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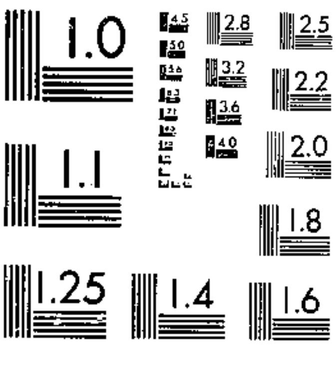

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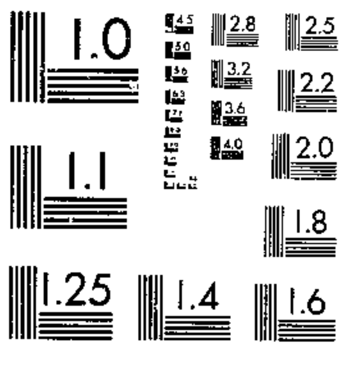

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL BULLETIN No. 95 FEBRUARY, 1929

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

THE MEAL WORMS

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The meal worms have long attracted the attention of both scientists and laymen, owing to their usefulness as food for birds, reptiles, fishes, and small mammals in zoological gardens, aquariums, and elsewhere, their desirability for anatomical and genetical research (for they are large in size and easily reared), and their destructiveness as flour, meal, and grain pests.

REVIEW OF LITERATURE

Moufet (*18*)[1] as early as 1634 and Ray (*21*) in 1710 referred to the yellow meal worm. Frisch (*9*) in 1721 described and illustrated its various stages, commented on the usefulness of the larvae as food for nightingales and other birds, and gave a short account of his observations on the life history of this meal worm. In 1758 Linnaeus (*15*) named and described it as *Tenebrio molitor*.

Judging from early accounts, the yellow meal worm was much more abundant in Europe in those times than the closely allied dark meal worm, which was described by Fabricius (*8*) in 1792 as *T. obscurus*. Joyeuse (*12*), De Geer (*11*), Latreille (*14*), Sturm (*29*), Curtis (*7*), Westwood (*33*), Taschenberg (*30*), and many others published short, interesting accounts of one or both of the meal worms, but little accurate biological information was published prior to the observations of Riley (*22*) in 1883. He found that eggs of *T. molitor* laid on May 29, 1876, hatched on June 5, one larva molted for the first time on June 15, and had molted 11 times by May 3 of the following year, when it died. A second larva had molted 12 times

[1] Italic numbers in parentheses refer to "Literature cited," p. 36.

by June 10 of the following year, when it also died. Three larvae of T. *obscurus*, from eggs hatched April 30, 1876, were reared to adults. One molted 11 times by August 30 of the same year, pupated Januar 20, 1877, and finally emerged as an adult beetle February 7, 1877. The other two molted 12 times and attained the adult state on Feb ruary 18 and March 9, respectively. All were kept under the sam food conditions.

Chittenden in 1896 (*5, 6*) gave short general accounts of the mea worms and included observations on the egg laying of *T. molitor*. Rau (*20*) published some interesting observations in 1915 on th pupation of the two species and on the longevity of *T. obscurus*. H found that the larvae of T. *obscurus* began to pupate in the labora tory toward the end of February but that none of those of *T. molitor* pupated before May. The duration of the pupal stage of 54 specimens of *T. obscurus* ranged from 4 to 24 days.

The most comprehensive work on the biology of the meal worms with which the writer is familiar has been done by Arendsen Hein, the results of which have been published in articles appearing in 1920 (*2*) and 1923 (*3*). In conducting experiments on variations occurring in the different stages of the meal worms, he made many observations on their life histories. He found that under favorable conditions of food and temperature both species would breed uninterruptedly the year round, the larval period averaging from 6 to 8 months, and that female beetles of *T. molitor* lived from 89 to 132 days.

References to the anatomy and morphology of the meal worms are numerous but will not be noted in this bulletin, a long list of these and other references to the meal worms having been given by Gebien in 1911 (*10*).

SYNONYMY

According to Gebien (*10*) *Tenebrio molitor* L. has but one synonym, *T. molitoria* Fourcr. No synonym is listed for *T. obscurus* Fab.

DISTRIBUTION AND ORIGIN

Both species of meal worms are cosmopolitan in distribution. The dark meal worm, *Tenebrio obscurus*, was considered by Curtis (*7*), Lintner (*16*), and early writers as a native of America, and to differentiate it from *T. molitor*, the yellow meal worm or European meal worm, they called it the American meal worm. In all probability both species are of European or Asiatic origin. In regard to their distribution in North America, records kept by the United States Bureau of Entomology indicate that *T. molitor* does not breed freely in the South but prefers the cooler climate of the more northern States. Figure 1 shows the localities from which reports have been received by the Bureau of Entomology of the destructive abundance of this species from 1881 to 1927, inclusive. As will be noted, only one complaint has been received from a State south of Virginia, that one coming from North Carolina. Records of *T. obscurus* would indicate that it breeds freely in practically all parts of North America.[2] (Fig. 2.)

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[2] The writer is indebted to F. H. Chittenden and J. A. Hyslop, of the Bureau of Entomology, for man distribution records.

ECONOMIC IMPORTANCE

The meal worms, although the largest of the insects that infest stored products, are not nearly so destructive as some of their smaller

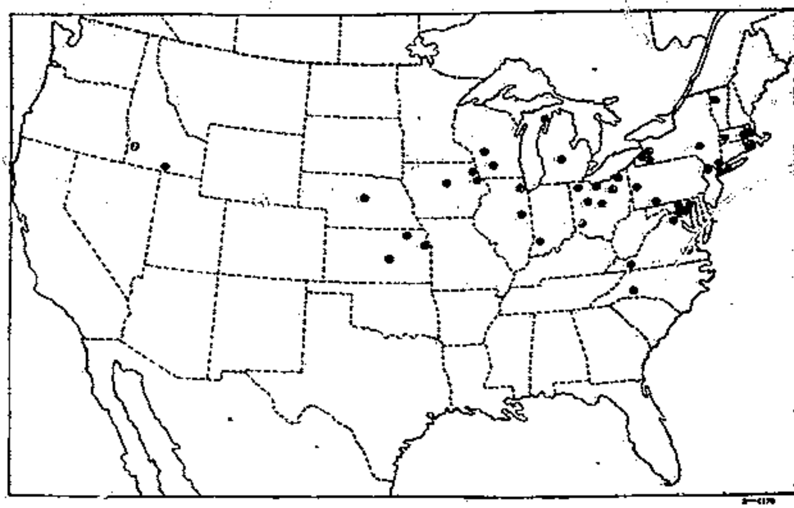

FIG. 1.—Localities in the United States from which specimens of *Tenebrio molitor* have been received during the period from 1881 to 1927, inclusive

associates. They are nocturnal in habit and frequent dark places, breeding in refuse grain, coarse cereal, and mill products that accumulate in dark corners, under sacks, in bins, and in similar places

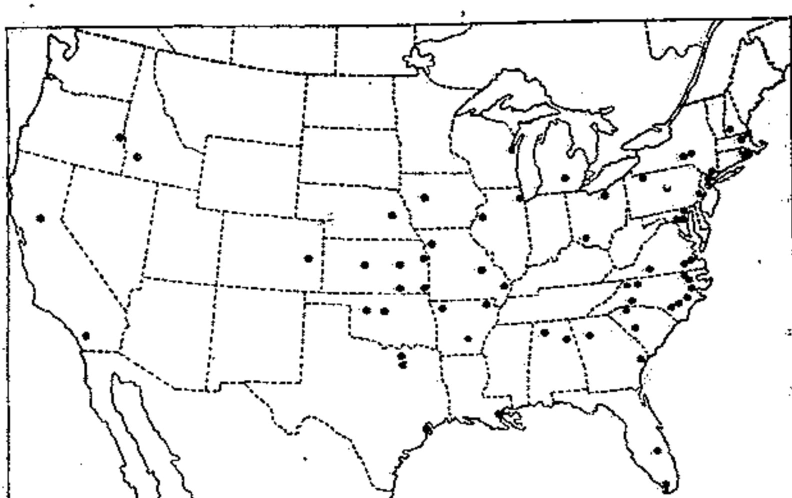

FIG. 2.—Localities in the United States from which specimens of *Tenebrio obscurus* have been received during the period from 1881 to 1927, inclusive

where they are not often disturbed. They are fond of moist situations and are often found among bags that are slightly damp. The larvae are active and not infrequently wander into strange places. They have been found in bags of fertilizer, bags of salt, boxes of soda ash, in ground black pepper, and other unlikely places. The larvae in infested cereal foods are occasionally accidentally swallowed by human beings. One such case was recorded by Acrel (*1*) in 1799, another by Riley and Howard (*23*) in 1889.

A rather interesting ghost story with the yellow meal worm in the rôle of ghost was recorded by Riley and Howard (*24*) in 1889.

A guest in a hotel in Rhode Island was awakened one night by a scratching sound that apparently emanated from a pincushion on the dressing table. After spending a sleepless night the guest reported to the landlord that the room was haunted. Investigation resulted in the discovery that the pincushion was literally alive with beetles. The cushion had been made about four years earlier and had been filled with coarse shorts. The beetles, which proved to be *Tenebrio molitor*, had been breeding in the cushion until they became so abundant as to attract attention by their struggles.

A rather unusual case of damage attributed to *Tenebrio molitor* has been reported by Scott (*28*), who states that perforations found in lead from the roof of a disused bakery are thought to have been made by *T. molitor*, living larvae and pupae of which were found in close proximity. The writer is inclined to doubt this. Full-grown larvae are occasionally found in the timbers of infested grain bins, but so far as the writer has observed, only when such timbers are rotting and soft.

Meal-worm larvae are used as food for many small birds, amphibians, reptiles, young insect-eating animals, carnivorous arthropods, and fish. In aquariums and zoological parks, where there are many hungry mouths to feed, they are in great demand. Their popularity as fish bait may be surmised from the statement made by a fish-bait vendor to the writer that he could use "half a billion" of them annually.

Meal worms are sold by the hundred, by the thousand, or by the pound, and the business of rearing them is very old. Frisch (*9*) more than 200 years ago referred to their use as food for nightingales and other birds, and many of the early writers gave directions for rearing the larvae for that purpose. More recently Wolf (*34*) in 1905, Krefft (*13*) in 1907, and Megušar (*17*) in 1912, discussed the uses of the meal worms for feeding purposes and have given minute directions for rearing them. So highly have they been valued as food for birds that according to Philippi (*19*) *Tenebrio molitor* was introduced into Chile solely for the purpose of rearing the larvae for bird food.

LIFE HISTORY

At Washington, D. C., the meal worms normally pass the winter in the larval state. The adults emerge in the spring and early summer, live for two or three months, and die. In the natural state there is, therefore, only one full generation a year. In the laboratory an occasional individual of *Tenebrio obscurus* completed its development from egg to adult in as short a time as four months, transforming in June, July, or August instead of waiting until the following spring; on the other hand, a number of individuals of the same species required two years to complete their development, although all were reared under the same conditions. Under similar conditions no specimens of *T. molitor* completed their development in less than 10 months, and slightly more than half of the specimens reared required two years to complete their development. When reared in an incubator with continuous favorable conditions of temperature, moisture, and food, both species bred uninterruptedly the year round and all stages were obtainable at any time.

THE EGG

The eggs of both species of meal worms are oblong-oval in shape, opaque, milky white, and shining. Eggs of *Tenebrio obscurus* (fig. 3, A), measured in the laboratory, ranged in length from 1.4 to 1.5 millimeters and in width from 0.60 to 0.66 millimeter; those of *T. molitor* ranged in length from 1.75 to 1.80 millimeters and in width from 0.60 to 0.70 millimeter.

INCUBATION PERIOD

The incubation period of the egg of both species of meal worms varies considerably, being influenced chiefly by temperature. The data in Table 1 indicate the length of the egg stage of *Tenebrio obscurus* when the average mean temperature ranges from 65° to 88° F. When the average mean temperature ranged from 80° to 88°, the incubation period ranged from 4 to 7 days, whereas with an average mean temperature of 65° the period was lengthened to 17 and 18 days. In like manner Table 1 shows the length of the egg stage of *T. molitor* as determined by the writer when the average mean temperature ranged from 66° to 88°. When the average mean temperature ranged from 82° to 88° the incubation period ranged in length from 4 to 6 days, whereas with an average mean temperature of 66° to 70° the length of the period ranged from 10 to 19 days.

TABLE 1.—*Incubation period of meal-worm eggs*

TENEBRIO OBSCURUS

No.	Date egg was laid	Date egg hatched	Length of incubation period	Average mean temperature for period	No.	Date egg was laid	Date egg hatched	Length of incubation period	Average mean temperature for period
	1923	1923	*Days*	° *F.*		1923	1923	*Days*	° *F.*
1	Mar. 3	Mar. 16	13	72	17	June 3	June 8	5	86
2	Mar. 7	Mar. 23	16	71	18	June 21	June 25	4	88
3	Mar. 19	Apr. 2	14	70	19	June 26	July 2	6	82
4	Mar. 21	Apr. 4	14	70	20	June 30	July 6	6	83
5	Mar. 23	Apr. 5	13	70	21	July 6	July 11	5	85
6	Apr. 2	Apr. 14	12	70	22	July 7	July 12	5	85
7	Apr. 5	Apr. 18	13	70		1924	1924		
8	Apr. 12	Apr. 24	12	70	23	Jan. 4	Jan. 22	18	65
9	Apr. 26	May 7	11	72	24	Jan. 10	Jan. 28	18	65
10	Apr. 29	May 11	12	71	25	Jan. 14	Jan. 31	17	66
11	May 3	May 14	11	72	26	Jan. 22	Feb. 9	18	65
12	May 8	May 18	10	73	27	Feb. 2	Feb. 19	17	65
13	May 12	May 21	9	75	28	Feb. 4	Feb. 22	18	65
14	May 26	June 2	7	80	29	Feb. 9	Feb. 26	17	65
15	May 31	June 6	6	84	30	Feb. 11	Feb. 28	17	65
16	June 2	June 7	5	86					

TENEBRIO MOLITOR

No.	Date egg was laid	Date egg hatched	Length of incubation period	Average mean temperature for period	No.	Date egg was laid	Date egg hatched	Length of incubation period	Average mean temperature for period
	1923	1923	*Days*	° *F.*		1923	1923	*Days*	° *F.*
1	June 10	June 23	4	88	14	Aug. 13	Aug. 21	8	76
2	June 20	June 25	5	88	15	Aug. 15	Aug. 23	8	75
3	June 22	June 26	4	86		1925	1925		
4	June 28	July 3	5	82					
5	June 29	July 5	6	82	16	Mar. 6	Mar. 25	19	67
6	July 1	July 7	6	85	17	Mar. 12	Mar. 23	11	66
7	July 5	July 11	6	85	18	Mar. 13	Mar. 24	11	66
8	July 9	July 15	6	86	19	Mar. 18	Mar. 28	10	69
9	July 11	July 17	6	86	20	Apr. 1	Apr. 11	10	68
10	July 14	July 20	6	84	21	Apr. 7	Apr. 17	10	70
11	July 17	July 23	6	83	22	Apr. 11	Apr. 21	10	70
12	Aug. 4	Aug. 10	6	83	23	Apr. 18	Apr. 27	9	73
13	Aug. 7	Aug. 13	6	82	24	Apr. 21	Apr. 30	9	73

