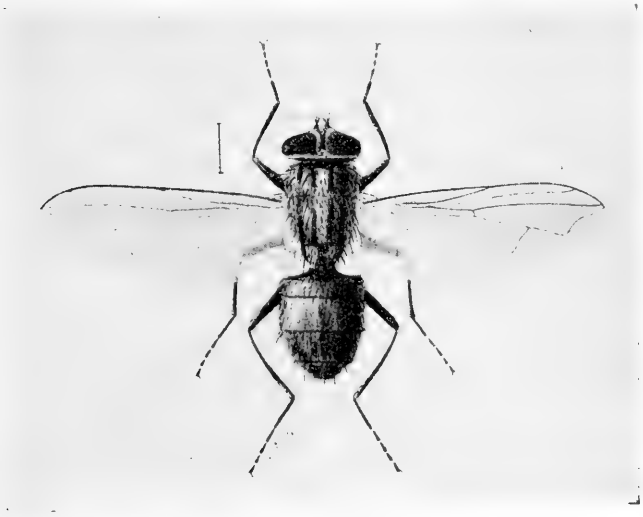


Fig. 137. House Fly. Lugger.

Equalling, if not exceeding in importance any other family, on

account of certain disease-introducing relations to man, this family is of peculiar interest, not only to the entomologist, but to all persons interested in hygienic living. Some one quite truly said, shortly after the Spanish war, "We lost only two hundred and fifty men by bullets, but five thousand by the agency of house flies," referring to the typhoid epidemic in some of the southern camps directly traceable to the actions of house flies, and so reported by the commission sent to investigate. This commission found that house flies, after frequenting the open trenches of filth accumulating at the hospitals, flew directly to the mess tables of the soldiers.

In this family occur the Blue Bottles and "Green Bottles," the Horn Fly, House Fly, Stable Fly, Screw Worm Fly, and others which either cause annoyance to man, and sometimes disease, in the house and elsewhere, or affect stock seriously. In our Civil War the sufferings of wounded soldiers in the field, by having their wounds "blown" by flies are said to have been greatly increased. In South Africa the Tsetse Fly (pronounced setse), *Glossina morsitans* (see Fig. 5) a close cousin of the stable fly, is the carrier of an organism which, when in the blood of certain animals, produces Nagana, or the "fly disease."

There is another side to the shield, for some members of this family are useful in the early stages of their existence. The rapidly multiplying blow flies remove carrion which might otherwise offend our nostrils; the dung feeding species help to remove this from pastures and elsewhere, and the larvæ of at least one species are useful in eating the eggs of locusts.

Formerly this family contained a large number of groups of somewhat diversified flies, which groups are now separate families, some thirty-five or more. We prefer to discuss the *Muscidæ* in its more modern, restricted sense, taking up the other families, i. e., the Bot Flies, Flesh Flies, Tachina Flies, Anthomyids and others which used to be included in the Muscidæ, in their proper places.

All true Muscids unite in certain well defined characters. They are short flies, either bare or only slightly hairy, the bristle (arista) on each antenna is usually plumose, or feathery, and the first posterior cell of the wing (Comstock's III 5) is either distictly narrowed or closed; the abdomen is not bristly, except occasionally at the tip; the winglets "alulæ," at base of wings are always of good

size in this family, and strikingly enough, the "halteres" or balancers are small in proportion as the "alulæ" are large.

THE HOUSE FLY.

Musca domestica.

Found practically over the entire world; lays its eggs in piles of horse manure, or, in the absence of this preferred larval food, in other filth, one female depositing as many as 160 eggs. In twenty-four hours the egg hatches, and the life of the maggot or larva is from five to seven days. It then changes to a pupa, the skin of the larva hardening to form a brown pupa case or puparium, and after from five to seven days the perfect fly emerges.

When cold weather comes, some adults hibernate in protected situations indoors and out, and emerge at the arrival of the first warm days in spring, only to hide in their retreats again if the weather becomes cold. Cold weather occurring during the breeding season, retards development, and it is claimed that this fly can winter in the pupal stage. Late summer brings to the adult fly diseases in the shape of fungi, which attack and kill them; small mites fasten themselves upon them, either as parasites or for transportation and at all times in the summer they are the legitimate prey of the dragon flies, wasps and other predatory animals.

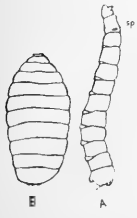


Fig. 138. Maggot and puparium of House Fly. From Packard.

At least one of the disgusting habits of this species has been referred to on a previous page, in discussing the family, and no careful housekeeper is going to allow house flies about the food in the house. A darkened pantry is not disturbed by flies. As is well known, typhoid fever is caused by a germ which, at a certain stage of the disease, is known to be present in the excreta of patients. Since these, or closely, allied germs, may be present sometimes in fæcal matter of parties not necessarily showing symptoms of the disease, and since the common house fly is a frequenter of such filth, the need of hygienic methods in the environment of the farm house need not be emphasized further. Privies should be covered, or

Fig. 139. Dead House Fly with mites attached. Lugger.

