THE EFFECT OF CERTAIN CHEMICALS UPON OVIPOSITION IN THE HOUSE-FLY (MUSCA DOMESTICA L.)[1]

By S. E. Crumb and S. C. Lyon

During the summer of 1916 the writers conducted a series of experiments with house-flies to learn, if possible, what substances in horse manure were capable of inciting them to oviposit. In the course of these experiments it was learned that the ether extract possessed this quality in some degree but that the chief incitant remained after complete ether extraction and was a product of fermentation. Further investigation gave positive evidence that this oviposition stimulant was carbon dioxide. A limited series of experiments with ammonia gave negative results.

As the conclusions to be drawn from our experiments did not agree with those of Mr. Richardson[2] it was decided to devise an apparatus for more thoroughly testing the effect of ammonia on fly oviposition and the experiments both with ammonia and carbon dioxide have been continued during the present summer.

The ammonia-testing apparatus (see Fig. 27) consists of a water tank of galvanized iron 7 feet long, 6 inches wide, and 9 inches high set on six legs about 3 feet high and provided with nipples every foot along the bottom. Each of these nipples is connected by tubing with a six-quart can which rests on the table beneath the tank and may be called the compression chamber. This compression chamber is further connected with a pint milk bottle by means of a glass tube which dips beneath the surface of the liquid in the bottle. This bottle rests on the table in front of the compression chamber and contains the ammonia or water used in the experiments. The exit from the milk bottle is through an upright glass tube bearing at its apex a porcelain drying funnel about three and one-half inches in diameter. This funnel has a fixed perforated, porcelain partition about one inch below the lip which bears the material provided as a nidus.

The flow of water from the tank to the compression chamber is regulated to any desired amount by adjustable clamps on the connecting rubber tubes and, as all connections in the apparatus are air-tight, an amount of water admitted to the compression chamber displaces an equal amount of air through the material in the funnel after it has

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[1] Published by permission of the Chief of the Bureau of Entomology.

[2] Charles H. Richardson. The Response of the House-Fly to Ammonia and Other Substances. Bull. 292, New Jersey Ag. Ex. Sta., Feb. 1, 1916. A Chemotropic Response of the House-Fly (Musca domestica L.). Science, new series, vol. 43, 613, April 28, 1916.

bubbled through the liquid in the bottle where the rate of flow is indicated by the number of bubbles produced per minute.

In selecting a material through which to percolate the odors to be tested, it was necessary to obtain something having a texture satisfactory to the ovipositing fly but which did not possess further inciting qualities. After testing asbestos, absorbent cotton, abraded blotting paper, ground chaff, animal charcoal, wheat bran and some other substances, the bran was selected as most nearly fulfilling these conditions. A special grade of this material was obtained which was nearly pure husk. This was thoroughly washed and dried in the sun and before use was moistened, packed in the funnels, and sterilized by steam for an hour or more. The use of this bran did not entirely eliminate eggs in the checks probably for the reason that the texture of the medium may be a secondary stimulant to oviposition.

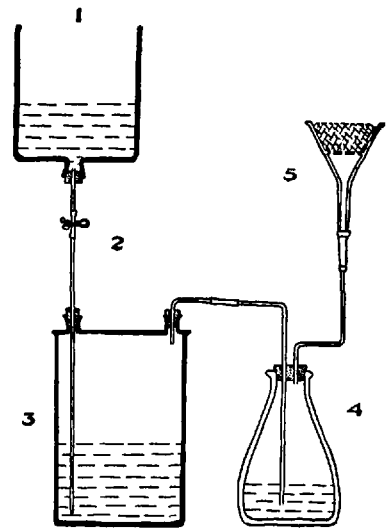

Fig. 27. Cross section of one unit of apparatus for testing the effect of ammonia on house-fly oviposition: 1, Cross section of water tank; 2, connecting tube between water tank and compression chamber. In use the spring clip was replaced by a tubing clamp for regulating the rate of flow of the water; 3, compression chamber; 4, milk bottle containing liquid to be tested; 5, porcelain funnel bearing wheat bran on the perforated porcelain partition.

Each unit of the apparatus for testing carbon dioxide consists of a milk bottle equipped as in the ammonia apparatus (see Fig. 27) excepting that the connecting tube from the compression chamber in the ammonia apparatus is replaced by a dripping funnel having a ground-glass stopper. The bottle was charged with pure carbonate in a little water and the dripping funnel with pure sulfuric acid diluted one to four. When the apparatus was in operation, the acid was allowed to drip into the bottle at such a rate that a continuous slow generation of carbon dioxide resulted. Calcium carbonate was used in the bottle to some extent but the sodium compound was found more satisfactory and was the carbonate chiefly employed. In interpreting the results of the experiments it should be borne in mind that the products of the reaction between the carbonate and sulfuric acid are a sulfate and carbon dioxide and that the sulfate in both cases is non-volatile at ordinary temperatures.

The flies used in the experiments were caught in fly traps and liberated in a cage 6 x 6 x 21 feet square in which the apparatus was set up on a level table. This cage had the roof and one side solid while the ends and west side were of wire screen. Flies of various species were liberated in the cage but all of the eggs obtained in the course of the investigation were placed in a breeding chamber and the house-fly was the only species obtained from the large number of flies bred.

The tests were run from about 10.30 in the morning until 4.00 in the afternoon and at the close of the exposure the funnels were removed and the number of eggs in each recorded. The flies distributed themselves about equally upon the series of funnels and exhibited no noticeable tendency to congregate especially at any of the odors tested. Only in the case of the strongest dosages of ammonia was there a distinct repellent effect after the experiment had been run for several hours.