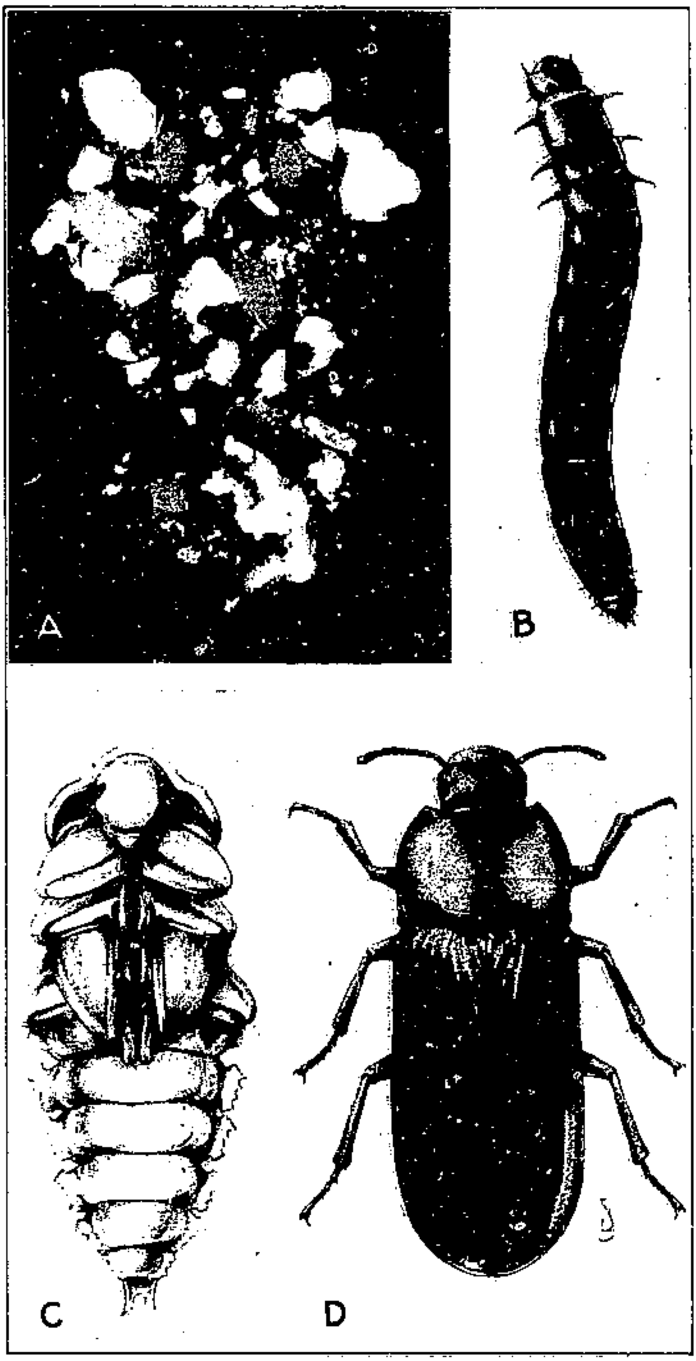

FIG. 3.—*Tenebrio obscurus*: A, Eggs, × 12; B, full-grown larva, × 3; C, pupa, × 4; D, adult beetle, × 4

THE LARVA

The larvae when newly emerged from the egg are white and between 2 and 2.5 millimeters in length. They begin at once to feed and soon acquire a yellowish-brown color. When fully grown, the larvae of both species are about 1 inch to 1¼ inches in length. They are easily distinguished by their characteristic color. The larva of *Tenebrio obscurus* (fig. 3, B) is dark brown, shading to much darker brown toward each end and at the articulation of each segment. The larva of *T. molitor* is bright yellow, shading to yellowish-brown toward each end and at the articulation of each segment. Immediately after molting the larvae are white but soon attain their normal coloring.

Technical descriptions of the larvae have been prepared by R. A. St. George and will be found toward the end of this bulletin.

FOOD OF LARVA

The larvae of both species of meal worms have similar feeding habits, and they are frequently found feeding together. They feed on meals and flours of all kinds, bran, refuse grain, coarse cereals, bread, crackers, mill sweepings, and all foods of like nature. They are also fond of food of animal origin, such as meat scrap, the bodies of dead insects, and feathers. They are usually found in dark, moist places, in neglected corners of mills where sweepings have been allowed to accumulate, in storehouses and feed stores, under bags of feed, or in the litter of chicken houses and bird houses where feathers and refuse grain are mixed with excrement.

In feeding the larvae in the laboratory the writer found a mixture of graham flour and meat scrap to be a very satisfactory food, and this was used throughout the experiments. Many breeders of meal worms supply them occasionally with fresh vegetables, such as pieces of carrot, potato, or lettuce. Probably because of the high moisture content of such foods, they are eagerly eaten by the larvae. To obtain the best results in breeding meal worms, it is necessary to keep the food supply fairly moist. Care must be exercised, however, to prevent molds from developing or the colony may be lost.

LENGTH OF LARVAL STAGE

The length of the larval stage varies considerably and is influenced by several factors. At Washington, D. C., both species of meal worms normally require at least one year for development under storehouse conditions. In the case of *Tenebrio obscurus* a few larvae that hatch in the early part of the year complete their growth and transform in midsummer, a few remain as larvae for two years before transforming, but the majority transform at the end of the first year during the spring and early summer months. The shortest larval period observed was 79 days, covering the period from March 15 to June 2, 1924 (Table 2); and the longest was 642 days, from April 5, 1923, to January 6, 1925. The shortest normal larval period recorded for *T. molitor* was 281 days, covering the period from July 25, 1923, to May 1, 1924; and the longest larval period recorded was 629 days, from June 26, 1922, to March 16, 1924. Of the specimens reared individually to obtain detailed life-history data, more than 50 per cent required more than one season to complete their growth. This was doubtless due to the difficulty of keeping small quantities of food at the optimum condition for normal development. Specimens reared in an incubator with continuous favorable conditions of temperature, humidity, and food completed the larval stage in six months.

TABLE 2.—*Life-history data of meal worms obtained at Washington, D. C., 1922–1925*

TENEBRIO OBSCURUS

No.	Date egg was laid	Date egg hatched	Length of egg stage	Date of pupation	Length of larval stage	Date adult emerged	Length of pupal stage	Period from egg to adult	Sex
	1922	1922	*Days*		*Days*		*Days*	*Days*	
1	June 13	June 20	7	Feb. 5, 1924	595	Feb. 23, 1924	18	620	Female.
2	June 12	do	8	Mar. 1, 1924	620	Mar. 15, 1924	14	642	Male.
3	June 13	do	7	Jan. 4, 1924	563	Jan. 20, 1924	16	586	Do.
	1923	1923							
4	Mar. 7	Mar. 23	16	Jan. 7, 1924	290	Jan. 23, 1924	16	322	Do.
5	do	do	16	Mar. 12, 1924	355	Mar. 29, 1924	17	383	Female.
6	do	do	16	Feb. 19, 1924	333	Mar. 6, 1924	16	365	Do.
7	do	do	16	Feb. 14, 1924	328	Mar. 1, 1924	16	360	Male.
8	do	do	16	Feb. 6, 1924	320	Feb. 22, 1924	16	352	Female.
9	do	do	16	Feb. 2, 1924	316	Feb. 18, 1924	16	348	Do.
10	Mar. 17	Mar. 31	14	Jan. 6, 1924	281	Jan. 22, 1924	16	311	Do.
11	do	do	14	Jan. 20, 1924	295	Feb. 7, 1924	18	327	Do.
12	do	do	14	do	295	do	18	327	Male.
13	do	do	14	Feb. 20, 1924	326	Mar. 5, 1924	14	354	Do.
14	do	do	14	Jan. 31, 1924	306	Feb. 16, 1924	16	336	Do.
15	do	do	14	Jan. 26, 1924	301	Feb. 10, 1924	15	330	Do.
16	do	do	14	Jan. 13, 1924	288	Jan. 30, 1924	17	319	Female.
17	Mar. 19	Apr. 2	14	Mar. 9, 1924	342	Mar. 26, 1924	17	373	Male.
18	do	do	14	Feb. 13, 1924	317	Feb. 29, 1924	16	347	Female.
19	do	do	14	Jan. 6, 1924	279	Jan. 20, 1924	14	307	Male.
20	do	do	14	Jan. 11, 1924	284	Jan. 26, 1924	15	313	Do.
21	Mar. 21	Apr. 4	14	Mar. 7, 1924	338	Mar. 25, 1924	18	370	Do.
22	do	do	14	Feb. 29, 1924	331	Mar. 15, 1924	15	360	Female.
23	Mar. 23	Apr. 5	13	Jan. 20, 1924	290	Feb. 6, 1924	17	320	Do.
24	do	do	13	Feb. 11, 1924	312	Feb. 27, 1924	16	341	Do.
25	do	do	13	Mar. 25, 1924	354	Apr. 7, 1924	13	381	Male.
26	do	do	13	June 22, 1924	444	June 29, 1924	7	464	Do.
27	do	do	13	May 22, 1924	413	June 4, 1924	13	439	Female.
28	do	do	13	Jan. 6, 1925	642	Jan. 26, 1925	20	675	Male.
29	do	do	13	Mar. 23, 1924	353	Apr. 6, 1924	14	380	Female.
30	Mar. 30	Apr. 11	12	Jan. 30, 1924	294	Feb. 16, 1924	17	323	Do.
31	Mar. 29	do	13	Jan. 26, 1924	290	Feb. 12, 1924	17	320	Do.
32	Mar. 30	do	12	Jan. 16, 1924	280	Feb. 2, 1924	17	309	Male.
33	do	do	12	Feb. 5, 1924	300	Feb. 21, 1924	16	328	Female.
34	Apr. 2	Apr. 14	12	Dec. 30, 1923	260	Jan. 15, 1924	16	288	Do.
35	do	do	12	Jan. 6, 1924	267	Jan. 23, 1924	17	296	Do.
36	do	do	12	Jan. 10, 1924	271	do	13	296	Do.
37	do	do	12	Jan. 17, 1924	278	Feb. 2, 1924	16	306	Do.
38	Apr. 13	Apr. 25	12	Jan. 12, 1924	262	Jan. 29, 1924	17	291	Do.
39	do	do	12	Jan. 23, 1924	273	Feb. 8, 1924	16	301	Do.
40	Apr. 12	do	13	Feb. 7, 1924	288	Feb. 24, 1924	17	318	Male.
41	Apr. 26	May 7	11	Jan. 29, 1924	267	Feb. 14, 1924	16	294	Do.
42	May 20	June 2	7	Feb. 17, 1925	626	Mar. 5, 1925	16	649	Do.
43	May 20	May 28	8	Jan. 21, 1924	238	Feb. 6, 1924	16	262	Do.
44	June 28	July 4	6	Feb. 12, 1925	589	Feb. 26, 1925	14	609	Female.
	1924	1924							
45	Mar. 1	Mar. 15	14	June 2, 1924	79	June 14, 1924	12	105	Do.
46	Mar. 3	Mar. 17	14	June 18, 1924	93	June 28, 1924	10	117	Do.
47	Mar. 5	Mar. 19	14	July 2, 1924	105	July 10, 1924	8	127	Do.
48	Mar. 10	Mar. 23	13	July 16, 1924	115	July 24, 1924	8	136	Do.
49	Apr. 2	Apr. 14	12	Dec. 2, 1924	232	Dec. 18, 1924	16	260	Male.
50	Apr. 10	Apr. 22	12	do	224	Dec. 19, 1924	17	253	Female.

TABLE 2.—*Life-history data of meal worms obtained at Washington, D. C., 1922–1925*—Continued

TENEBRIO MOLITOR

No.	Date egg was laid	Date egg hatched	Length of egg stage	Date of pupation	Length of larval stage	Date adult emerged	Length of pupal stage	Period from egg to adult	Sex
	1922	1922	*Days*		*Days*		*Days*	*Days*	
1	June 4	June 10	6	Feb. 10, 1924	610	Feb. 28, 1924	18	634	Female.
2	June 20	June 26	6	Mar. 16, 1924	629	Mar. 30, 1924	14	649	Do.
3	do	do	6	Mar. 12, 1924	625	Mar. 27, 1924	15	646	Do.
4	July 5	July 11	6	Feb. 28, 1924	597	Mar. 13, 1924	14	617	Male.
5	do	do	6	May 8, 1923	301	May 22, 1923	14	321	Female.
6	do	do	6	Mar. 6, 1924	604	Mar. 21, 1924	15	625	Male.
7	July 6	do	5	Mar. 18, 1924	616	Apr. 1, 1924	14	635	Female.
8	do	do	5	May 12, 1923	305	May 23, 1923	11	321	Male.
	1923	1923							
9	June 19	June 23	4	May 7, 1924	319	May 21, 1924	14	337	Female.
10	June 20	June 25	5	June 1, 1924	342	June 12, 1924	11	358	Male.
11	June 26	July 1	5	Feb. 13, 1925	593	Mar. 2, 1925	17	615	Do.
12	do	do	5	May 24, 1924	328	June 6, 1924	13	346	Female.
13	do	do	5	May 14, 1924	318	May 24, 1924	10	333	Male.
14	June 28	July 3	5	Feb. 20, 1925	598	Mar. 8, 1925	16	610	Female.
15	do	do	5	Feb. 11, 1925	589	Feb. 28, 1925	17	611	Do.
16	July 3	July 9	6	Feb. 13, 1925	585	do	16	606	Do.
17	July 9	July 15	6	Feb. 7, 1925	573	Feb. 22, 1925	15	594	Female.
18	July 10	July 16	6	Jan. 29, 1925	563	Feb. 14, 1925	16	585	Male.
19	do	do	6	Jan. 27, 1925	561	Feb. 12, 1925	16	583	Do.
20	do	do	6	Jan. 29, 1925	563	Feb. 13, 1925	15	584	Do.
21	July 12	July 18	6	Feb. 9, 1925	572	Feb. 25, 1925	16	594	Female.
22	do	do	6	Feb. 10, 1925	573	do	15	594	Do.
23	do	do	6	Jan. 24, 1925	556	Feb. 9, 1925	16	578	Male.
24	do	do	6	Jan. 15, 1925	547	Jan. 31, 1925	16	569	Female.
25	do	do	6	June 23, 1924	341	June 30, 1924	7	354	Do.
26	do	do	6	May 31, 1924	318	June 11, 1924	11	335	Male.
27	do	do	6	May 7, 1924	294	May 21, 1924	14	314	Do.
28	July 15	July 20	5	Feb. 13, 1925	574	Mar. 1, 1925	16	595	Do.
29	do	do	5	Feb. 15, 1925	576	Mar. 2, 1925	15	596	Do.
30	do	do	5	Feb. 10, 1925	571	Feb. 26, 1925	16	592	Female.
31	July 17	July 23	6	Jan. 28, 1925	555	Feb. 12, 1925	15	576	Do.
32	do	do	6	Feb. 7, 1925	565	Feb. 25, 1925	18	580	Do.
33	do	do	6	Feb. 18, 1925	576	Mar. 6, 1925	16	598	Male.
34	do	do	6	Feb. 12, 1925	570	Feb. 27, 1925	15	591	Do.
35	do	do	6	May 17, 1924	299	May 31, 1924	14	319	Do.
36	July 18	July 25	7	May 1, 1924	281	May 14, 1924	13	301	Do.
37	July 26	Aug. 1	6	Feb. 20, 1925	569	Mar. 8, 1925	16	591	Do.
38	do	do	6	Feb. 11, 1925	560	Feb. 27, 1925	16	582	Female.
39	do	do	6	Jan. 31, 1925	549	Feb. 14, 1925	14	569	Male.
40	July 31	Aug. 7	7	Feb. 11, 1925	554	Feb. 27, 1925	16	577	Do.
41	Aug. 4	Aug. 10	6	June 27, 1924	322	July 6, 1924	9	337	Female.

NUMBER OF MOLTS

The number of larval molts varies somewhat in both species of meal worms. As will be noted in Table 3, 12 was the least number of molts recorded for any larva of *Tenebrio obscurus* during its entire developmental period, whereas the greatest number recorded was 22. Approximately one-half of all the specimens reared molted either 14 or 15 times each.