Fig. 140. House Fly killed by fungus disease. Lugger.

means taken to destroy or cover with earth or ashes fæcal matter as soon as deposited. A large number of Diptera breed in human excrement. Dr. Howard says that out of seventy-seven species of Diptera

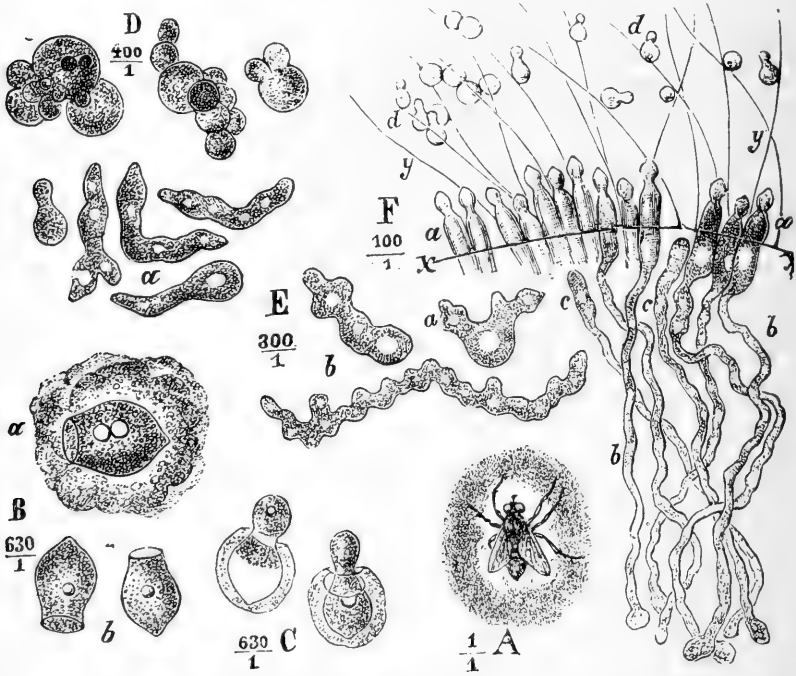


Fig. 141. Details of fungus which kills house flies, as seen under the microscope. *A*, fly on pane of glass, surrounded by characteristic halo; *B*, *C*, *D*, *E*, and *F*, different stages in the growth of the fungus. The fractions by each capital letter show the amount of enlargment of each figure. After Brefeld.

studied in this connection, thirty-six were found to breed in human faeces, while the remaining forty-one were captured on such excrement. It should be said in connection with the facts cited regarding typhoid epidemics in our southern camps during the Spanish war, that Surgeon General Sternberg was thoroughly alive to this danger, and issued directions covering this point, but these directions were not regarded. Flies have been carried by railway cars and other conveyances into districts where they were not previously present. The writer, when in Oregon, was told by some one of the old settlers, that before the advent of the railway in Western Oregon house flies were unknown there.

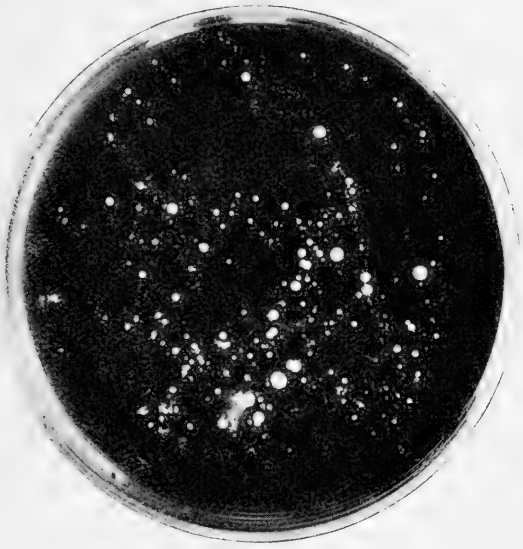


Fig. 142. A petri dish containing agar, over which we allowed a house fly to crawl. The white spots are colonies of bacteria started by germs on the feet of the fly. Original; courtesy of Mr. Beebe of the Veterinary Department.

THE STABLE FLY.

Stomoxys calcitrans, Linn.

Resembling the house fly so closely in general appearance as to be classified as such by the ordinary observer, until what he regards as a "house fly" pierces his skin, causing for an instant a sharp pain. This common mistake is enhanced by the fact that the stable

fly sometimes, particularly in the fall, enters the house. It is an unpleasantly evident fact that stable flies can penetrate thin clothing with their sharp beaks. It is found in large numbers about stables,

Fig. 143. Stable Fly. Enlarged. Lugger.

hence its name, where it annoys stock. Like the house fly, it lays its eggs in, and the larvæ feed upon, fresh horse manure. Disposing of this horse manure promptly lessons the evil. Stock is but little molested in a darkened stable.

Fig. 144. Mouth parts of Stable Fly, much enlarged. The pointed proboscis projects in front of the head. Lugger.

THE HORN FLY.

Hæmatobia serrata, R. Desv.

So called because of its habit of clustering at the base of the horns of cattle (see illustration). It in no way injures the horn, though it at one time was believed to do so. Such a situation ap-

pears to afford it a safe resting place when not engaged in biting. It is to be noted that when it is resting its wings are pointing backward, whereas, while biting, its wings make more of an angle with the body.

This fly is about half the size of the common house fly, which it very much resembles. Dark colored, particularly black, cattle, suffer more than light colored animals. Eggs are laid in manure freshly dropped from the animals they attack. Moist weather, by conserving the moisture of the droppings, is conducive to the increase of this pest; hence, a wet and muggy summer will produce more flies than a very dry summer. Some go to the trouble of scattering the droppings in the pasture with a shovel, or by dragging brush across the field, thus insuring the speedy drying of the manure, and the depriving of the larva of its food. Some also place a spadeful of lime on each dropping—an action which is not always practicable; furthermore, lime so changes the character of the manure as to make it (the manure) less desirable as a fertilizer. The use of kerosene or kerosene emulsion on cow droppings in the field would be preferable to lime, or (and cheaper) the scattering of the droppings, as already suggested. While the use of lime is not desirable, gypsum or land plaster, on the other hand, conserves the qualities of the manure, and may well be used on a manure pile in yard or in stable.