In the following tables the results of our experiments are summarized:

TABLE 1.—COMPARISON OF RESULTS OBTAINED WITH CARBON DIOXIDE AND AIR

Chemicals	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Carbon dioxide	6:20 to 7:10, '17	11	5,144	47	109.4	
Air (no current)	6:20 to 7:10, '17	11	291	32	9.1	
Carbon dioxide	8:2 to 8:9, '17	7	3,737	28	133.4	
Air (with current)	8:2 to 8:9, '17	7	294	28	10.5	
Totals:						
Carbon dioxide			8,881	75	118.4	92.4
Air			585	60	9.7	7.6

The above series of experiments consists of two divisions, as indicated, in one of which the conditions in the two sets of apparatus were duplicated, air being forced through the bran in the checks after bubbling through water, while in the other no current of air was provided for the checks to correspond with the gentle current produced by the evolution of carbon dioxide. There was also another difference in the two divisions. In the first the two sets of units were intermingled and set only from 4 to 6 inches apart while in the other the checks were grouped at one end of the series so as to reduce the possibility of their being influenced by the proximity of the funnels evolving carbon dioxide. It will be noted that the checks intermingled closely with the carbon-dioxide units and emitting air at the rate of from 10 to 250 bubbles per minute yielded practically the same average number of eggs as those checks which were isolated and without air current.

TABLE 2.—COMPARISON OF THE RESULTS OBTAINED WITH CARBON DIOXIDE AND AMMONIA

Chemical	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Carbon dioxide	8:10 to 8:28, '17	9	9,768	27	361.8	91.4
Ammonia	8:10 to 8:28, '17	9	1,320	39	33.8	8.6

The two sets of units in the above experiments were placed from 4 to 6 inches apart in a series and air was bubbled through the ammonia at rates varying in different units from 12 to 240 bubbles per minute. The lower rate gave the bran only a faint ammoniacal odor at the end of the experiment while the higher gave the bran a powerful odor of the gas. The ammonia used was of U. S. P. strength diluted with an equal volume of water, and one hundred cubic centimeters of the liquid were placed in each bottle. The experiments were run the greater part of the time with five ammonia units and three carbon dioxide units equably distributed, thus giving the ammonia the greater opportunity for profiting by chance oviposition. It will be noted that the carbon dioxide received 91.4 per cent of the unit average of the eggs deposited while the ammonia received 8.6 per cent. This ratio is very nearly the same as that shown in Table 1, in which carbon dioxide and air are compared.

TABLE 3.—COMPARISON OF THE RESULTS OBTAINED WITH AMMONIA AND AIR

Chemicals	Inclusive Dates	Number Days Run	Total Eggs	Number of Units	Average Number Eggs per Unit	Per Cent of Total Unit Average
Ammonia	8:29 to 9:8, '17	9	1,170	36	32.5	32.6
Air	8:29 to 9:8, '17	9	2,424	36	67.3	67.4

Eight units divided equally between the ammonia and air were run throughout these experiments. The ammonia was of the strength and quantity used in the previous series and an equal amount of water was placed in the check bottles. The two sets were placed alternately about one foot apart and three of the adjacent pairs of bottles, one containing ammonia and the other water, had air bubbled through the liquid at equal rates, varying in different pairs from 5 bubbles to 250 bubbles per minute, the usual series being about 12, 24, and 180 bubbles per minute respectively. An additional check bottle had no air current and the remaining ammonia had air bubbled through the liquid at some rate intermediate with the above. No oviposition

occurred which could be ascribed to any particular dosage of ammonia though the north end of the series, which was usually occupied by the heavier dosages, produced most eggs both on the ammoniated bran and the checks but when the lighter dosages were shifted to this end the heavy oviposition continued to occur at the north end of the series. The check funnels received 67.4 per cent of the unit-average of the eggs deposited and received decidedly more eggs than the ammoniated units on seven of the nine days the experiments were run.

A careful analysis of Mr. Richardson's experiments leads us to believe that the apparent discrepancy between his results and ours is only in drawing conclusions. Certainly he obtained marked oviposition in no case where carbon dioxide was undoubtedly absent and we believe that this was the oviposition-inciting principle in his investigation as well as in our own.

THE LIFE-HISTORY OF THE OKRA OR MALLOW CATERPILLAR (COSMOPHILA EROSA HÜBNER)

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Introduction

The attention of the writer was first called to this insect on July 16, 1916, on passing by an okra field at Gainesville, Fla., and observing badly eaten leaves of the plants. A search quickly revealed the culprit to be the larva of some noctuid.

As I shall mention later in this article, the work of this larva has probably been attributed to that of *Autographa brassicæ*.

Since this insect was of undoubted economic importance, a study of it was begun upon which the present paper is based. All investigations were carried on at Gainesville, Fla.

Dr. Chittenden[1] calls this the Abutilon moth but here in Florida it would seem more appropriate to call it the okra or mallow caterpillar, since it is found on such a large number of the Malvaceæ.

History

The moth was first figured by Hübner (Zeitr. 287, 288) in 1818. It was fully described by Guenée who describes the larva, under the name of Cosmophila, in a few words, giving its food plant as Hibiscus. Comparatively little mention of this species has been made since this time.

[1] Bulletin No. 126, Bureau of Entomology. This bulletin contains a full bibliography.