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TABLE 3.—*Length of larval periods of Tenebrio obscurus*

No.	Date egg hatched	Date first molt	Date second molt	Date third molt	Date fourth molt	Date fifth molt	Date sixth molt	Date seventh molt	Date eighth molt	Date ninth molt	Date tenth molt	Date eleventh molt	Date twelfth molt	Date thirteenth molt
	1923	1923	1923	1923	1923	1923	1923	1923	1923					
1	Mar. 23	Apr. 15	May 22	June 5	July 3	July 12	July 19	Aug. 4	Aug. 13	Sept. 6, 1923	Sept. 23, 1923	Oct. 8, 1923	Nov. 1, 1923	Dec. 12, 1923
2	do	Apr. 19	May 16	May 28	June 10	June 21	July 5	July 14	July 30	Aug. 15, 1923	Aug. 29, 1923	Sept. 13, 1923	Sept. 30, 1923	Oct. 20, 1923
3	do	Apr. 22	May 12	May 27	June 5	June 19	July 4	July 12	July 22	Aug. 4, 1923	Aug. 14, 1923	Aug. 28, 1923	Sept. 11, 1923	Sept. 29, 1923
4	do	Apr. 12	May 9	June 3	June 18	July 1	July 12	July 22	Aug. 6	Aug. 13, 1923	Aug. 29, 1923	Sept. 10, 1923	Sept. 28, 1923	Oct. 19, 1923
5	do	Apr. 14	May 3	June 14	July 1	July 11	Aug. 2	Aug. 10	Aug. 22	Sept. 5, 1923	Sept. 23, 1923	Oct. 8, 1923	Oct. 30, 1923	Dec. 10, 1923
6	do	do	May 15	May 30	June 10	June 24	July 8	July 30	Aug. 13	Aug. 31, 1923	Sept. 13, 1923	Sept. 28, 1923	Oct. 15, 1923	Nov. 8, 1923
7	do	Apr. 12	May 9	May 23	June 8	June 19	June 28	July 7	July 17	Aug. 2, 1923	Aug. 14, 1923	Aug. 28, 1923	Sept. 13, 1923	Sept. 30, 1923
8	do	do	do	May 21	June 4	June 14	June 22	July 4	July 15	July 28, 1923	Aug. 8, 1923	Aug. 20, 1923	Sept. 3, 1923	Sept. 22, 1923
9	do	Apr. 13	May 6	May 20	May 31	June 15	June 25	July 7	July 28	Aug. 7, 1923	Aug. 17, 1923	Sept. 2, 1923	Sept. 20, 1923	Oct. 8, 1923
10	do	Apr. 14	May 7	May 22	June 12	June 22	July 5	July 14	Aug. 6	Aug. 15, 1923	Aug. 27, 1923	Sept. 6, 1923	Sept. 23, 1923	Oct. 10, 1923
11	do	Apr. 20	May 13	May 28	July 1	July 10	Aug. 8	Aug. 21	Sept. 1	Sept. 13, 1923	Sept. 27, 1923	Oct. 15, 1923	Nov. 5, 1923	Dec. 20, 1923
12	Mar. 31	Apr. 24	May 30	June 12	June 21	June 29	July 9	July 18	Aug. 1	Aug. 10, 1923	Aug. 21, 1923	Sept. 5, 1923	Sept. 23, 1923	Oct. 15, 1923
13	do	do	May 16	May 28	June 8	June 19	July 4	July 17	Aug. 4	Aug. 15, 1923	Aug. 27, 1923	Sept. 9, 1923	Sept. 25, 1923	Do.
14	do	Apr. 23	May 12	May 29	do	June 18	June 30	July 9	July 17	July 31, 1923	Aug. 8, 1923	Aug. 16, 1923	Aug. 29, 1923	Sept. 13, 1923
15	do	Apr. 22	May 11	May 25	June 5	June 14	June 22	July 1	July 11	July 20, 1923	Aug. 3, 1923	Aug. 13, 1923	Aug. 28, 1923	Sept. 11, 1923
16	do	Apr. 27	May 16	May 30	June 16	June 23	July 1	July 10	July 21	Aug. 4, 1923	Aug. 13, 1923	Aug. 25, 1923	Sept. 6, 1923	Sept. 24, 1923
17	do	Apr. 25	May 24	June 5	June 15	do	July 2	July 11	July 20	do	Aug. 15, 1923	Aug. 29, 1923	Sept. 11, 1923	Sept. 29, 1923
18	do	Apr. 24	May 19	June 4	June 17	June 30	July 12	Aug. 6	Aug. 14	Sept. 1, 1923	Sept. 23, 1923	Oct. 11, 1923	Jan. 16, 1924	----------
19	do	Apr. 23	May 16	May 30	June 8	June 18	June 26	July 6	July 16	July 23, 1923	Aug. 4, 1923	Aug. 13, 1923	Aug. 24, 1923	Sept. 5, 1923
20	do	Apr. 22	May 9	May 29	June 11	June 21	June 30	July 10	July 22	Aug. 3, 1923	Aug. 13, 1923	Aug. 28, 1923	Sept. 9, 1923	Sept. 28, 1923
21	do	do	May 16	May 28	June 5	June 15	June 25	July 3	July 13	July 23, 1923	Aug. 4, 1923	Aug. 14, 1923	Aug. 29, 1923	Sept. 12, 1923
22	do	Apr. 27	June 9	June 19	June 28	July 7	July 16	July 30	Aug. 7	Aug. 16, 1923	Aug. 29, 1923	Sept. 13, 1923	Sept. 27, 1923	Oct. 15, 1923
23	do	Apr. 25	May 17	May 31	June 17	June 25	July 3	July 14	July 22	Aug. 3, 1923	Aug. 13, 1923	Aug. 24, 1923	Sept. 5, 1923	Sept. 23, 1923
24	do	Apr. 24	May 16	May 28	June 7	June 18	June 29	July 9	July 30	Aug. 9, 1923	Aug. 20, 1923	Sept. 1, 1923	Sept. 18, 1923	Oct. 5, 1923
25	Apr. 2	Apr. 23	do	do	June 8	June 19	July 8	July 17	Aug. 6	Aug. 15, 1923	Aug. 27, 1923	Sept. 9, 1923	Sept. 26, 1923	Oct. 14, 1923
26	do	Apr. 25	May 14	May 27	June 10	June 22	July 2	do	do	Aug. 13, 1923	Aug. 28, 1923	Sept. 8, 1923	Sept. 24, 1923	Oct. 11, 1923
27	do	do	May 15	do	June 16	June 27	July 13	Aug. 6	Aug. 15	Aug. 29, 1923	Sept. 14, 1923	Sept. 30, 1923	Oct. 22, 1923	Dec. 12, 1923
28	do	Apr. 26	May 13	do	do	July 7	July 19	Aug. 8	Aug. 20	Sept. 3, 1923	Sept. 21, 1923	Oct. 3, 1923	Oct. 24, 1923	Nov. 20, 1923
29	do	Apr. 24	May 15	do	June 5	June 19	July 1	July 17	Aug. 2	Aug. 13, 1923	Aug. 28, 1923	Sept. 12, 1923	Oct. 3, 1923	Oct. 26, 1923
30	do	do	May 12	May 25	June 4	June 16	June 27	July 11	July 31	Aug. 9, 1923	Aug. 18, 1923	Sept. 2, 1923	Sept. 20, 1923	Oct. 5, 1923
31	do	Apr. 23	do	May 27	do	do	do	July 13	do	Aug. 10, 1923	Aug. 20, 1923	Aug. 31, 1923	Sept. 13, 1923	Sept. 28, 1923
32	do	Apr. 24	May 13	May 30	June 12	July 1	July 12	Aug. 1	Aug. 13	Aug. 25, 1923	Sept. 7, 1923	Sept. 25, 1923	Oct. 10, 1923	Nov. 5, 1923
33	Apr. 4	Apr. 26	May 18	do	do	June 22	July 3	July 13	July 25	Aug. 6, 1923	Aug. 16, 1923	Sept. 1, 1923	Sept. 18, 1923	Oct. 6, 1923
34	do	Apr. 27	May 16	May 28	June 10	June 20	July 1	July 11	July 21	Aug. 3, 1923	Aug. 13, 1923	Aug. 28, 1923	Sept. 8, 1923	Sept. 25, 1923
35	do	Apr. 25	May 13	May 20	May 30	June 10	June 21	July 1	July 13	July 27, 1923	do	Aug. 29, 1923	Sept. 13, 1923	Oct. 2, 1923
36	do	do	May 16	May 28	June 12	June 23	July 7	July 24	Aug. 7	Aug. 20, 1923	Sept. 12, 1923	Sept. 29, 1923	Oct. 25, 1923	----------
37	do	Apr. 28	May 21	May 31	June 13	June 22	July 4	July 15	Aug. 3	Aug. 15, 1923	Sept. 1, 1923	Sept. 23, 1923	Oct. 10, 1923	Nov. 7, 1923
38	Apr. 5	Apr. 26	May 12	May 25	June 7	June 20	do	July 24	Aug. 14	Sept. 9, 1923	Sept. 29, 1923	Oct. 27, 1923	Dec. 6, 1923	Jan. 9, 1924
39	do	do	May 14	May 28	do	June 18	June 28	July 11	July 30	Aug. 10, 1923	Aug. 20, 1923	Aug. 31, 1923	Sept. 17, 1923	Sept. 30, 1923
40	do	Apr. 24	May 8	May 23	June 3	June 16	June 26	July 12	Aug. 17	Sept. 2, 1923	Sept. 18, 1923	Oct. 5, 1923	Oct. 25, 1923	Nov. 23, 1923
41	do	Apr. 26	May 16	May 28	June 7	June 20	July 2	July 20	Aug. 5	Aug. 13, 1923	Aug. 27, 1923	Sept. 8, 1923	Sept. 24, 1923	Oct. 10, 1923

42	do	Apr. 24	May 13	June 4	June 19	July 3	July 21	Aug. 13	Aug. 31	Sept. 20, 1923	Oct. 3, 1923	Oct. 25, 1923	Dec. 30, 1923	Jan. 23, 1924
43	do	Apr. 20	May 10	June 3	June 21	June 28	July 10	July 24	Aug. 11	Aug. 29, 1923	Sept. 22, 1923	Oct. 10, 1923	Oct. 27, 1923	Dec. 6, 1923
44	do	Apr. 25	May 13	May 29	June 8	June 22	July 4	July 26	Aug. 13	Sept. 2, 1923	Sept. 18, 1923	Oct. 5, 1923	Oct. 24, 1923	Nov. 20, 1923
45	do	Apr. 22	May 11	May 27	June 7	June 20	June 29	July 12	Aug. 1	Aug. 11, 1923	Aug. 22, 1923	Sept. 3, 1923	Sept. 23, 1923	Oct. 8, 1923
46	do	Apr. 23	May 13	do	June 8	June 21	July 6	July 22	Aug. 17	Oct. 2, 1923	Nov. 4, 1923	Dec. 9, 1923	Dec. 31, 1923	Feb. 4, 1924
47	do	Apr. 25	May 22	June 3	June 18	June 29	July 13	Aug. 8	Aug. 16	Aug. 29, 1923	Sept. 12, 1923	Oct. 21, 1923	Nov. 11, 1923	Nov. 30, 1923
48	do	Apr. 21	May 9	do	June 14	June 22	June 30	July 17	Aug. 11	Aug. 25, 1923	Sept. 7, 1923	Sept. 28, 1923	Oct. 18, 1923	Nov. 26, 1923
49	June 2	June 8	June 18	June 30	July 19	July 30	Aug. 13	Sept. 6	Sept. 30	Oct. 20, 1923	Nov. 23, 1923	Dec. 31, 1923	Feb. 2, 1924	Mar. 13, 1924
50	July 4	July 7	July 18	Aug. 7	Aug. 13	Sept. 7	Sept. 26	Oct. 14	Nov. 4	Jan. 2, 1924	Jan. 30, 1924	Mar. 8, 1924	Apr. 18, 1924	June 16, 1924

No.	Date fourteenth molt	Date fifteenth molt	Date sixteenth molt	Date seventeenth molt	Date eighteenth molt	Date nineteenth molt	Date twentieth molt	Date twenty-first molt	Date twenth-second molt	Date larva pupated	Length of larval period (days)
1	Jan. 16, 1924									Mar. 12, 1924	355
2	Nov. 22, 1923	Dec. 27, 1923								Feb. 14, 1924	328
3	Oct. 24, 1923	Dec. 17, 1923								Feb. 6, 1924	320
4	Nov. 19, 1923	Jan. 6, 1924								Mar. 11, 1924	354
5										Feb. 2, 1924	316
6	Dec. 18, 1923									Jan. 22, 1924	305
7	Oct. 24, 1923									Feb. 3, 1924	317
8	Oct. 14, 1923									Jan. 7, 1924	290
9	Oct. 28, 1923	Dec. 8, 1923								Jan. 29, 1924	312
10	Oct. 29, 1923	Nov. 29, 1923	Jan. 3, 1924							Feb. 18, 1924	332
11										Feb. 19, 1924	333
12	Nov. 7, 1923									Jan. 26, 1924	301
13	Nov. 5, 1923	Dec. 14, 1923								Feb. 20, 1924	326
14	Sept. 28, 1923	Oct. 19, 1923								Jan. 13, 1924	288
15	Sept. 29, 1923	do	Nov. 19, 1923							Jan. 6, 1924	281
16	Oct. 15, 1923	Nov. 2, 1923								Feb. 1, 1924	307
17	Oct. 21, 1923	Nov. 20, 1923	Dec. 14, 1923							Jan. 14, 1924	289
18										Mar. 3, 1924	338
19	Sept. 23, 1923	Oct. 10, 1923	Oct. 30, 1923	Nov. 27, 1923						Jan. 30, 1924	305
20	Oct. 18, 1923	Nov. 14, 1923	Dec. 14, 1923							Jan. 31, 1924	306
21	Sept. 30, 1923	Oct. 26, 1923								Jan. 20, 1924	295
22										Jan. 7, 1924	282
23	Oct. 10, 1923	Oct. 29, 1923	Nov. 23, 1923							Jan. 15, 1924	290
24	Oct. 26, 1923									Jan. 20, 1924	295
25	Dec. 12, 1923									Jan. 18, 1924	291
26	Nov. 11, 1923									Jan. 6, 1924	279
27										Feb. 13, 1924	317
28	Dec. 24, 1923									Mar. 9, 1924	342
29	Dec. 9, 1923									Jan. 11, 1924	284
30	Oct. 24, 1923	Nov. 25, 1923	Jan. 7, 1924							Feb. 15, 1924	319
31	Oct. 15, 1923	Nov. 19, 1923								Mar. 8, 1924	341
32										Jan. 11, 1924	284
33	Jan. 11, 1924									Feb. 29, 1924	331
34	Oct. 14, 1923	Nov. 19, 1923								Mar. 1, 1924	332

TABLE 3.—*Length of larval periods of Tenebrio obscurus*—Continued

No.	Date fourteenth molt	Date fifteenth molt	Date sixteenth molt	Date seventeenth molt	Date eighteenth molt	Date nineteenth molt	Date twentieth molt	Date twenty-first molt	Date twenty-second molt	Date larva pupated	Length of larval period (days)
35	Jan. 11, 1924									Mar. 7, 1924	338
36										Jan. 29, 1924	300
37	Jan. 6, 1924									Mar. 7, 1924	338
38	Feb. 10, 1924									Mar. 25, 1924	355
39	Oct. 26, 1923									Jan. 20, 1924	290
40	Dec. 26, 1923									Feb. 11, 1924	312
41	Oct. 29, 1923	Nov. 30, 1923	Dec. 30, 1924							Feb. 5, 1924	306
42										Feb. 27, 1924	328
43	Dec. 31, 1923	Jan. 23, 1924	Feb. 23, 1924	Apr. 6, 1924						June 3, 1924	425
44	Dec. 26, 1923	Jan. 26, 1924	Mar. 1, 1924	Apr. 17, 1924						May 18, 1924	409
45	Oct. 28, 1923	Nov. 26, 1923	Jan. 3, 1924	Feb. 7, 1924						Mar. 23, 1924	353
46	Feb. 27, 1924	Mar. 29, 1924	May 10, 1924	May 29, 1924	June 19, 1924	July 10, 1924	July 30, 1924	Sept. 3, 1924	Sept. 29, 1924	Jan. 6, 1925	642
47	Dec. 12, 1923	Jan. 8, 1924	Feb. 21, 1924	Mar. 26, 1924	Apr. 23, 1924					May 22, 1924	413
48	Jan. 3, 1924	Feb. 2, 1924	Mar. 7, 1924	Apr. 9, 1924	May 10, 1924	June 4, 1924				June 22, 1924	444
49	May 10, 1924	June 19, 1924	July 10, 1924	July 23, 1924	Aug. 6, 1924	Aug. 24, 1924	Sept. 16, 1924	Oct. 20, 1924		Feb. 17, 1925	626
50	July 20, 1924	Aug. 11, 1924	Sept. 14, 1924	Oct. 14, 1924						Feb. 12, 1925	589