Although this genus and species is troublesome in most of the United States, it is said to cause no trouble in England, where it is also found. The species was introduced into America from Europe probably about 1886, or a little before. Now the horn fly is found in almost every state east of the Rocky Mountains, and in many sections of Canada. The irritation and worry caused by their attacks result, when the insects are numerous, in loss of flesh, and, in the case of milch cows, a falling off in milk.

At the Experiment Station a few years ago we found that a mixture of one pound of rancid lard and one-half pint of kerosene, mixed thoroughly until a creamy mass formed, gave excellent results as a preventive, when rubbed with a cloth or with the bare hand, not too thickly, over the backs of a few cows, lasting for two or three days, and keeping away all kinds of flies, apparently, which frequent stock here. About three-eighths of a pound was used for each full grown

animal. Three parts of fish oil and one part of kerosene sprayed over steers also gave excellent rsults, and is manifestly the practical thing when many are to be treated. Fish oil costs in Minneapolis about 45 cents per gallon in barrel lots, 48 cents in half barrel lots,

Fig. 145. Horn Flies on horn of cow. Original.

and 60 cents for single gallons. Spraying an animal is best done with a knapsack sprayer, and it takes two or three minutes to spray each creature. This spray appeared to keep off horn flies and all other flies for two days. If a herd were to be treated, a man with some kind of spraying machine might stand on either side of a narrow passage, through which the animals had to pass, and quickly treat a large number. If the writer were keeping two, three or four family cows, he would not hesitate to use either one of the two remedies above described, which he has tried and found good. He was so situated, however, when keeping a cow, that he could turn his cow into the pasture at night during the hot weather and "fly time," and thus avoid trouble, keeping her in a dimly lighted stable during the day. They were observed this year at St. Anthony Park, May 19th.

Prof. Weed, in a Mississippi bulletin (No. 28), states that he found a mixture of two parts of crude cotton seed oil, or fish oil, with one part of pine tar very successful. It took him half a minute to apply this to each animal, using a large paint brush for the purpose. He claims that the efficacy of this wash lasted for a week or more.

To kill the flies Mr. Weed used a mechanical mixture of kerosene and water (two to ten) in a kero-water sprayer. The milch cows at his station were sprayed with this daily for seven days, a special effort being made to have the spray strike the flies. The pests were killed in this way, and, according to his statement, the numbers so reduced that after the seventh spraying practically no flies could be found, nor were they numerous again that season. It is probably to be assumed that this herd was more or less isolated, hence flies from infested herds did not reach it. Kerosene emulsion, one part of the emulsion to six or eight of water, would probably accomplish the same results. Kerosene emulsion is made by boiling half a pound of hard soap in a gallon of water, taking the same from the stove, and while boiling hot, adding gradually two gallons of cheap kerosene, churning the mixture all the time, and for several minutes afterward, through a force pump, until it becomes of the consistency of cream or clabbered milk. This is the stock solution, which should be diluted with water when wanted for use.

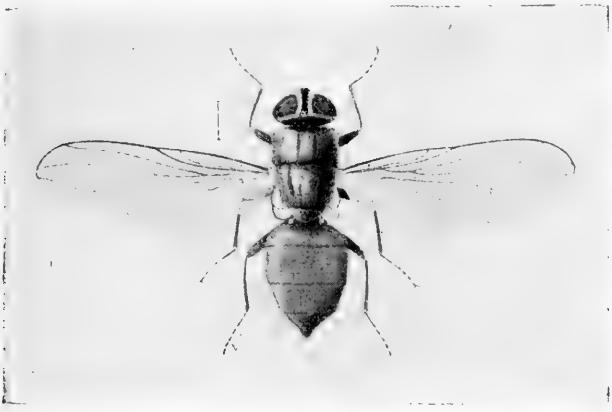


Fig. 146. Horn Fly, enlarged. Lugger.

A compound recommended by several entomologists as excellent, is a mixture of fish oil and crude carbolic acid. A sponge dipped into this, squeezed nearly dry, and passed lightly over the hairs (only the tips need be wet) is quite lasting in its effects. Continued rains will wash this off, as it will other compounds of similar nature.

Very fine tobacco dust sifted into the hair on the back, and wherever it will find lodgment, and the above wash applied to other parts which will not hold the dust, will obtain good results. Prof. J. B. Smith of New Jersey, reports success with this treatment, and says that tobacco dust is fatal to the horn fly, if the fly stays on the back of the animal where the dust has been scattered, long enough to bite. It is said by some to be one of the few things which will repel the stable fly.

A device, which we have never seen, to be arranged in a doorway of a stable, or, with certain modifications, in a pasture, has been extensively advertised in the papers. It consists practically of a passageway in which brushes are so arranged that when a cow enters the stable, the flies on the back or flank are brushed off, and rise into a glass dome above, attracted by the light. This constitutes a trap, for they never go down, and can bekilled there or allowed to die. It has been claimed that when some such contrivance is placed in a pasture, cows soon learn that they can obtain relief by passing through it.

THE BLOW FLY OR MEAT FLY.

Calliphora vomitoria, Linne.

Fig. 147. Blow Fly, enlarged. Lugger.