TABLE 4.—*Length of larval periods of Tenebrio molitor*

Number	Date egg hatched	Date first molt	Date second molt	Date third molt	Date fourth molt	Date fifth molt	Date sixth molt	Date seventh molt	Date eighth molt	Date ninth molt	Date tenth molt
1	July 11, 1922	July 15, 1922	July 28, 1922	Aug. 9, 1922	Aug. 18, 1922	Apr. 23, 1923	May 25, 1923	Aug. 14, 1923	Sept. 13, 1923	Jan. 10, 1924	----------
2	do	do	July 21, 1922	Aug. 2, 1922	do	Oct. 2, 1922	Dec. 17, 1922	Mar. 7, 1923	May 2, 1923	May 31, 1923	June 21, 1923
3	do	do	July 28, 1922	Oct. 2, 1922	Feb. 10, 1923	Apr. 3, 1923	May 8, 1923	May 30, 1923	July 29, 1923	Sept. 5, 1923	Jan. 22, 1924
4	June 23, 1923	June 26, 1923	July 9, 1923	July 23, 1923	Aug. 13, 1923	Aug. 31, 1923	Sept. 20, 1923	Oct. 7, 1923	Oct. 22, 1923	Nov. 7, 1923	Nov. 27, 1923
5	June 25, 1923	June 28, 1923	July 10, 1923	July 19, 1923	July 30, 1923	Aug. 10, 1923	Aug. 28, 1923	Sept. 9, 1923	Sept. 27, 1923	Oct. 14, 1923	Dec. 27, 1923
6	July 1, 1923	July 3, 1923	July 11, 1923	July 17, 1923	Aug. 3, 1923	Aug. 14, 1923	Aug. 27, 1923	Sept. 11, 1923	Jan. 2, 1924	Jan. 24, 1924	Feb. 21, 1924
7	do	July 4, 1923	July 15, 1923	Aug. 3, 1923	Aug. 14, 1923	Sept. 2, 1923	Sept. 23, 1923	Oct. 5, 1923	Oct. 24, 1923	Dec. 6, 1923	Dec. 31, 1923
8	do	do	do	July 27, 1923	Aug. 7, 1923	Aug. 17, 1923	Sept. 1, 1923	Sept. 23, 1923	Oct. 10, 1923	Dec. 30, 1923	Jan. 15, 1924
9	July 3, 1923	July 7, 1923	July 21, 1923	Aug. 3, 1923	Aug. 13, 1923	Aug. 31, 1923	Sept. 26, 1923	Oct. 23, 1923	Dec. 24, 1923	Jan. 18, 1924	Feb. 29, 1924
10	do	do	July 17, 1923	July 29, 1923	Aug. 21, 1923	Sept. 8, 1923	Sept. 27, 1923	Oct. 26, 1923	Nov. 20, 1923	Dec. 31, 1923	Jan. 23, 1924
11	July 9, 1923	July 12, 1923	July 28, 1923	Aug. 18, 1923	Sept. 21, 1923	Nov. 20, 1923	Jan. 11, 1924	Feb. 6, 1924	Mar. 4, 1924	Mar. 26, 1924	Apr. 14, 1924
12	July 15, 1923	July 18, 1923	July 26, 1923	Aug. 10, 1923	Aug. 25, 1923	Sept. 20, 1923	Oct. 8, 1923	Oct. 25, 1923	Nov. 7, 1923	Nov. 30, 1923	Dec. 27, 1923
13	July 16, 1923	July 19, 1923	July 28, 1923	Aug. 15, 1923	Sept. 1, 1923	Sept. 23, 1923	Oct. 10, 1923	Nov. 3, 1923	Nov. 26, 1923	Dec. 51, 1923	Jan. 25, 1924
14	do	do	July 26, 1923	Aug. 6, 1923	Sept. 2, 1923	Sept. 15, 1923	Sept. 27, 1923	Oct. 15, 1923	Oct. 27, 1923	Dec. 26, 1923	Jan. 30, 1924
15	do	do	do	Aug. 7, 1923	Aug. 13, 1923	Sept. 5, 1923	Sept. 21, 1923	Oct. 1, 1923	Oct. 24, 1923	Jan. 7, 1924	Feb. 3, 1924
16	July 18, 1923	July 21, 1923	July 29, 1923	Aug. 13, 1923	Aug. 30, 1923	Sept. 20, 1923	Oct. 10, 1923	Dec. 4, 1923	Jan. 14, 1924	Feb. 12, 1924	Mar. 19, 1924
17	do	July 20, 1923	July 28, 1923	Aug. 6, 1923	Aug. 18, 1923	Sept. 23, 1923	do	Oct. 27, 1923	Nov. 14, 1923	Jan. 3, 1924	Jan. 29, 1924
18	do	July 22, 1923	July 30, 1923	Sept. 6, 1923	Oct. 1, 1923	Oct. 23, 1923	Dec. 8, 1923	Jan. 11, 1924	Feb. 11, 1924	Mar. 21, 1924	Apr. 10, 1924
19	do	July 21, 1923	do	Aug. 13, 1923	Aug. 23, 1923	Sept. 13, 1923	Sept. 30, 1923	Oct. 22, 1923	Dec. 8, 1923	Jan. 9, 1924	Feb. 5, 1924
20	do	July 20, 1923	July 28, 1923	Aug. 7, 1923	Aug. 14, 1923	Sept. 1, 1923	Sept. 23, 1923	Oct. 5, 1923	Oct. 22, 1923	Jan. 17, 1924	Feb. 21, 1924
21	do	July 21, 1923	July 29, 1923	Aug. 10, 1923	Aug. 30, 1923	Sept. 21, 1923	Oct. 5, 1923	Dec. 1, 1923	Feb. 20, 1924	Mcr. 12, 1924	Apr. 7, 1924
22	do	July 22, 1923	Aug. 7, 1923	Aug. 27, 1923	Sept. 7, 1923	Sept. 22, 1923	Oct. 1, 1923	Oct. 16, 1923	Nov. 2, 1923	Nov. 23, 1923	Dec. 15, 1923
23	July 20, 1923	July 23, 1923	Aug. 2, 1923	Aug. 20, 1923	Sept. 6, 1923	Sept. 23, 1923	Oct. 10, 1923	Oct. 30, 1923	Dec. 24, 1923	Jan. 22, 1924	Feb. 21, 1924
24	do	July 24, 1923	do	Aug. 11, 1923	Sept. 5, 1923	Sept. 26, 1923	Oct. 28, 1923	Dec. 12, 1923	Jan. 14, 1924	Feb. 21, 1924	Mar. 30, 1924
25	July 23, 1923	July 27, 1923	Aug. 3, 1923	do	Sept. 17, 1923	Sept. 30, 1923	Oct. 18, 1923	Oct. 27, 1923	Nov. 23, 1923	Dec. 31, 1923	Jan. 24, 1924
26	do	July 26, 1923	do	Sept. 1, 1923	Sept. 29, 1923	Oct. 17, 1923	Oct. 30, 1923	Dec. 31, 1923	Jan. 22, 1924	Feb. 20, 1924	Mar. 21, 1924
27	do	July 27, 1923	do	Aug. 15, 1923	Sept. 2, 1923	Sept. 19, 1923	Oct. 5, 1923	Nov. 14, 1923	Dec. 31, 1923	Jan. 22, 1924	Mar. 11, 1924
28	do	do	do	Aug. 10, 1923	Aug. 27, 1923	Sept. 23, 1923	Oct. 21, 1923	Nov. 7, 1923	Nov. 28, 1923	Dec. 27, 1923	Jan. 18, 1924
29	do	July 26, 1923	do	Aug. 27, 1923	Sept. 11, 1923	Oct. 2, 1923	Oct. 22, 1923	Nov. 20, 1923	Dec. 10, 1923	Dec. 31, 1923	Jan. 22, 1924
30	July 25, 1923	July 29, 1923	Aug. 6, 1923	Sept. 29, 1923	Oct. 15, 1923	Oct. 30, 1923	Nov. 14, 1923	Nov. 28, 1923	Dec. 15, 1923	do	Jan. 17, 1924
31	Aug. 1, 1923	Aug. 4, 1923	Aug. 25, 1923	Sept. 26, 1923	Oct. 11, 1923	Oct. 29, 1923	do	Jan. 23, 1924	Feb. 23, 1924	Mar. 25, 1924	Apr. 14, 1924
32	do	Aug. 5, 1923	Aug. 22, 1923	Oct. 5, 1923	Oct. 24, 1923	Nov. 7, 1923	Nov. 30, 1923	Jan. 29, 1924	Mar. 6, 1924	Apr. 4, 1924	Apr. 26, 1924
33	do	do	Aug. 30, 1923	Sept. 29, 1923	Nov. 10, 1923	Dec. 10, 1923	Dec. 31, 1923	Jan. 16, 1924	Feb. 7, 1924	Mar. 5, 1924	Apr. 2, 1924
34	Aug. 7, 1923	Aug. 11, 1923	Aug. 20, 1923	Sept. 17, 1923	Nov. 23, 1923	Dec. 26, 1923	Jan. 17, 1924	Feb. 14, 1924	Mar. 21, 1924	Apr. 18, 1924	May 6, 1924
35	Aug. 10, 1923	Aug. 14, 1923	Aug. 22, 1923	Aug. 31, 1923	Sept. 29, 1923	Oct. 23, 1923	Nov. 9, 1923	Nov. 28, 1923	Dec. 24, 1923	Jan. 7, 1924	Feb. 1, 1924

TABLE 4.—*Length of larval periods of Tenebrio molitor*—Continued

No.	Date eleventh molt	Date twelfth molt	Date thirteenth molt	Date fourteenth molt	Date fifteenth molt	Date sixteenth molt	Date seventeenth molt	Date eighteenth molt	Date nineteenth molt	Date twentieth molt	Date larva pupated	Length of larval period, days
1											Feb. 28, 1924	597
2	Aug. 13, 1923	Sept. 22, 1923	Jan. 16, 1924								Mar. 6, 1924	604
3											Mar. 10, 1924	608
4	Dec. 18, 1923	Jan. 7, 1924	Jan. 31, 1924	Feb. 27, 1924	Mar. 25, 1924	Apr. 18, 1924					May 7, 1924	319
5	Feb. 3, 1924	Mar. 11, 1924	Apr. 7, 1924								June 1, 1924	342
6	Mar. 16, 1924	Apr. 7, 1924	Apr. 28, 1924	May 12, 1924	June 20, 1924	July 27, 1924					Feb. 13, 1925	593
7	Jan. 23, 1924	Feb. 28, 1924	Apr. 1, 1924	Apr. 26, 1924							May 24, 1924	328
8	Feb. 6, 1924	Feb. 29, 1924	Mar. 24, 1924	Apr. 14, 1924							May 14, 1924	318
9	Mar. 31, 1924	Apr. 19, 1924	May 6, 1924	June 7, 1924	June 23, 1924	July 6, 1924	July 26, 1924	Aug. 27, 1924	Sept. 18, 1924	Feb. 5, 1925	Feb 20, 1925	598
10	Feb. 29, 1924	Apr. 6, 1924	Apr. 26, 1924	May 22, 1924	June 16, 1924	July 3, 1924	July 19, 1924	July 29, 1924	Oct. 6, 1924		Feb. 11, 1925	589
11	Apr. 30, 1924	May 22, 1924	June 16, 1924	July 3, 1924	July 20, 1924	Sept. 11, 1924					Feb. 13, 1925	585
12	Jan. 14, 1924	Feb. 20, 1924	Mar. 28, 1924	Apr. 24, 1924	May 30, 1924	June 20, 1924	July 10, 1924	Aug. 13, 1924	Sept. 12, 1924		Feb. 7, 1925	573
13	Feb. 26, 1924	Mar. 26, 1924	Apr. 21, 1924	May 5, 1924	June 26, 1924	July 7, 1924	July 22, 1924	Sept. 11, 1924			Jan. 29, 1925	563
14	Feb. 27, 1924	Mar. 24, 1924	June 17, 1924	July 8, 1924	Aug. 6, 1924	Dec. 22, 1924					Jan. 27, 1925	561
15	Feb. 28, 1924	Mar. 22, 1924	Apr. 14, 1924	Apr. 30, 1924	May 30, 1924	June 24, 1924	July 10, 1924	Sept. 15, 1924			Jan. 29, 1925	563
16	Apr. 24, 1924	May 14, 1924	May 23, 1924	June 16, 1924	June 26, 1924	July 10, 1924	July 22, 1924	Aug. 6, 1924	Jan. 6, 1925		Feb. 9, 1925	572
17	Feb. 26, 1924	Mar. 29, 1924	Apr. 20, 1924	May 14, 1924	June 7, 1924	June 24, 1924	July 19, 1924	Aug. 22, 1924			Feb. 10, 1925	573
18	May 23, 1924	June 9, 1924	June 26, 1924	July 11, 1924	July 22, 1924	Aug. 13, 1924	Sept. 14, 1924	Dec. 10, 1924			Jan. 24, 1925	556
19	Mar. 5, 1924	Apr. 4, 1924	May 2, 1924	May 23, 1924	June 27, 1924	July 5, 1924	July 21, 1924	Sept. 14, 1924			Jan 15, 1925	547
20	Mar. 24, 1924	Apr. 11, 1924	Apr. 28, 1924	May 17, 1924	June 4, 1924						June 23, 1924	341
21	Apr. 29, 1924										May 31, 1924	318
22	Jan. 7, 1924	Feb. 1, 1924	Feb. 27, 1924	Mar. 25, 1924	Apr. 19, 1924						May 7, 1924	294
23	Mar. 27, 1924	Apr. 18, 1924	May 12, 1924	June 1, 1924	June 22, 1924	July 13, 1924	Aug. 4, 1924				Feb. 15, 1925	576
24	Apr. 19, 1924	May 11, 1924	June 9, 1924	June 26, 1924	July 7, 1924	July 22, 1924	Aug. 23, 1924	Jan. 7, 1925			Feb. 10, 1925	571
25	Mar. 5, 1924	Apr. 3, 1924	Apr. 19, 1924	May 2, 1924	May 17, 1924	May 31, 1924	June 20, 1924	July 3, 1924	July 21, 1924	Sept. 16, 1924	Jan 28, 1925	555
26	Apr. 14, 1924	May 4, 1924	May 24, 1924	June 7, 1924	June 22, 1924	July 9, 1924	July 26, 1924				Feb. 7, 1925	565
27	Apr. 24, 1924	June 21, 1924	July 6, 1924	July 22, 1924	July 29, 1924	Sept. 8, 1924	Jan. 23, 1925				Feb. 18, 1925	576
28	Feb. 29, 1924	Apr. 4, 1924	Apr. 24, 1924	May 10, 1924	June 12, 1924	June 21, 1924	July 3, 1924	July 21, 1924	July 30, 1924	Sept. 15, 1924	Feb. 12, 1925	570
29	Feb. 20, 1924	Mar. 11, 1924	Apr. 1, 1924	Apr. 22, 1924							May 17, 1924	299
30	Feb. 12, 1924	Mar. 8, 1924	Apr. 2, 1924								May 1, 1924	281
31	May 4, 1924	May 20, 1924	June 21, 1924	July 8, 1924	July 24, 1924	Aug. 8, 1924	Aug. 26, 1924	Feb. 2, 1925			Feb. 20, 1925	569
32	May 12, 1924	June 6, 1924	do.	July 7, 1924	July 22, 1924	Sept. 11, 1924					Feb. 11, 1925	560
33	Apr. 21, 1924	May 16, 1924	May 29, 1924	June 20, 1924	July 20, 1924	Aug. 24, 1924	Jan. 9, 1925				Jan. 31, 1925	549
34	June 6, 1924	June 24, 1924	July 6, 1924	July 21, 1924	Aug. 6, 1924	Sept. 15, 1924					Feb. 11, 1925	554
35	Feb. 26, 1924	Mar. 21, 1924	Apr. 9, 1924	Apr. 30, 1924	May 16, 1924	June 9, 1924					June 27, 1924	322

The data in Table 4 indicate that the least number of molts recorded for a larva of *T. molitor* was [illegible], and the greatest number recorded was 20. Approximately half of the specimens molted either 17, 18, or 19 times each.

LENGTH OF LARVAL INSTARS

With the number of larval molts varying as they do, it is not surprising that the length of the larval instars also varies. Table 5 contains data that indicate the variations in the length of the different instars.

TABLE 5.—*Length of larval instars of meal worms*

TENEBRIO OBSCURUS

No.	Length in days of larval instar No.—																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	23	37	14	28	9	7	16	9	24	17	15	24	41	35	56								
2	27	27	12	13	11	14	9	16	16	14	15	17	20	33	35	49							
3	30	20	15	9	14	15	8	10	13	10	14	14	18	25	54	51							
4	20	27	25	15	13	11	10	15	7	16	12	18	21	31	48	65							
5	22	19	42	17	10	22	8	12	14	18	15	22	41	54									
6	22	31	15	11	14	14	22	14	18	13	15	17	24	40	35								
7	20	27	14	16	11	9	9	10	16	12	14	16	17	24	102								
8	20	27	12	14	10	8	12	11	13	11	12	14	19	22	85								
9	21	23	14	11	15	10	12	21	10	10	16	18	18	20	41	52							
10	22	23	15	21	10	13	9	23	9	12	10	17	17	19	31	35	46						
11	28	23	15	34	9	29	13	11	12	14	18	21	45	61									
12	24	36	13	9	8	10	9	14	9	11	15	18	22	23	80								
13	24	22	12	11	11	15	13	18	11	12	13	16	20	21	39	68							
14	23	19	17	10	10	12	9	8	14	8	8	13	15	15	21	86							
15	22	19	14	11	9	8	9	10	9	14	10	15	14	18	20	31	48						
16	27	19	14	17	7	8	9	11	14	9	12	12	18	21	18	91							
17	25	29	12	10	8	9	9	9	15	11	14	13	18	22	30	24	31						
18	24	25	16	13	13	12	25	8	18	22	18	97	47										
19	23	23	14	9	10	8	10	10	7	12	9	11	12	18	17	20	28	64					
20	22	17	20	13	10	9	10	12	12	10	15	12	19	20	27	30	48						
21	22	24	12	8	10	10	8	10	10	12	10	15	14	18	26	86							
22	27	12	10	9	9	9	14	8	9	13	15	14	18	84									
23	25	22	14	17	8	8	11	8	12	10	11	12	18	17	19	25	53						
24	24	22	12	10	11	11	10	21	10	11	12	17	17	21	86								
25	21	23	12	11	11	19	9	20	9	12	13	17	18	59	37								
26	23	19	13	14	12	10	15	20	7	15	11	16	17	31	56								
27	23	20	12	20	11	16	24	9	14	16	16	22	51	63									
28	24	17	14	20	21	12	20	12	14	18	12	21	27	34	76								
29	22	21	12	9	14	12	16	16	11	15	15	21	23	44	33								
30	22	18	13	10	12	11	14	20	9	9	15	18	15	19	32	43	39						
31	21	19	15	8	12	11	16	18	10	10	11	13	15	17	35	110							
32	22	19	17	13	18	11	20	12	12	13	18	15	26	67									
33	22	22	12	13	10	11	10	12	12	10	16	17	18	97	49								
34	23	19	12	13	10	11	10	10	13	10	15	11	17	19	36	103							
35	21	18	7	10	11	11	10	12	15	16	16	15	19	101	56								
36	21	21	12	15	11	14	17	14	13	23	17	26	96										
37	24	23	10	13	9	12	11	19	12	17	22	17	28	60	61								
38	21	16	13	13	13	14	20	21	26	20	28	40	34	32	44								
39	21	18	14	10	11	10	13	19	11	10	11	17	13	26	86								
40	19	14	15	11	13	10	16	36	16	16	17	20	29	33	47								
41	21	20	12	10	13	12	18	16	8	14	12	16	16	19	32	30	37						
42	19	19	22	15	14	18	23	18	20	13	22	66	24	35									
43	15	20	24	18	7	12	14	18	18	24	18	17	40	25	23	31	43	58					
44	20	18	16	10	14	12	22	18	20	16	17	19	27	36	31	35	47	31					
45	17	19	16	11	13	9	13	20	10	11	12	20	15	20	29	38	35	45					
46	18	20	14	12	13	15	16	26	46	33	35	22	35	23	31	42	19	21	21	20	35	26	99
47	20	27	12	15	11	14	26	8	13	14	39	21	19	12	27	44	34	28	29				
48	16	18	25	11	8	8	17	25	14	13	21	20	39	38	30	34	33	31	25	18			
49	6	10	12	19	11	14	24	24	20	34	38	33	40	58	40	21	13	14	18	23	34	120	
50	3	11	20	6	25	10	18	21	59	28	38	41	59	34	22	34	30	121					

TENEBRIO MOLITOR

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	4	13	12	9	248	32	50	30	119	49													
2	4	6	12	16	45	76	80	56	29	21	53	40	116	50									
3	4	13	66	131	51	36	22	60	38	139	48												
4	3	13	14	21	18	20	17	15	16	20	21	20	24	27	27	24	16						
5	3	12	9	11	11	18	12	18	17	74	38	37	27	55									
6	2	8	6	17	11	13	15	113	22	28	24	22	21	14	39	37	201						
7	3	11	19	11	19	21	12	19	43	25	23	36	33	25	28								
8	3	11	12	11	10	15	22	17	81	16	22	23	24	21	30								
9	4	14	13	10	18	26	27	62	25	42	31	19	17	32	16	13	20	32	22	140	15		
10	4	10	12	23	181	19	29	25	41	23	37	37	20	26	25	17	16	19	69	128			

TABLE 5.—*Length of larval instars of meal worms*—Continued

TENEBRIA MOLITOR—Continued

No.	Length in days of larval instar No.—																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
11	3	16	21	34	60	52	26	27	22	19	16	22	25	17	17	53	155	---	---	---	---	---	---
12	3	8	15	15	26	18	17	13	23	27	18	37	37	27	36	21	20	34	30	148	---	---	---
13	3	9	18	17	22	17	24	23	35	25	32	29	26	14	52	11	15	51	140	---	---	---	---
14	3	7	11	27	13	12	18	12	60	35	28	26	85	21	29	138	36	---	---	---	---	---	---
15	3	7	12	6	23	18	10	23	75	27	25	23	23	16	30	25	10	67	13	6	---	---	---
16	3	8	15	17	21	20	55	41	29	36	36	20	9	24	10	14	12	15	153	34	---	---	---
17	2	8	9	12	36	17	17	18	50	26	28	32	22	24	24	17	25	34	172	---	---	---	---
18	4	8	38	25	22	46	34	31	39	20	43	17	17	15	11	22	32	87	45	---	---	---	---
19	3	9	14	10	21	17	22	47	32	27	29	30	28	21	35	8	16	55	123	---	---	---	---
20	2	8	10	7	18	22	12	17	87	35	32	18	17	19	18	19	---	---	---	---	---	---	---
21	3	8	12	20	22	14	57	81	21	26	22	32	---	---	---	---	---	---	---	---	---	---	---
22	4	16	20	11	15	9	15	17	21	22	23	25	20	27	25	18	---	---	---	---	---	---	---
23	3	10	18	17	17	17	20	55	29	30	35	22	24	20	21	21	22	195	---	---	---	---	---
24	4	9	9	25	21	32	45	33	38	38	20	22	29	17	11	15	32	137	34	---	---	---	---
25	4	7	8	37	13	18	9	27	38	24	41	29	16	13	15	14	20	13	18	57	134	---	---
26	3	8	29	28	18	13	62	22	29	30	24	20	20	14	15	17	17	196	---	---	---	---	---
27	4	7	12	18	17	16	40	47	22	40	44	58	15	16	7	41	137	26	---	---	---	---	---
28	4	7	7	17	27	28	17	21	20	22	42	35	20	16	33	9	12	18	9	47	150	---	---
29	3	8	24	15	21	20	29	20	21	22	29	20	21	21	25	---	---	---	---	---	---	---	---
30	4	8	54	16	15	15	14	17	16	17	26	25	25	29	---	---	---	---	---	---	---	---	---
31	3	21	32	16	18	16	70	31	31	20	20	16	32	17	16	15	18	160	18	---	---	---	---
32	4	17	44	19	14	23	60	37	29	22	16	25	15	16	15	51	153	---	---	---	---	---	---
33	4	25	30	42	30	21	16	22	27	28	19	25	13	22	30	35	138	22	---	---	---	---	---
34	4	9	28	67	33	22	28	36	28	18	31	18	12	15	16	40	149	---	---	---	---	---	---
35	4	8	9	29	24	17	19	26	14	25	25	24	19	21	16	24	18	---	---	---	---	---	---

PUPATION

After becoming apparently full grown the larvae may transform to the pupal form or may remain for many months with but little change in size or outward appearance.

In the laboratory at Washington, which was heated during the winter, the larvae of *Tenebrio obscurus* began to pupate in numbers in November and continued to do so throughout the winter and spring months. A few of the larvae that hatched very early in the year pupated as early as June of the same year, and pupae were obtained in small numbers during each succeeding month until November, when their numbers increased. In barns, storehouses, or similar structures that are unheated during the winter months, the larvae do not pupate normally until spring or early summer.

The larvae of *T. molitor* do not begin to pupate so early in the season as those of the foregoing species. In the laboratory the first pupae were obtained in late January, but in unheated warehouses or storehouses they do not normally pupate until May or June.

When about ready to pupate the larvae of both species come to the surface of the food stuff in which they are living and pass through a short prepupal period during which they are sluggish and exhibit few signs of life.

THE PUPA

The pupa of both species when first transformed is white, except for the tips of the caudal spine and the tips of the lateral appendages. As the pupa becomes older it changes in color to a yellowish brown. The pupae are always naked and unprotected by pupal cases. The pupae of *Tenebrio obscurus* (fig. 3, C) reared in the laboratory at Washington, D. C., ranged in length from 14.5 to 20.5 mm., and in width from 4.5 to 6.5 mm. The pupae of *T. molitor* ranged in length from 14 to 19 mm. and in width from 5 to 7 mm.

DURATION OF THE PUPAL STAGE

The length of the pupal stage is dependent chiefly on the prevailing temperature. As shown in Table 6, the pupal stage of *Tenebrio obscurus* ranged in length from a maximum of 20 days during December and January with an average mean temperature of 65° F., to a minimum of 7 days in June and August, when the mean average temperature ranged from 77° to 78°. The pupal period of *T. molitor* varied from a maximum of 18 days during February with an average mean temperature of 65° to a minimum of 6 days in June with an average mean temperature of 81°.

TABLE 6.—*Length of pupal stage of meal worms*

TENEBRIO OBSCURUS

No.	Date larva pupated	Date adult emerged	Length of pupal period	Average mean temperature for period	No.	Date larva pupated	Date adult emerged	Length of pupal period	Average mean temperature for period
	1923	1924	*Days*	°*F.*		1924	1924	*Days*	°*F.*
1	Dec. 22	Jan. 11	20	65	18	Mar. 12	Mar. 29	17	66
2	Dec. 28	Jan. 13	16	67	19	Mar. 23	Apr. 6	14	67
3	Dec. 30	Jan. 15	16	66	20	Mar. 25	Apr. 7	13	67
					21	Apr. 2	Apr. 15	13	67
	1924				22	Apr. 8	Apr. 21	13	68
4	Jan. 4	Jan. 20	16	66	23	Apr. 17	Apr. 30	13	68
5	Jan. 6	Jan. 23	17	65	24	Apr. 30	May 13	13	68
6	Jan. 10	do	13	66	25	May 3	May 16	13	68
7	Jan. 15	Feb. 1	17	65	26	May 5	May 18	13	68
8	Jan. 21	Feb. 6	16	65	27	May 18	May 31	13	66
9	Jan. 25	Feb. 9	15	66	28	May 21	June 4	14	66
10	Jan. 30	Feb. 15	16	65	29	June 7	June 19	12	73
11	Feb. 1	Feb. 17	16	65	30	June 9	June 21	12	74
12	Feb. 7	Feb. 21	14	66	31	June 11	do	10	75
13	Feb. 17	Mar. 4	16	66	32	June 22	June 29	7	78
14	Feb. 20	Mar. 5	14	66	33	July 16	July 24	8	76
15	Feb. 29	Mar. 15	15	65	34	July 28	Aug. 4	7	77
16	Mar. 1	do	14	65	35	July 30	Aug. 7	8	79
17	Mar. 7	Mar. 23	16	65					

TENEBRIO MOLITOR

No.	Date larva pupated	Date adult emerged	Length of pupal period	Average mean temperature for period	No.	Date larva pupated	Date adult emerged	Length of pupal period	Average mean temperature for period
1	Feb. 3	Feb. 20	17	66	15	May 14	May 24	10	68
2	Feb. 6	Feb. 24	18	65	16	May 17	May 31	14	66
3	Feb. 10	Feb. 28	18	65	17	May 24	June 6	13	67
4	Feb. 28	Mar. 13	17	66	18	June 1	June 12	11	69
5	Mar. 6	Mar. 21	15	65	19	June 16	June 22	6	81
6	Mar. 10	Mar. 26	16	65	20	June 23	June 30	7	76
7	Mar. 12	Mar. 27	15	65	21	June 27	July 6	9	73
8	Mar. 16	Mar. 30	14	66					
9	Apr. 2	Apr. 15	13	68		1925	1925		
10	Apr. 6	Apr. 20	14	66	22	Jan. 15	Jan. 31	16	67
11	Apr. 8	Apr. 22	14	67	23	Jan. 24	Feb. 9	16	67
12	Apr. 17	Apr. 30	13	68	24	Jan. 28	Feb. 12	15	68
13	May 1	May 14	13	68	25	Jan. 29	Feb. 14	16	68
14	May 7	May 21	14	67					

THE ADULT

The adult beetles of the two species closely resemble each other in size and form. They are both considerably more than half an inch in length, but *Tenebrio molitor* (Fig. 4) is shining brown to almost black in color, while *T. obscurus* (Fig. 3, D) is normally a dull pitchy black. Both species possess well-developed wings and are occasionally attracted to bright lights. While generally rather uniform in size, the individual beetles occasionally vary greatly. Arendsen Hein (*2, p. 262*), in his studies on variation, found that the adults of *T. molitor* ranged in size from 10.5 to 23.5 mm. Males and females occur in about equal proportions in both species. Superficially both sexes look alike, but they can be readily differentiated by an examination of the genitalia, which are easily exposed by a slight pressure on the abdomen.

EMERGENCE

At Washington, D. C., the adults normally begin to appear in the spring and from then on may be seen all through the summer. The adults of *Tenebrio obscurus* are the first to be out, many of them emerging a month or more before the first appearance of *T. molitor.* In the laboratory, which was heated during the day in winter to a temperature that ranged between 55° and 75° F., adults of *T. obscurus* emerged in every month of the year. Larvae of the first generation began to pupate as early as June, a few adults emerged in June and July, and with each succeeding month the numbers of emerging adults increased until the peak was reached the following February. Adults of *T. molitor* did not begin to emerge in the laboratory until January, the peak of the emergence also occurring in February. Larvae of *T. obscurus* kept throughout the winter in an unheated building began to pupate in April, and adults began to emerge in late April and early May. Larvae of *T. molitor* under similar conditions pupated during the latter part of May and June.

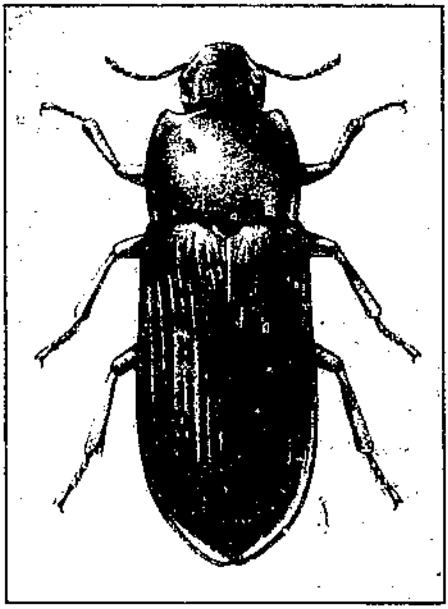
FIG. 4.—*Tenebrio molitor*, adult beetle, × 4

LONGEVITY

As compared with many stored-grain pests, the adult meal worms are relatively short lived. Statistics of several hundred specimens reared in the laboratory showed the average length of life of adults of *Tenebrio molitor* to be about two months, while the average length of life of adults of *T. obscurus* was about three months. The life of the female adults of *T. molitor* ranged from 37 days as a minimum to 96 days as a maximum, with an average of 65 days; the life of male adults ranged from a minimum of 39 to a maximum of 92 days, with an average of 58 days. Arendsen Hein (*2, p. 244–245*) recorded male beetles living from 39 to 113 days and female beetles from 89 to 132 days. He obtained an average life of 60 days for the males and 111 days for the females of this species.

Female adults of *T. obscurus* reared in the laboratory ranged in length of life from a minimum of 42 to a maximum of 152 days, with an average of 84.5 days. Male adults ranged in length of life from a minimum of 31 to a maximum of 132 days, with an average of 83.4 days. Rau (*20*) found that the length of life of adults of this species ranged from 10 to 55 days, with an average of 24 days.

OVIPOSITION

The eggs of both species of beetles are laid singly or in small clusters, sometimes loosely in the flour or meal in which they are breeding, at other times along the sides of the bin or other receptacle. They are covered with a sticky secretion that causes them to adhere to adjacent surfaces or objects and become coated with the flour or meal in which they are laid. For the purpose of obtaining oviposition records adults were confined in glass Petri dishes with a small quantity of graham flour mixed with meat scrap. The eggs for the most part adhered to the bottom of the Petri dish and were easily counted.