A large blackish fly with bluish abdomen. When cabbage or cauliflower or corned beef is being cooked, it is mostly these flies which come about the kitchen door, or inside, if the latter is not screened, in large numbers. They lay their eggs, from 300 to 600, which quickly hatch, upon meat and vegetables, and are at times a great nuisance. This species is well illustrated on Plate I, Fig. 12.

Packard says that in the Civil War wounded soldiers lying on the field were tormented by these flies endeavoring to lay eggs in their wounds. Wounds on stock should be quickly dressed with weak carbolic acid (one part of carbolic acid to thirty parts of water), and then coated with tar (U. S. Department of Agriculture). If eggs are already in the wounds, they should be removed carefully, the wounds washed with the above carbolic acid solution, and dressed with tar.

THE GREEN BOTTLE FLY.

Pseudopyrellia (Lucilia) cornicina, Fab.

Fig. 6, Plate I, is common on stock, laying its eggs on dung in the pasture. Observed this year as early as March 24th.

THE BLUE BOTTLE.

Lucilia cæsar, Linne.

This fly hibernates in the perfect or imago stage, and appears quite early in the spring, laying its eggs in meat, and also, it is said, in the putrid mass of dead insects found in the pitcher plant, *Sarracenia.* The maggots live on the decaying matter, and pupate, but when they emerge as flies they are held as prisoners, and are added to the rotting mass in the plant. This fly also attacks stock.

THE SCREW-WORM FLY.

Chrysomyia (Compsomyia) macellaria, Fab.

This fly (see illustration) is not only an annoying pest to stock in the South, but it is to be dreaded on account of its pernicious habit of laying eggs in wounds and other openings in cattle and men, sometimes even in the nostrils and ears of human beings sleeping out of doors or in unscreened houses. The larvæ or maggots, by their activities in such localities, cause sickness and frequently

death. This species is about one-third of an inch long, metallic green, with reddish eyes, resembling a little the Green Bottle, but

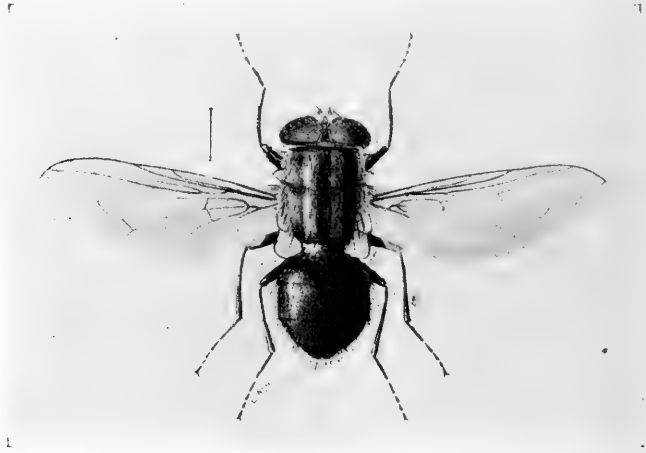


Fig. 148. The Screw-worm Fly, enlarged. Lugger.

with three dark stripes on the dorsal part of the thorax, see Fig. 148. Although this fly is found in Minnesota, fortunately it does not appear to commonly attack man in the northern states. The egg is one-sixteenth of an inch long, yellowish; it hatches a few hours after being laid. The maggot, when full grown, is three-fourths of an inch long, tapering toward one end, with the posterior end truncated. It gets its name of "screw-worm" from the fact that a ring of bristles runs around its body between each segment, causing a fancied resemblance to the thread of a screw. From four to six days after hatching it becomes full grown. At this time it leaves its food, and goes into the ground to pupate. In about seven days the fly emerges.

The Screw-worm Fly attacks also sheep, horses and hogs. Weed says that in the case of hogs the chief point of attack is the ears. The odor arising from catarrhal conditions in man appear to attract it, and we have several instances in this country of the fly laying its eggs in the nostrils of man sleeping in the daytime out of doors, causing disastrous results. Dr. Howard McI. Morton of Minneapo-

lis, in 1895, reported two cases, possibly this fly, where the ear was the point of attack. The writer was not here at that date, and finds no specimen thus labeled in the collection.

Three cases of some interest, not occurring in this country, are mentioned here. In one case 250 larvæ or maggots were found in the nasal fossæ of a sixteen-year-old girl. The second case was that of an old man with an ulcer on his leg, filled with maggots. The third case was that of a three-year-old boy attacked in his left ear. These are only a few of many which are on record. In cases where it is known that eggs have but recently been laid in the nostrils, if a physician cannot be obtained at once, the nasal passages should be most thoroughly syringed with a solution of one part of carbolic acid to 200 parts of water.

Methods of Preventing Attacks of the Fly.

Sores made by barbed wire or otherwise on domestic animals should be immediately dressed. A solution of one part of carbolic acid in 30 parts of water makes a good dressing; or a mixture of one ounce of oil of tar in 20 ounces of sweet oil is also recommended. Carcasses of animals dying or killed on the farm should be buried.

Fig. 149. *Morellia micans.* Original.

When human beings are infested a skillful physician should at once be summoned.

This fly is found in North America, Mexico, Cuba, Columbia, Venezuela, Cayenne, Brazil, Peru, Chili, Uruguay, Argentine Republic and New Holland. It is more injurious in tropical and subtropical countries than elsewhere.