AGE AT WHICH MATING AND OVIPOSITION BEGIN

Mating takes place within a few days after emergence and is repeated at intervals throughout the life of the beetles. Observations have shown that when once fertilized the female produces fertile eggs for a considerable time, probably throughout the average egg-laying period. Unfertilized females were observed to lay a few eggs, but none of these hatched.

The preoviposition period varies somewhat and is influenced chiefly by temperature. As shown in Table 7, adults of *Tenebrio obscurus* commenced egg laying in from 9 to 20 days after emergence, the beetles in all cases being kept at ordinary laboratory temperatures. Adults of *T. molitor* commenced egg laying in from 5 to 18 days after emergence. The adults with preoviposition periods of less than 10 days had been placed in an incubator at the time of emergence so that the shorter preoviposition periods were doubtless due to the higher temperature maintained. The temperature of the incubator ranged from 80° to 85° F.

TABLE 7.—*Data concerning oviposition and longevity of meal worms at Washington, D. C.*

TENEBRIO OBSCURUS

No.	Date adult emerged	Date first egg was laid	Length of preoviposition period	Date last egg was laid	Length of oviposition period	Number of eggs laid	Date adult died	Length of life of adult
	1923	1923	*Days*	1923	*Days*		1923	*Days*
1	Feb. 18	Mar. 3	13	July 18	137	970	July 20	152
2	Mar. 6	Mar. 16	10	May 19	64	292	May 24	79
3	do	Mar. 17	11	June 10	94	276	July 3	119
4	do	do	11	May 9	53	326	May 11	66
5	do	Mar. 20	14	June 13	85	546	June 16	102
6	do	Mar. 21	15	May 18	58	73	May 30	85
7	Mar. 13	Mar. 22	9	July 1	101	844	July 5	114
8	Mar. 15	Mar. 24	9	June 28	96	778	June 29	106
9	Mar. 17	Mar. 29	[illegible]	June 21	84	955	June 28	103
10	Mar. 19	Apr. 8	20	June 26	79	155	do	101
11	do	Apr. 3	15	June 8	66	410	June 11	84
12	Mar. 22	do	12	July 4	92	909	July 5	105
13	Mar. 24	Apr. 7	14	June 26	80	710	July 2	100
14	Mar. 25	Apr. 6	12	June 30	85	745	do	99
15	Mar. 28	Apr. 9	12	June 21	73	733	do	96
16	Mar. 29	Apr. 10	12	June 7	58	420	June 14	77
17	Mar. 30	Apr. 16	16	May 7	22	78	May 11	42
18	Apr. 4	Apr. 17	13	June 19	63	155	July 2	89
19	Apr. 6	Apr. 22	16	July 15	84	668	July 16	101
20	Apr. 12	Apr. 25	13	June 5	41	214	June 8	57
21	Apr. 16	Apr. 29	13	June 9	41	263	June 23	68
22	Apr. 23	May 2	9	June 10	39	173	June 18	56
23	Apr. 25	May 6	11	June 17	42	330	do	54
24	May 2	May 12	10	June 27	46	253	June 28	57
25	May 13	May 22	9	July 1	40	307	July 9	57

TABLE 7.—*Data concerning oviposition and longevity of meal worms at Washington, D. C.*—Continued

TENEBRIO MOLITOR

No.	Date adult emerged	Date first egg was laid	Length of preoviposition period	Date last egg was laid	Length of oviposition period	Number of eggs laid	Date adult died	Length of life of adult
	1923	1923	*Days*	1923	*Days*		1923	*Days*
1	May 23	June 9	17	Aug. 4	56	77	Aug. 27	96
2	June 3	June 13	10	Aug. 13	61	167	Aug. 22	80
3	June 5	June 20	15	---do---	54	163	Aug. 21	77
4	June 18	July 6	18	Aug. 18	43	135	Aug. 28	71
	1925	1925		1925			1925	
5 [1]	Jan. 31	Feb. 7	7	Mar. 28	49	185	Apr. 4	63
6	Feb. 5	Feb. 15	10	Apr. 23	67	384	May 1	85
7	Feb. 7	Feb. 17	10	Apr. 24	66	360	May 13	95
8 [1]	Feb. 15	Feb. 23	8	Apr. 7	43	327	Apr. 9	53
9	---do---	---do---	8	Apr. 4	40	197	Apr. 10	54
10	---do---	---do---	8	Apr. 8	44	357	Apr. 9	53
11	Feb. 16	---do---	7	Apr. 25	61	576	Apr. 30	73
12	---do---	Feb. 22	6	Mar. 27	33	283	Mar. 31	43
13	---do---	Feb. 23	7	Apr. 18	54	338	Apr. 20	63
14	Feb. 18	---do---	5	Apr. 4	40	418	Apr. 6	47
15	---do---	---do---	5	Apr. 15	51	405	Apr. 29	70
16	---do---	---do---	5	Apr. 8	44	318	Apr. 9	50
17	Feb. 20	Feb. 25	5	May 1	65	96	May 17	86
18 [1]	Feb. 28	Mar. 5	5	Mar. 26	21	203	Apr. 6	37

[1] No. 5 and Nos. 8 to 18 were reared in an incubator.

PERIOD OF OVIPOSITION

The oviposition period extends over the greater portion of the life of the beetles. The data of Table 7 show that the oviposition period of adults of *Tenebrio obscurus* reared in the laboratory ranged from a minimum of 22 days, April 15 to May 7, to a maximum of 137 days, March 3 to July 18. The oviposition period of adults of *T. molitor* reared in the laboratory ranged from a minimum of 21 days, March 5 to March 26, to a maximum of 67 days, February 15 to April 23. Arendsen Hein (*2, p. 244*) found that the oviposition period of *T. molitor* ranged from 50 to 130 days, with an average of about 2 months.

FREQUENCY AND RATE OF OVIPOSITION

The Tenebrio females bred in the laboratory did not oviposit with any great regularity. As shown in Table 8, frequent intervals occurred between egg layings. Eggs were often laid for several days in succession, and on one occasion a female *T. obscurus* laid eggs on 13 consecutive days and after an interval of 1 day laid eggs on the 17 following days. Similarly an adult female *T. molitor* deposited eggs on each of 27 consecutive days. The intervals between ovipositions ranged from one day to as many as nine days.

TABLE 8.—*Daily oviposition records of meal worms* [1]

TENEBRIO OBSCURUS

Date	Number of eggs laid by individual No.—														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1923															
Mar. 3	2	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 4	4	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 6	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 7	22	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 8	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 16	0	3	---	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 17	12	1	28	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 18	0	1	0	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 19	10	0	0	---	---	---	---	---	---	---	---	---	---	---	---
Mar. 20	0	1	18	1	---	---	---	---	---	---	---	---	---	---	---
Mar. 21	15	0	0	2	3	---	---	---	---	---	---	---	---	---	---
Mar. 22	0	0	16	6	0	42	---	---	---	---	---	---	---	---	---
Mar. 23	20	0	24	22	10	0	---	---	---	---	---	---	---	---	---
Mar. 25	4	0	0	0	0	0	---	---	---	---	---	---	---	---	---
Mar. 27	0	2	0	0	0	0	---	---	---	---	---	---	---	---	---
Mar. 28	22	0	7	0	2	1	---	---	---	---	---	---	---	---	---
Mar. 29	0	0	4	3	3	23	3	---	---	---	---	---	---	---	---
Mar. 30	33	0	0	1	4	0	24	---	---	---	---	---	---	---	---
Mar. 31	0	1	15	53	2	1	14	---	---	---	---	---	---	---	---
Apr. 2	0	2	0	0	0	42	0	---	---	---	---	---	---	---	---
Apr. 3	11	3	0	0	0	0	0	12	9	---	---	---	---	---	---
Apr. 4	2	0	1	0	0	0	30	0	1	---	---	---	---	---	---
Apr. 5	15	0	15	0	0	3	25	34	2	---	---	---	---	---	---
Apr. 6	7	9	7	26	1	0	0	18	0	1	---	---	---	---	---
Apr. 7	9	0	13	0	1	2	23	14	0	2	3	---	---	---	---
Apr. 8	8	5	0	2	0	0	0	0	8	3	0	---	---	---	---
Apr. 9	10	0	0	0	1	28	0	0	0	0	12	---	---	---	---
Apr. 10	10	8	8	2	1	8	1	38	8	46	40	10	---	---	---
Apr. 11	11	7	15	32	0	0	0	0	6	2	0	0	---	---	---
Apr. 12	2	3	6	0	1	14	62	23	3	0	0	20	---	---	---
Apr. 13	17	7	19	0	2	0	0	0	0	4	0	0	---	---	---
Apr. 14	3	4	10	12	0	0	0	30	3	0	0	18	---	---	---
Apr. 15	5	0	0	10	0	0	0	0	4	2	14	0	---	---	---
Apr. 17	15	3	0	6	0	2	38	0	0	16	0	0	---	---	---
Apr. 18	2	7	6	8	0	14	0	7	1	8	29	21	---	---	---
Apr. 19	5	3	12	7	1	0	6	13	3	5	0	0	---	---	---
Apr. 20	0	10	0	0	1	18	0	0	4	0	0	0	---	---	---
Apr. 21	4	2	0	4	7	12	18	3	8	14	32	26	---	---	---
Apr. 22	8	12	5	25	6	0	0	0	0	0	0	0	---	---	---
Apr. 23	16	8	0	49	5	13	48	54	4	48	44	20	---	---	---
Apr. 24	10	0	12	0	2	0	0	0	0	1	0	25	2	---	---
Apr. 25	12	17	23	0	6	2	29	0	5	15	11	0	40	---	---
Apr. 26	7	16	7	0	2	8	28	34	30	0	4	0	0	---	---
Apr. 27	2	4	0	0	6	18	16	16	0	14	51	21	0	---	---
Apr. 28	22	0	30	10	0	1	6	0	2	4	0	0	32	---	---
Apr. 29	4	12	0	6	4	34	0	20	0	0	0	0	0	---	---
Apr. 30	6	0	0	20	0	20	9	0	20	22	0	0	0	---	---
May 1	8	16	2	0	0	0	20	38	0	20	50	4	40	---	---
May 2	14	0	2	34	0	12	37	0	32	0	0	0	0	2	---
May 3	23	11	0	0	0	3	0	0	7	24	0	12	30	6	---
May 4	0	8	1	5	0	5	20	40	0	0	24	0	0	0	---
May 5	9	21	0	2	0	0	14	0	0	2	11	43	0	0	---
May 6	0	0	14	0	0	34	0	0	18	0	0	0	46	2	0
May 7	12	0	0	2	0	0	14	44	0	27	34	0	0	0	0
May 8	8	10	5	10	0	17	36	18	10	4	6	0	0	6	0
May 9	14	0	1	11	0	0	12	0	12	61	14	0	3	0	0
May 10	0	12	0	0	0	0	18	1	0	0	0	5	0	0	0
May 11	2	12	0	6	2	6	1	0	2	0	3	30	0	7	0
May 12	0	2	0	0	0	5	7	1	12	0	25	0	5	0	0
May 13	41	7	0	32	0	20	12	40	21	40	20	0	17	23	0
May 14	0	1	0	0	0	46	0	0	0	2	0	13	0	0	0
May 15	13	0	0	24	2	0	28	33	0	0	8	0	24	0	0
May 16	0	7	0	9	1	42	27	8	0	10	17	15	2	5	0
May 17	4	13	0	15	0	0	15	0	8	30	29	18	6	8	0
May 18	8	2	0	0	3	17	0	0	6	4	0	12	27	0	0
May 19	9	10	0	0	0	9	25	12	6	0	12	0	0	0	0
May 20	0	0	0	34	0	0	0	0	0	32	0	0	30	16	0
May 21	26	0	0	0	0	17	5	44	16	0	31	0	0	0	0
May 22	30	0	0	12	0	56	31	10	7	2	28	7	0	0	39
May 23	2	0	0	0	0	0	0	14	9	3	0	12	0	1	12
May 24	0	0	0	0	0	0	10	0	0	29	1	0	10	8	0
May 25	0	0	0	0	0	2	16	6	34	6	2	0	0	0	0
May 27	48	0	0	0	0	25	13	42	8	20	26	17	40	24	2
May 29	4	0	0	2	0	61	35	6	0	0	44	29	0	5	36
May 30	0	0	0	0	0	0	0	0	0	36	0	0	27	0	0

[1] Dates on which no eggs were laid by any of the beetles have been omitted from this table.

TABLE 8.—*Daily oviposition records of meal worms*—Continued

TENEBRIO OBSCURUS—Continued

Date	Number of eggs laid by individual No.—														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1923															
May 31	4	0	0	6	0	0	37	9	27	0	26	15	0	21	44
June 1	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0
June 2	2	0	0	1	0	0	0	10	12	1	0	8	0	0	0
June 3	0	0	0	0	0	0	42	0	0	26	32	0	24	6	4
June 4	20	0	0	0	0	12	0	30	16	0	0	0	0	0	0
June 5	0	0	0	11	0	0	30	0	0	29	0	1	48	15	32
June 6	31	0	0	0	0	15	0	26	23	0	0	0	0	0	0
June 7	22	0	0	1	0	42	19	24	4	10	0	4	0	10	0
June 8	2	0	0	2	0	0	0	2	3	4	0	0	10	4	12
June 9	18	0	0	0	0	1	0	0	0	0	3	0	6	0	0
June 10	0	0	0	0	0	0	2	0	0	0	0	0	0	4	9
June 11	7	0	0	0	0	0	0	3	0	5	1	0	15	0	0
June 12	19	0	0	0	0	18	0	6	0	0	0	0	0	0	0
June 13	5	0	0	5	0	0	2	2	0	0	0	0	8	0	0
June 14	6	0	0	0	0	0	0	4	0	0	0	0	10	0	6
June 15	18	0	0	0	0	0	3	9	0	12	3	0	1	0	2
June 17	0	0	0	0	0	10	0	15	0	0	0	0	0	0	0
June 18	18	0	0	0	0	0	20	35	0	10	8	0	32	0	15
June 19	0	0	0	0	0	15	32	4	0	9	6	0	0	0	4
June 20	8	0	0	0	0	3	0	0	0	0	0	0	12	0	11
June 21	18	0	0	0	0	7	1	12	0	0	4	0	5	0	15
June 22	15	0	0	0	0	22	0	0	0	0	1	0	6	0	0
June 23	11	0	0	0	0	0	0	4	0	0	0	0	0	0	4
June 24	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0
June 25	12	0	0	0	0	0	0	6	0	0	0	0	18	0	15
June 26	10	0	0	0	0	2	0	6	0	4	1	0	26	0	9
June 28	4	0	0	0	0	4	0	6	0	12	0	0	4	0	16
June 29	7	0	0	0	0	4	0	0	0	0	0	0	0	0	0
June 30	2	0	0	0	0	3	0	2	0	7	0	0	8	0	0
July 1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	20
July 2	5	0	0	0	0	0	0	6	0	0	0	0	6	0	0
July 3	4	0	0	0	0	0	0	10	0	0	0	0	1	0	0
July 4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
July 5	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July 6	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0
July 8	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July 9	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0
July 10	7	0	0	0	0	0	0	0	0	0	0	0	1	0	0
July 11	7	0	0	0	0	0	0	0	0	0	0	0	2	0	0
July 12	4	0	0	0	0	0	0	0	0	0	0	0	4	0	0
July 13	4	0	0	0	0	0	0	0	0	0	0	0	4	0	0
July 14	4	0	0	0	0	0	0	0	0	0	0	0	12	0	0
July 15	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
July 16	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July 17	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
July 18	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	970	284	326	541	73	844	955	909	410	745	710	420	058	673	307