Species of *Muscidae* taken in Minnesota are as follows: *Stomoxys calcitrans,* Linn.; *Calliphora vomitoria,* Linn.; *Compsomyia (Lucilia) macellaria,* Fab.; *Cyrtoneura,* sp.; *Pollenia rudis,* Fab.; *Pseudopyrellia cornicina,* Fab.; *Lucilia caesar,* Linn.; *Musca domestica,* Linn.; *Morellia micans,* Macq.; *Muscina stabulans,* Fall.; *Haematobia serrata,* Desv.; *Graphomyia maculata,* Scop.

TACHINIDAE.

Tachina-flies.

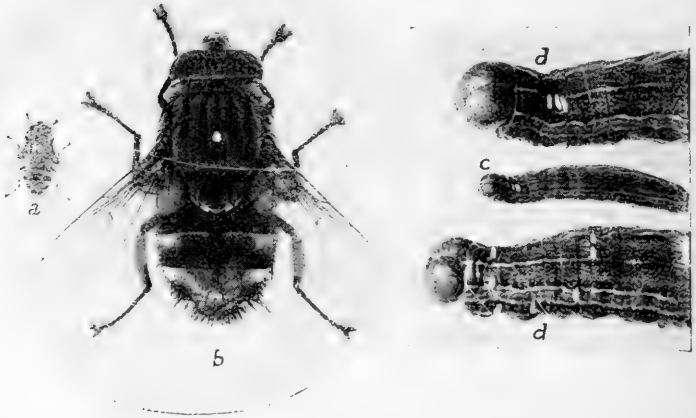


Fig. 150. The Red-tailed Tachina-fly, *Winthemia pustulata,* a parasite of the Army Worm; *a,* fly, natural size; *b,* fly enlarged; *c,* Army Worm, natural size, upon which eggs have been laid; *d,* parasitized army worms, much enlarged. After Slingerland.

This extremely beneficial family, from the standpoint of the ariculturist, is well represented in this state, we having taken here 25 species, and almost every species found here is represented by many individuals. These flies are useful in that the larvæ are parasitic, living for the most part inside of caterpillars which prey upon our

fruit and shade trees, vegetables, grain, etc. The female lays her eggs upon the caterpillar, and the young maggot, upon hatching, bores its way into the tissues of its host, where it lives until full grown. A caterpillar so attacked, and very many are thus affected, is sure to die. The white eggs of these useful flies can frequently be seen upon caterpillars, looking much like the representation in Fig. 150, which shows on the right two caterpillars upon which eggs have been laid. This is a common species, and has been bred from at least fourteen different host species, among them the common large Cecropia moth. This species also occurs in Europe. There is no question but that this family, from its parasitic habits and abundance, is practically first in importance among insects which are indirectly beneficial to man. While they frequently waste their eggs by depositing them in undesirable places, they compensate us by choosing a great variety of victims from among injurious insects, a single species of Tachina fly having been known to parasitize insects of two or three different orders. It must be confessed, how-

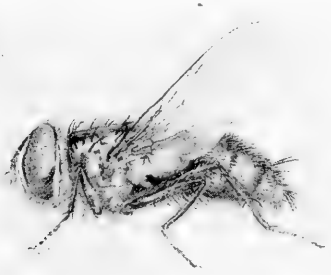


Fig. 151. Side view of fly shown in Fig. 150. Original.

ever, that under certain conditions some of the members of this family injure us by attacking insects which are useful. *Ugimyia sericariæ*, for example, in Japan attacks the silk worm. It is believed that this cunning fly lays its eggs on the mulberry leaves which are eaten by the silk worm. As many as five of the maggots of this fly may be found in one worm, of which rarely more than one is said to reach maturity.

These flies, which are so generally useful in this state, are generally grayish or black, or gray and black. The largest one in our collection is nearly or quite an inch long. This species, *Echinomyia*

(*Jurinia*) *algens*, Weid., Fig. 8, Plate I, is black with yellow marking on back part of the head, and with the alulæ or scales under the base of the wing, yellow, in striking contrast to the shiny black and sparsely haired abdomen, *Bombyliomyia* (*Hystricia*) *abrupta*, Wied., shown in Colored Plate II, Fig. 16, is one of the largest and most striking forms, with its large yellow abdomen scantily covered with blackish hairs. *Peleteria tesselata*, Fab., Fig. 154, looks like a small edition of the previous species.

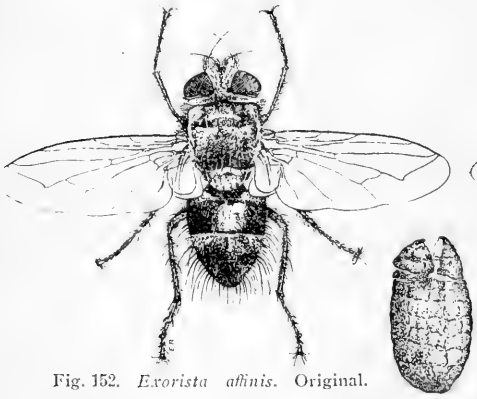


Fig. 152. *Exorista affinis*. Original.

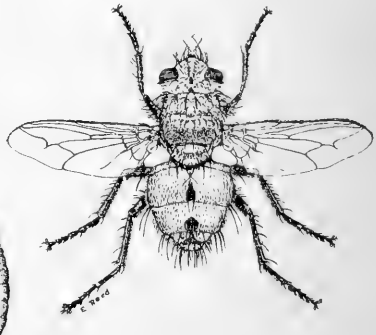


Fig. 153a. *Peleteria tessellata*. Original.

Fig. 153. Puparium of *E. affinis*. Original.

There are apparently 200 or more species of this family in Great Britain, and Aldrich lists 957 species in his Diptera of North America. Minnesota has so far yielded the following species: *Bombyliomyia abrupta*, Wied.; *Belvosia bifasciata*, Fab.; *Blepharipeza adusta*, Loew; *Echinomyia* (*Jurinia*) *algens*, Weid.; *Exorista affinis*, Fall.; *Peleteria tessellata*, Fab.; *P. robusta*, Weid.; *Phyto clesides*, Walk.; *Phorantha occidentis*, Walk.; So. Dak.; *Phorichaeta sequax*, Will.; *Musicera normula*, V. d. W.; *Winthemia quadripustulata*, Fab.; *Tachina robusta*, Town, Fig. 6, Plate II; *T. mella*, Walk.; *Trichophora ruficauda*, Wulp; *Gonia capitata*, De G.; *Gymnosoma fulignosa*, Desv.; *Frontina frenchii*, Will.; *Senotainia trilineata*, Wulp.; *Sturmia inquinata*, Wulp.; *Ocyptera carolinae*, Desv.; *Archytas analis*, Fab.; *A. aterrima*, Coq.; *A. lateralis*, Macq.; *Hypostena variabilis*, Coq.; *Linnaemyia picta*, Meig. We find an unnamed form in collection labeled "from *Cimbex americana*."

DEXIIDAE.

Small, slender flies closely allied to the *Tachinidae*, and, like that family, parasitic upon various insects, notably the beetles.

Aldrich lists 165 North American species. We have taken in

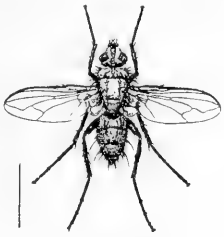


Fig. 154. *Ptilodexia tibialis*. Original.

Minnesota: *Dexia vertebrata*, Say.; *Dexia cremides*, Walk.; *Ptilodexia tibialis*, *Desv.*

HIPPOBOSCIDAE.

Louse Flies.

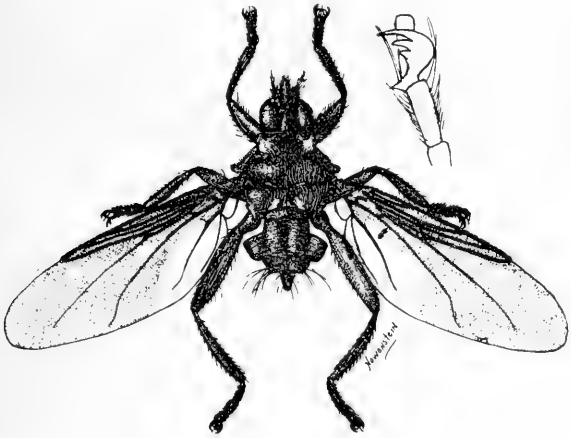


Fig. 155. *Pseudolfersia maculata*. Lugger.

When a boy the writer was much interested in Ornithology, and occasionally in his bird collecting he would secure a specimen (particularly would this be true of horned owls, as he recalls it)

upon and amongst the feathers of which most uncanny flies, about one-third of an inch long, would be observed crawling, slipping in and out amongst the plumage, in an evident attempt to hide, and in creeping over one's hand or through one's hair affording a very unpleasant and louse-affected-like sensation. Though these creatures had wings, they were not, at those times, observed to use them, but they clung with their claw-like feet persistently to the feathers or to any surface upon which they were placed.

These belong to the family of *Louse Flies,* and they are found in the hair of other animals as well as on the feathers of birds. Some of the species are wingless, and still others pass through a winged stage, and then lose these appendages.

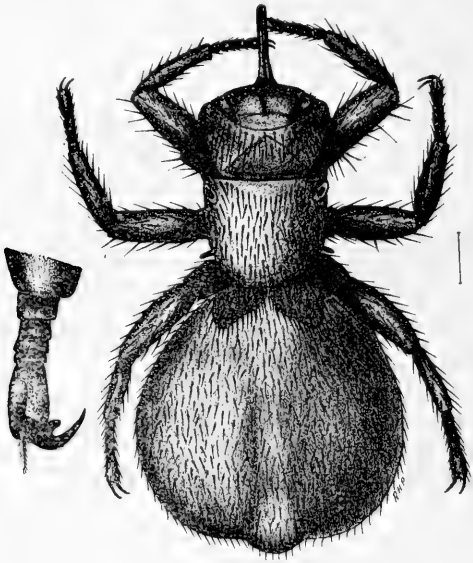


Fig. 156. Sheep Tick and enlarged foot. Greatly enlarged. Lugger.

The sheep tick is found here, a wingless form, especially constructed for crawling through the wool when on the living animal, and bearing not the slightest resemblance, superficially at least, to a fly. Its scientific name is *Melophagus ovinus.* It was described by Linnaeus in 1761 under the name of *Hippobosca ovinus.* It occurs the world over. To the best of the writer's knowledge, this species

is not found on animals other than sheep. The insect is about one-sixth of an inch long, a wingless fly, and is apt to be common where sheep are in crowded quarters, for it is only when sheep are crowded together that this parasite crawls from one animal to another. The female brings forth young in the pupal stage, and the species is most abundant in spring and summer. Lambs suffer particularly just after the older sheep have been sheared, for in the hair of the unsheared lambs the ticks find a safe retreat and succulent food close at hand. As many as 100 ticks can be found sometimes upon one lamb.

Treatment.