TENEBRIO MOLITOR

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1925															
Feb. 7	4														
Feb. 11	2	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Feb. 15	14	8	----	----	----	----	----	----	----	----	----	----	----	----	----
Feb. 17	3	6	10	----	----	----	----	----	----	----	----	----	----	----	----
Feb. 18	6	22	3	----	----	----	----	----	----	----	----	----	----	----	----
Feb. 19	2	6	10	----	----	----	----	----	----	----	----	----	----	----	----
Feb. 20	8	24	5	----	----	----	----	----	----	----	----	----	----	----	----
Feb. 21	6	0	4	----	----	----	----	----	----	----	----	----	----	----	----
Feb. 22	0	0	0	----	----	----	----	2	----	----	----	----	----	----	----
Feb. 23	2	6	0	3	1	2	4	6	2	4	6	4	----	----	----
Feb. 24	0	0	14	7	0	0	10	5	10	20	2	8	----	----	----
Feb. 25	0	5	18	5	10	2	2	10	0	2	17	2	4	----	----
Feb. 26	2	8	7	2	7	4	24	2	8	16	5	12	0	----	----
Feb. 27	1	0	3	6	26	8	14	0	7	2	0	1	0	----	----
Feb. 28	5	12	19	0	2	0	18	3	12	14	12	5	0	----	----
Mar. 1	4	16	9	18	15	4	6	14	0	4	8	6	0	----	----
Mar. 2	6	8	7	30	3	4	8	7	4	8	9	12	0	----	----
Mar. 3	10	0	16	7	0	8	22	10	3	0	4	0	0	----	----
Mar. 4	0	6	0	0	8	0	14	0	0	12	10	0	0	----	----
Mar. 5	0	9	5	2	31	7	8	7	7	8	9	0	0	14	----
Mar. 6	2	14	0	12	11	0	4	9	8	4	4	27	0	2	----
Mar. 7	0	0	0	6	0	3	16	8	8	10	26	16	3	0	----
Mar. 8	0	6	2	8	4	10	10	13	5	0	12	8	0	0	----
Mar. 9	0	2	6	6	16	6	12	26	6	6	10	6	0	0	----

TABLE 8.—*Daily oviposition records of meal worms*—Continued

TENEBRIO MOLITOR—Continued

Date	Number of eggs laid by individual No.—														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1925															
Mar. 10	16	1	18	12	14	1	14	17	2	30	12	14	9	36	----
Mar. 11	4	0	0	0	0	4	8	5	18	3	8	0	0	4	----
Mar. 12	8	17	22	12	3	29	24	0	12	24	9	8	2	12	----
Mar. 13	6	5	5	28	1	9	14	15	7	4	2	6	0	20	----
Mar. 14	14	16	14	22	0	16	12	19	21	30	1	20	0	15	----
Mar. 15	0	8	8	2	0	20	10	7	17	2	10	0	0	2	----
Mar. 16	16	10	3	10	0	20	14	0	15	16	12	5	0	6	----
Mar. 17	2	4	6	4	2	2	2	10	8	6	8	0	15	8	----
Mar. 18	10	6	5	14	2	12	17	23	8	16	6	40	0	30	----
Mar. 19	1	5	2	18	0	10	12	14	4	8	25	16	0	10	----
Mar. 20	6	0	11	12	0	16	6	9	14	10	16	0	0	6	----
Mar. 21	8	0	14	4	0	20	12	2	0	5	22	6	0	16	----
Mar. 22	0	0	16	0	0	0	0	5	0	0	4	0	0	0	----
Mar. 23	3	0	0	4	0	7	15	1	6	14	7	0	0	0	----
Mar. 24	4	13	7	14	10	18	2	4	10	13	12	1	4	16	----
Mar. 25	8	2	1	4	4	9	17	2	0	22	0	13	0	0	----
Mar. 26	0	9	8	9	0	11	17	6	7	12	16	0	0	0	----
Mar. 27	0	10	2	9	17	10	8	2	3	16	9	12	0	0	----
Mar. 28	2	8	17	10	0	7	3	0	9	15	5	0	0	0	----
Mar. 29	0	0	0	0	0	0	0	0	0	0	14	0	0	0	----
Mar. 30	0	10	0	1	2	0	10	0	15	18	3	11	0	0	----
Mar. 31	0	8	6	6	0	6	25	0	10	17	10	2	12	0	----
Apr. 1	0	0	4	1	2	15	11	0	4	15	17	1	0	0	----
Apr. 2	0	6	10	5	0	7	14	0	0	13	8	3	0	0	----
Apr. 3	0	0	0	1	5	4	10	0	4	3	0	8	3	0	----
Apr. 4	0	7	8	0	1	8	9	0	2	1	3	12	0	0	----
Apr. 5	0	8	5	6	0	12	17	0	7	0	7	4	4	0	----
Apr. 6	0	3	0	0	0	6	8	0	0	0	0	14	0	0	----
Apr. 7	0	0	1	12	0	2	4	0	0	0	4	10	8	0	----
Apr. 8	0	7	4	0	0	5	0	0	0	0	0	5	9	0	----
Apr. 9	0	4	1	0	0	0	12	0	12	0	0	0	2	0	----
Apr. 10	0	4	0	0	0	0	2	0	8	0	9	0	0	0	----
Apr. 11	0	0	2	0	0	0	0	0	0	0	3	0	0	0	----
Apr. 12	0	6	0	0	0	0	6	0	3	0	0	0	0	0	----
Apr. 13	0	8	0	0	0	0	11	0	6	0	0	0	0	0	----
Apr. 14	0	0	2	0	0	0	0	0	4	0	2	0	3	0	----
Apr. 15	0	14	3	0	0	0	0	0	8	0	1	0	0	0	----
Apr. 16	0	0	2	0	0	0	8	0	2	0	0	0	0	0	----
Apr. 17	0	0	0	0	0	0	0	0	2	0	0	0	8	0	----
Apr. 18	0	4	0	0	0	0	6	0	2	0	0	0	0	0	----
Apr. 19	0	8	2	0	0	0	0	0	0	0	0	0	0	0	----
Apr. 20	0	0	0	0	0	0	10	0	0	0	0	0	0	0	----
Apr. 21	0	6	0	0	0	0	6	0	0	0	0	0	0	0	----
Apr. 22	0	0	0	0	0	0	16	0	0	0	0	0	0	0	----
Apr. 23	0	5	0	0	0	0	10	0	0	0	0	0	0	0	----
Apr. 24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	----
Apr. 25	0	0	0	0	0	0	2	0	0	0	0	0	0	0	----
Apr. 26	0	0	0	0	0	0	0	0	0	0	0	0	2	0	----
Apr. 28	0	0	0	0	0	0	0	0	0	0	0	0	3	0	----
Apr. 30	0	0	0	0	0	0	0	0	0	0	0	0	1	0	----
May 1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	----
Total	185	384	360	327	107	357	676	263	338	418	405	318	96	203	----

The number of eggs laid during any one day varied considerably. Female beetles of *T. obscurus* were more prolific than those of *T. molitor* and laid the larger daily batches of eggs. The largest number of eggs laid by a female of *T. obscurus* during 24 hours was 62, whereas the largest number laid by a female *T. molitor* was 40. Occasionally females of both species laid only one egg in 24 hours.

NUMBER OF EGGS DEPOSITED BY FEMALES

The Tenebrio beetles are relatively prolific egg layers, and were it not for the rather prolonged larval period they would be capable of increasing in numbers at a tremendous rate. Females of *T. obscurus* reared in the laboratory deposited an average of about 463 eggs. The smallest number laid by one female was 73 and the largest number 970. Females of *T. molitor* deposited an average of about 276 eggs each. The smallest number laid by one female was 77; the largest, 576. (See Table 7.)

Arendsen Hein (*2, p. 244*) obtained an average of from 100 to 150 eggs per female of *T. molitor*, with a minimum of 36 and a maximum of 359 eggs.

LENGTH OF LIFE CYCLE

Both species of meal worms have been considered as having one generation a year in the United States. The investigations of the writer indicate that this is for the most part correct. Under very favorable conditions, however, there may be a partial second generation of *Tenebrio obscurus* as far north as Washington, D. C. As may be seen in Table 2, individual No. 45 passed through the period from egg to adult in 105 days. The egg was laid March 1, and the adult emerged June 14. A preoviposition period of 9 days added to this gives a minimum life cycle of 114 days. On the other hand, a small percentage of individuals require two years to complete their development; No. 28 (Table 2) emerged as an adult 675 days after the egg was laid.

The shortest period from egg to adult recorded for *T. molitor* was 301 days. (Table 2, No. 36.) The egg was laid July 18, 1923, and the adult emerged May 14, 1924. With a preoviposition period of 10 days, this would give a minimum life cycle of 311 days. Many specimens bred in the laboratory at Washington, D. C., required two seasons or more than 500 days to complete their development. The longest developmental period recorded for this species was 649 days. (Table 2, No. 2.) The egg was laid June 20, 1922, and the adult emerged March 30, 1924.

RESISTANCE TO STARVATION

The larvae of the meal worms are very resistant to starvation, being able to go for very long periods without food or moisture. Of 50 larvae of *Tenebrio obscurus* kept without food or moisture at ordinary room temperature, half survived 6 months, 8 survived 8 months, and 1 specimen survived 9 months.

EFFECT OF EXTREME TEMPERATURES

All stages of both species were killed by a one-hour exposure to a temperature of 125° F.

Eggs of both species were killed by a 24-hour exposure to a temperature of 30° F. or lower. Adults of both species were killed by a 24-hour exposure to a temperature of 10° or lower. Pupae of *T. obscurus* exposed for 24 hours to a temperature of 5° to 10° were unable to transform to adults, and soon died. Larvae of both species were killed by a 24-hour exposure to 0°. A 4-day exposure to a temperature varying from 5° to 10° resulted in the death of larvae of *T. obscurus*, but larvae of *T. molitor* exposed to this temperature for three weeks showed faint movements on being removed to normal room temperature, and exhibited these movements for several days before succumbing. Temperatures around the freezing point had little effect on the larvae. Larvae of both species showed signs of life after having been exposed for more than seven months to a temperature ranging from 30° to 35°.

PARASITES

The meal worms appear to be almost free from the attack of parasites. Schulze (*27*) records the destruction of a brood of *Tenebrio molitor* by a mite, *Tyroglyphus mycophagus* Megnin, which attacked larval, pupal, and adult stages, but so far as the writer is aware the meal worms are not attacked by hymenopterous parasites.

CONTROL MEASURES

Owing to the large size and comparatively slow development of the meal worms, their control is relatively simple. Periodic and thorough cleaning of mills, warehouses, granaries, etc., should prevent them from becoming established. Infested material may be treated by fumigation with heavier-than-air gases or by subjecting it to a temperature of 130° F. for an hour or longer.

The most satisfactory of the heavier-than-air gases for this purpose are carbon disulphide and ethylene dichloride-carbon tetrachloride mixture. Carbon disulphide in the vapor form is highly inflammable and explosive, hence its use should be restricted to situations in which the fire hazard can be absolutely controlled. The ethylene dichloride-carbon tetrachloride mixture is noninflammable and nonexplosive and can be used when it is impossible to use carbon disulphide with safety.

DESCRIPTION OF THE MATURE LARVA OF TENEBRIO MOLITOR LINNAEUS [3]

Larvae of the genus Tenebrio LeConte belong to the tenebrionid subfamily Tenebrioninae, a characterization of which was given by the writer in a previous paper (*25*). The following description is based on the mature larva of *Tenebrio molitor*.

Length 30 mm.; color testaceous with head and anterior face of legs somewhat darker; sternum, hypopleurum and epipleurum of thorax, anterior and posterior margins of pronotum, and posterior margins of the following segments castaneo-testaceous; anterior portion of mesonotum and metanotum, of first abdominal segment, and of nearly all nota of seventh, eighth, and ninth abdominal segments ferrugineo-testaceous,[4] each of the last-mentioned segments darker than preceding one; tips of mandibles, claws, and cerci somewhat piceous; anterior and posterior margins of prothorax and posterior margins of the following 10 segments longitudinally finely striated; terga on thoracic and on first to eighth abdominal segments with a median longitudinal line. Surface punctate, punctures quite far apart. Form elongate cylindrical, about ten times as long as wide (fig. 5, C); dorsally convex, ventrally slightly flattened; pygidium movable up and down, subconically produced, bicornute. Head, ventral side of thoracic segments, anterior portion of sternum of first abdominal segment, pygidium, ninth sternum, and legs clothed with reddish setae; rest of body glabrous with few thin hairs.

Cranium rounded (fig. 5, B), nutant, exserted, about three-fourths as long as wide (from epistomal margin (*epi*) to occipital foramen), broadest medianly, dorsally somewhat convex, ventrally slightly less so. Anterior frontal angle (*fa*) rounded.

Frons (*f*) two-thirds the length of cranium, about as wide as long with extreme width anteriorly, side margins convex.

Epicranial halves (fig. 5, B, *epc*) meeting dorsally; epicranial suture one-third the length of cranium; ventrally the halves separated by the gula (fig. 6, C, *gu*); dorsally with a few long reddish setae (fig. 5, B), 2 near posterior (1 on each side)

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[3] By R. A. St. George. The material on which this description is based was reared by R. T. Cotton and has been placed in the National Museum collection under the Hopk. U. S. No. 10041.

[4] Probably approaches Arendsen Hein's (*8*) *Tenebrio molitor* OR (orange-red) variety.

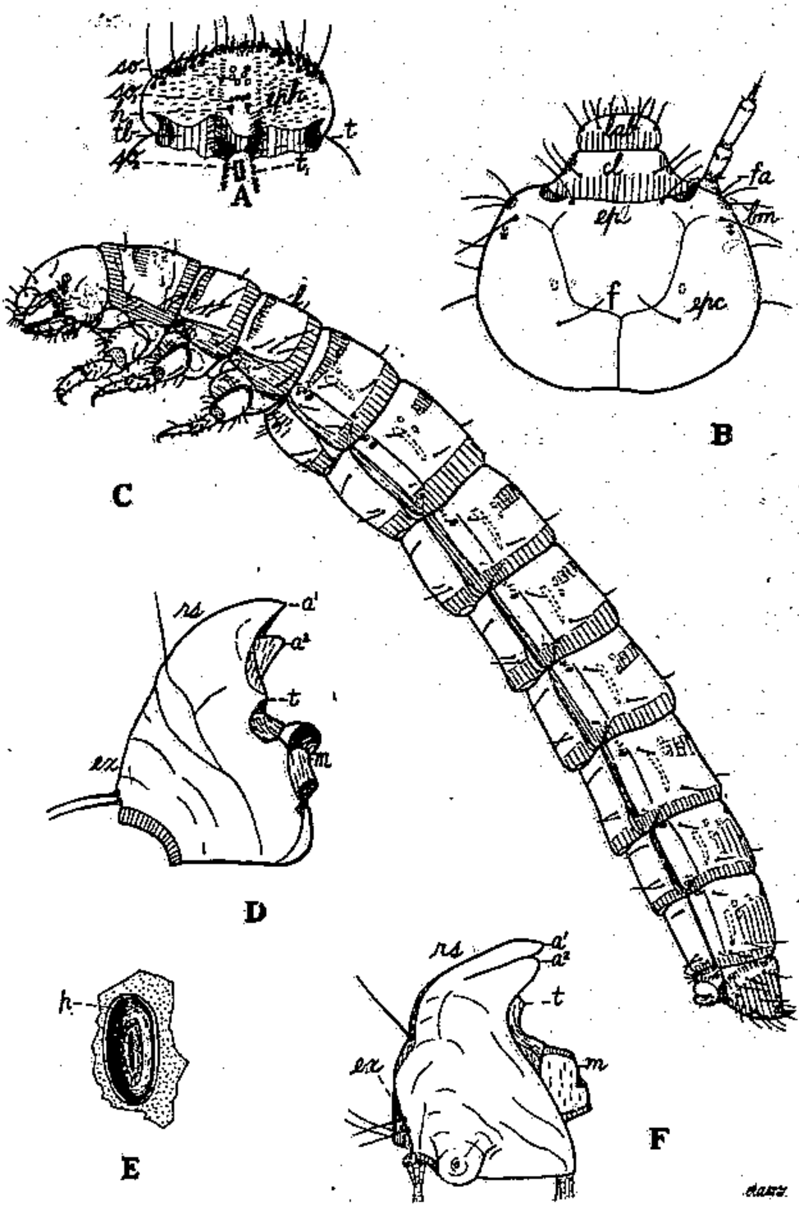

FIG. 5.—*Tenebrio molitor*, mature larva: A, Ephipharynx and anterior margin of labrum, × 32; B, head of larva from above, × 12; C, lateral view of larva, × 5; D, dorsal side of left mandible, × 32; E, first thoracic spiracle, × 62; F, ventral side of right mandible, × 32. (Magnifications are approximate.) a^1, a^2, Bicuspidate apex; *bm*, basal membrane of antenna; *cl*, clypeus; *epc*, epicranium; *eph*, ephipharynx; *epi*, epistoma; *ex*, excavation opposite molar part; *f*, frons; *fa*, anterior angle of front; *h*, median hook; *l*, chitinous line; *lab*, labrum; *m*, molar part; *p*, phrame of peritreme; *rs*, rounded surface on exterior side of cutting edge; *so*, so_1, so_2, sensory organs; *t*, t_1, teeth; *tb*, transverse band