Scrubbing or combing or washing with water will do but little good. Dipping with some insecticide is the only sure remedy. At the State Experiment Station at St. Anthony Park dips made from coal tar or creosote products are used one gallon of dip to one hundred

Fig. 157. Head of sheep tick, much enlarged. Lugger. Below, uterus-like enlargement of oviduct. After Leuckart.

gallons of water, once in the spring immediately after shearing, and again in the fall before going into winter quarters. If they are not so dipped, the ticks, as mentioned above, will migrate as soon as possible to the unshorn lambs. They should be kept in the liquid at least one minute. Sheep added to the flock from the outside should be dipped before they join the home flock to prevent the in-

troduction of ticks and other parasites. Dipped sheep should not be returned at once to the same pen or enclosure occupied before shearing or dipping, but should be allowed to remain for a while in a different enclosure to prevent reinfestation. Wool, if infested when clipped, should be stored at a distance from the sheep in order to be sure that no ticks escape from it and return to the animals. A second dipping should be given about twelve days after the first. However, a careful examination of a few sheep will determine whether there are enough ticks on them to call for this. Dipping for ticks, as above, will at the same time kill lice and many other external parasites; a thorough spraying of the pens or other enclosures, with zenoleum of the strength given above, or with kerosene emulsion, will kill all wandering ticks or mange mites and most other vermin, and is a desirable thing to do.

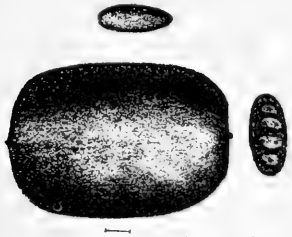


Fig. 158. Young larva and puparium with breathing pores, of sheep tick. Greatly enlarged. Lugger.

A winged form of *Hippoboscid, H. equina,* lives on the horse; another, *Lipoptena cervi,* on the British red deer. The members of

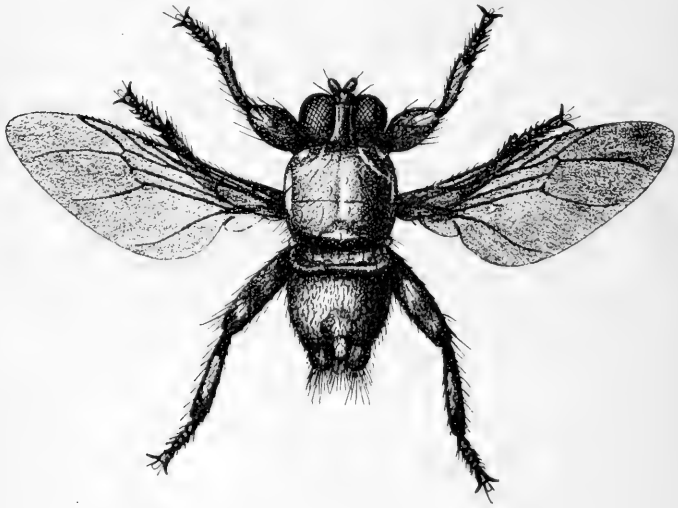


Fig. 159. Horse-tick, or Forest Fly. Lugger.

this latter genus are first winged, and are parasitic upon birds; later they migrate to quadrupeds, and either cast or bite off their wings. Most of this peculiar family, however, live upon birds. Any of the hawks and owls may harbor them, though the swallow is said to be their preference. One in our collection is labeled "from Grosbeak."

Fig. 160. Foot of Horse-tick, greatly enlarged. Horace Knight in Ormerod's Report.

The family is represented in North America by forty-six species, flattened blackish or brownish insects, easily recognized from the above description. These flies are viviparous; that is, the egg is hatched within the mother, the maggot passing its entire larval life in her body, and is born when it is full grown and ready for the pupal stage.

In our collection we have the following Minnesota species: *Melophagus ovinus, Linn.*; *Ornithomyia avicularia*, Linn. (on snow-bird); *Ornithoctona erythrocephala*, Leach. (on broad-winged hawk); *Olfersia americana*, Leach. (from barred owl); *O. brunnea*, Oliv. (on night hawk); *O. ardeæ*, Macq. (on bittern).

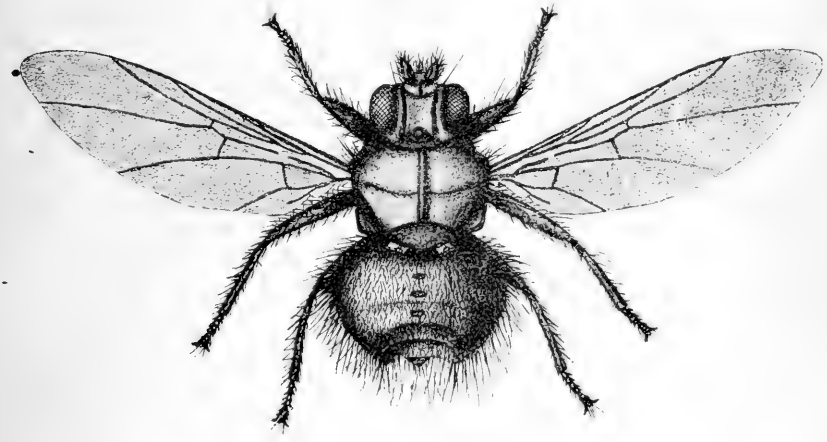


Fig. 161. Louse fly from Grosbeak. Lugger.

NYCTERIBIIDAE.

Bat Ticks.

Fig. 162. Female Bat-tick, showing peculiar appearance of upper surface. From Sharp.

Individuals of this family are rare. North America has only five species, belonging to four genera, and we have never taken them in Minnesota. They are wingless, and live parasitically on bats. They have no compound eyes. Their reproduction is like that of the *Hippoboscidae.*

BRAULIDAE.

Bee Louse.

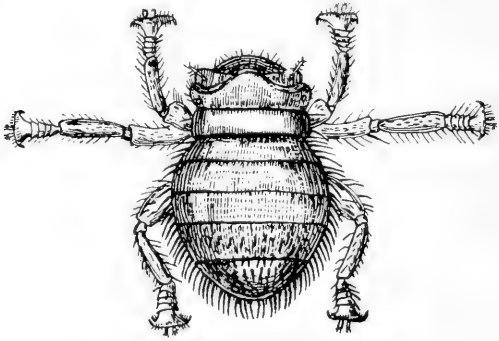


Fig. 163. Bee Louse. After Meinert.

One representative known, *Braula coeca,* about one-sixteenth of an inch long, which lives as a parasite upon the honey bee, and is said to be especially fond of the queen bee on account of the exposed membranes between its body segments. It has no wings, and no compound eyes, yet in spite of its name, *coeca,* it is not blind. It is believed that its reproduction is like that of the *Hippoboscids* and *Nycteribiids,* though there is doubt expressed upon this point.

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GENERAL INDEX.

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MINNESOTA DIPTERA.

Additional species collected in Minnesota, and named since the Annual Report of the State Entomologist for 1905 was printed.

AGROMYZIDAE.

Desmometopa m-nigrum, Zett.; *D. latipes*, Meig.; *Agromyza aeneoventris*, Fall.; *Ceratomyza dorsalis*, Loew.

ANTHOMYIDAE.

Pegomyia bicolor, Wied.; *Hylemya alcathoe*, Walk.; *Schoenomyza dorsalis*, Loew.; *Coenosia*, sp.; *C. lata*, Walk.; *C. flavifrons*, Stein.

BIBIONIDAE.

Scatopsé atrata, Say.

CECIDOMYIDAE.

Diplosis, sp.

CHIRONOMIDAE.

Ceratopogon sanguisuga, Coq.; *C. ciliipes*, Coq.

CULICIDAE.

Culex frickii, Ludlow, n. sp., Fort Snelling, Minn., October 1, 1905.

DOLICHOPODIDAE.

Argyra albicans, Loew.; *Chrysotus*, sp.; *C. obliquus*, Loew.; *Diaphorus*, sp.; *Dolichopus acuminatus*, Loew.; *D. angustatus*, Ald.; *D. batillifer*, Loew.; *D. longipennis*, Loew.; *D. luteipennis*, Loew.; *D. pachycnemus*, Loew.; *D. reflectus*, Ald.?; *Gymnopternus*, sp.; *Neurigona lateralis*, Say-Ald. = *N. superbiens*, Loew.; *N. Nothosympycnus nodatus*, Loew.; *Pelastoneurus vagans*, Loew.; *Sympycnus lineatus*, Loew.; *Synarthus palmarus*, Loew.

DROSOPHILIDAE.

Drosophila amoena, Loew.; *D. punctulata*, Loew.; *D.* (*Scaptomyza*) *graminum*, Fallen.

EMPIDAE.

Hilara femorata, Loew.; *Platypalpus trivialis*, Loew.; *Rhamphomyia fumosa*, Loew.

EPHYDRIDAE.

Hydrellia hypoleuca, Loew.; *Paralimna appendiculata*, Loew., *Psilopa atrimanus*, Loew.; *P. sompta*, Meig.; *Scatella stagnalis*, Fall.

GEOMYZIDAE.

Anthomyza tenuis, Loew.; *Diastata vagans*, Loew.

HELOMYZIDAE.

Helomyza plumata, Loew. = *H. quinquipunctata*, Say.

LEPTIDAE.

Xylomya pallipes, Loew.

LONCHOPTERIDAE.

Lonchoptera lacustris, Meig.; *L. lutea*, Panz.

MUSCIDAE.

Myiospila meditabunda, Fab.

MYCETOPHILIDAE.

Zygoneura, sp.

ORTALIDAE.

Melieria ochricornis, Loew.; *M. similis*, Loew.

OSCINIDAE.

Chlorops proxima, Say.; *Elachiptera costata*, Loew.; *E. longula*, Loew.; *Hippelates flavipes*, Loew.; *H. plebeius*, Loew.; *H. pusio*, Loew.

PIPUNCULIDAE.

Pipunculus nigripes, Loew.

PSILIDAE.

Loxocera cylindrica, Say.

SAPROMYZIDAE.

Lonchea polita, Say.; *Sapromyza longipennis* Fab.; *S. lupulina*, Fab.; *S. philadelphica*, Macq.

SCATOPHAGIDAE.

Cordylura adusta, Loew.; *Parallelomma varipes*, Walk.

SCIOMYZIDAE.

Tetanocera saratogensis, Fitch.

SEPSIDAE.

Nemopoda minuta, Wied.; *Prochyliza xanthostoma*, Walk.; *Sepsis cynipsea*, Linn.

SIMULIIDAE.

Simulium meridionale, Riley.

SYRPHIDAE.

Myiolepta nigra, Loew.

TACHINIDAE.

Cistogaster immaculata, Macq.; *Polidea areos*, Walk.

TRYPETIDAE.

Eutreta sparsa, Wied.; (*Tephritis puciola*, Bigot, = *Eusina humilis*, Loew., Ald.)

. of F. L. Washburn.)

...rm. Rep. for yr. 1905.

...te Entomologist.