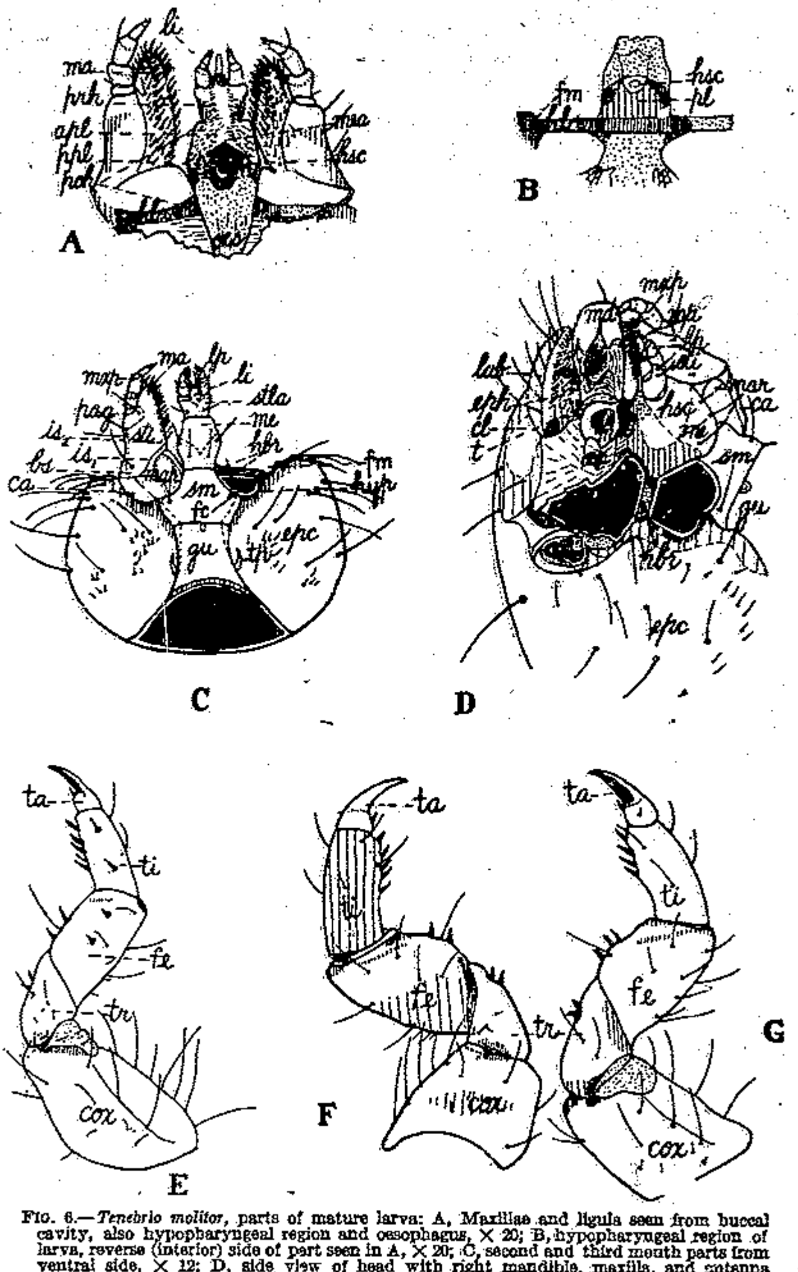

FIG. 6.—*Tenebrio molitor*, parts of mature larva: A, Maxillae and ligula seen from buccal cavity, also hypopharyngeal region and oesophagus, × 20; B, hypopharyngeal region of larva, reverse (interior) side of part seen in A, × 20; C, second and third mouth parts from ventral side, × 12; D, side view of head with right mandible, maxilla, and antenna removed, showing how dorsal surface of molar part of each mandible and basal spines of epipharynx come together, and ho· ventral surface of molar part of each mandible and hypopharyngeal sclerite come together to form grinding surfaces, × 20; E, left mesothoracic leg, showing posterior face, × 25; F and G, left prothoracic leg, anterior and posterior faces, respectively, × 25. (Magnifications approximate.) *apl*, anterior paragnathal lobes; *bs*, base of stipes; *ca*, cardo; *cl*, clypeus; *cox*, coxa; *epc*, epicranium; *eph*, epipharynx; *fc*, fossa for cardo; *fe*, femur; *fm*, fossa for mandible; *gu*, gula; *hbr*, hypopharyngeal bracon; *hsc*, hypopharyngeal sclerite; *hyp*, hypostoma; is_1, is_2, inner margin of stipes; *lab*, labrum; *li*, ligula; *lp*, labial palpus; *m*, molar part; *ma*, mala maxillaris; *mar*, maxillary articulating area; *md*, mandible; *me*, mentum; *mea*, median area; *mxp*, maxillary palpus; *oes*, oesophagus; *pag*, basal membrane of maxillary palpus; *pl*, plate supporting sclerite; *poh*, posthypopharynx; *ppl*, posterior paragnathal lobes; *prh*, prehypopharynx; *sm*, submentum; *stl*, stipes maxillaris; *stla*, stipes labii; *t*, teeth; *ta*, tarsus; *ti*, tibia; *tp*, tentorial pit; *tr*, trochanter

and 4 near anterior (2 on each side) ends of frontal suture, inner 2 of these anterior setae placed on epistoma almost touching clypeus (*cl*); on each side near basal membrane (*bm*) of antenna, 5 or 6 setae, 3 of which are on the dorsolateral side; ventrally several thin reddish setae; behind setae around antennal membrane and along sides of the head about 6 long setae (fig. 6, C), farther inward near gula 2 additional long setae, and behind these several short ones.

Gula (fig. 6, C, *gu*) distinct, well chitinized, hourglass-shaped, slightly longer than wide, widest posteriorly, with tentorial pits (*tp*) just below middle of side margins.

Clypeus (fig. 5, B, *cl*) subtrapezoidal, widest posteriorly, length to extreme width as 1 to 3, medianly with slight transverse ridge, on each side two well developed setae, one near outer margin, the other more inwardly placed along the ridge; side margins of anterior half testaceous, rest slightly chitinous; side margins of posterior half and portion along epistomal margin castaneo-testaceous, rest testaceous.

Labrum (fig. 5, B, *lab*) well developed, movable, transversely rectangular, twice as wide as long, anterior half testaceous, posterior half castaneo-testaceous, anterior margins nearly straight, anterior corners strongly rounded, side margins convex; disk between center and lateral margins with 2 long, reddish setae, 1 on each side, and exterior to these, and placed a little more anteriorly, 1 seta at margin on each side; on each of the anterior corners 2 more long setae; toward middle of front margin another slightly shorter seta on each side, and in front of these and along the extreme edge 4 short setae: along anterior corners on ventral side of labrum about 12 or 13 irregularly placed, shorter, chitinous, slightly curved setae [5] (fig. 5, A), the ones nearest the center more heavily chitinized.

Ocelli vanishing, arranged in two groups on each side, just behind antennal ring (fig. 5, B); both groups transverse, the anterior one with three more or less fused lenses, the posterior one with two fused lenses.

Antenna close to mandible, attached to a distinctly colored rim behind dorsal mandibular fossa (fig. 5, C, B); basal antennal membrane (*bm*) well developed with its posterior dorsal margin slightly chitinized; three articles, all testaceous, with anterior portions rather membranous; basal article clavate, cylindrical, about as long as labrum, twice as long as wide; second article slightly darker than first, clavate, cylindrical, not quite as thick as basal article, about three times as long as wide, distally with a few minute setae; apical article very small, cylindrical, about three times as long as wide and about one-fourth as long as second article; distally bearing a hair as long as the article and in addition several minute tactile hairs; no supplementary appendix.

Mandibles of right and left sides differing in shape; both apically bifid (fig. 5, D, F, a^1, a^2), each with an additional tooth (*t*) between apex and molar part (*m*); tooth of right mandible (F, *t*), however, prominent and placed near apex, that of left (D, *t*) less developed and placed close to molar part; molar part of right mandible with bituberculate crown, that of left mandible with hollow crown; ventrally with cutting part deeply excavated;[6] apex, cutting edge, and molar part heavily chitinized and somewhat piceous, rest of mandible ferrugineo-testaceous; exterior surface (the back of the mandible), distally rounded (*rs*), without margination, bearing a single seta on dorsal surface arising from a slight depression behind apical teeth; proximally (opposite the molar part) excavated (*ex*), without membranous elevation, bearing 4 setae, 2 long chitinous ones on dorsal surface above the fossa and 2 shorter ones on ventral surface near the condyle.

Maxilla dorsally almost completely covered by mandible (fig. 6, D), well chitinized; palpus (fig. 6, C, *mxp*) surmounting mala (*ma*) by about one-third of its own length; palpiger (*pag*) small, ring-shaped, rather membranous except at base, where it is somewhat chitinized and bears some minute hairs; three articles, all testaceous, with anterior portions rather membranous; basal article clavate, about one-third the entire length of palpus, nearly as long as wide, near base on outer side with a minute seta and distally with a few more setae; second article subcylindrical, clavate, about one-third longer than wide, about one-fifth narrower and longer than the basal article, distally with a few minute setae; apical article conical, two-thirds as long and one-half as thick as the second, slightly longer than apical article of labial palpus, with soft tip bearing a few minute tactile hairs.

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[5] This character can be used to separate this species from *Tenebrio obscurus* Fab., *T. opacus* Duft., and *Neatus picipes* Hbst.(= *Tenebrio picipes* Hbst.). A discussion of the genus Neatus was published by the writer in 1924 (*25*).

[6] No soft setae placed closely together near base halfway between condyle and molar part as on the mandibles of the Eleodes-Blaptinae group, which it strongly resembles. See the writer's article (*25, p. 4*).

Mala conical, on dorsal (buccal) surface (fig. 6, A, *ma*) testaceous, with a series of well-developed, somewhat curved, chitinous setae extending right back of and parallel to inner margin and with a corresponding series on inner margin itself; rest of dorsal surface clothed with many thin setae; ventral (exterior) surface heavily chitinized, apically bearing two thin setae (fig. 6, C, *ma*).

Stipes (fig. 6, C, *sti*) fused with mala, well chitinized, right in front of palpiger with 1 long thin seta, just below palpiger (*pag*) near exterior margin with 2 long setae, occasionally with 1 short one between them, and at base (*bs*) near cardo with another seta; proximal half of inner margin (is_1) of stipes connected with maxillary articulating area (*mar*), distal half (is_2), right behind mala, free, bearing one short seta near margin.

Cardo (*ca*) subrectangular, well chitinized, nearly as long as maxillary palpus, entire, adjacent to curved hypostomal thickening (*hyp*), between fossa for ventral mandibular condyle (*fm*) and fossa for tip of cardo (*fc*); inner margin of cardo near middle with an indication of fusion with maxillary articulating area (*mar*); near outer posterior margin with one seta.

Maxillary articulating area (*mar*) protuberant, divided into halves; exterior half connected with maxilla, subdivided into an upper membranous and lower chitinized portion; an oval elevation arising from latter connected with cardo; interior half connected with submentum, entire, well chitinized, ovate, lobelike, without setae.

Submentum (*sm*) strongly chitinized, trapezoidal, broadest posteriorly; side margins slightly concave anteriorly, convex posteriorly and adjacent to maxillary articulating area; surface bearing two long setae, one on each side, near ends of transverse middle line.

Mentum (*me*) with anterior half slightly chitinized, posterior half strongly chitinized; only slightly longer than wide, barrel-shaped, side margins free, on each side of posterior half two long setae, posterior one longer and placed near base and slightly more inward than anterior.

The two stipites labii (*stla*) fused into a chitinized unit with two setae near base and two slightly longer ones apically on the slightly chitinous portion near ligula (*li*).

Labial palpus (*lp*) about half as long as maxillary palpus, with two articles, both testaceous, the anterior portions rather membranous, basal article subcylindrical, clavate, one-sixth longer than wide; a minute seta near base on outer side, a few more distally; apical article conical, about two-thirds as long and one-third as wide as first article, with soft tip bearing a few minute tactile hairs.

Ligula (*li*) slightly testaceous, small, broadly conical, about as wide as long, with one terminal pair of long setae, and several rather short rigid ones along front margin and on buccal surface (fig. 6, A, *li*).

Prehypopharynx [7] (fig. 6, A, *prh*) simple, membranous, with posterior side margins slightly chitinous and with a longitudinal series of tactile hairs on each side, seen only with aid of very high magnification.

Paragnathal areas [8] of posthypopharynx somewhat bilobed and membranous. Anterior portion of each paragnatha (fig. 6, A, *apl*) large, cushionlike, and covered with microscopic tactile hairs; posterior portion (*ppl*), placed on each side of the hypopharyngeal sclerite (*hsc*), small, free, ovate, lobelike, and covered with minute setae.

Sclerite of hypopharyngeal chitinization (fig. 6, A, B, D, *hsc*) elongately rectangular, somewhat rounded at base, projecting, strong, and supported below by a chitinous plate (B, *pl*) extending forward from bracon (*hbr*); anteriorly tricuspidate, the median cusp largest; disk excavate; molar part of each mandible and hypopharyngeal sclerite grinding together (fig. 6, D, *m*, *hsc*).[9] Bracon of hypopharyngeal chitinization (A, B, D, *hbr*) heavily chitinized below the chitinous plate (*pl*), otherwise rather membranous.

Median area of posthypopharynx (A, *mea*), above the hypopharyngeal sclerite (*hsc*) and between the posterior portions of the anterior part of the paragnathal areas (*apl*), membranous and without tactile projections.

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[7] The buccal ventral surface behind the ligula the writer terms hypopharynx and divides it into an anterior part named prehypopharynx (*prh*) and a posterior part named posthypopharynx (*poh*). The prehypopharynx ("hypopharynx" MacGillivray) is simple and membranous, usually covered with fine tactile projections; it is normally placed above the stipites labii. The posthypopharynx ("subgusto" MacGillivray) is composed of the hypopharyngeal chitinization, the paragnathal areas (*apl*, *ppl*) (Crampton), two-lobed or simple, and a median area (*mea*) between them. The hypopharyngeal chitinization usually is composed of a sclerite (*hsc*) and bracon (*hbr*). The posthypopharynx normally is placed above and about the mentum-submentum region.

[8] These areas correspond to those pointed out by Böving (*4*) in the larva of the social beetle *Coccidotrophus socialis* (Schwarz and Barber), which there are named the maxillulae.

[9] Böving (*31*) was the first to point out this function of sclerite and molar part of mandible.

Epipharynx (fig. 5, A, *eph*) soft skinned, with a posterior, transverse, broad sinuous, chitinous band (*tb*) carrying one pair of stublike teeth (*t*) and just behind each of these four or five minute teeth (t_1) in a row extending toward oesophagus; between the two rows of teeth (t_1) eight sensory punctures (so_2); on outer side and in front of the stublike teeth (*t*), extending anteriorly over soft-skinned part to a pair of short chitinous hooks (*h*), with many minute brushlike hairs. Median part of epipharynx glabrous, with six large ring-shaped sensory punctures [10] (*so*) near anterior margin; behind them, near hooks (*h*), four more, but smaller, punctures (so_1); rest of epipharynx beset with tactile hairs visible only with high-power magnification; the stublike teeth on epipharynx also grind against the mandibles, working together with the dorsal sides of the molar structures. (Fig. 6, D, *t*, *m*.)

Legs well developed, surrounded at base by a large articulating area (fig. 7, C, *ar*).

Prothoracic legs only slightly larger than those of mesothorax and metathorax. Anterior faces of legs somewhat darker than posterior faces. Coxae (fig. 7, C; fig. 6, F, G, *cox*) of first pair attached so closely together that they are nearly contiguous at base, about as long as wide, anterior face testaceous and posterior face thinly chitinized; several long reddish setae on both faces, arranged mainly along outer and inner margins, also with a few minute setae; trochanter (*tr*) twice as long as wide, front margin about as long as that of coxa, thinly chitinized; on inner margin distally, armed with 2 strong spinelike setae; [11] on anterior face 4 or 5 minute setae, on posterior face 2 long setae; femur (F, G, *fe*) one-third longer than wide, posterior margin about one-fourth longer and two-fifths wider than inner margin of trochanter, proximal portion of anterior face well chitinized; on inner margin usually armed with 2 or 3 spinelike setae, but 4 may be present and also several long thin setae on each face; tibia (F, G, *ti*) two and one-half times as long as wide, inner margin about as long and half as thick as that of femur, anterior face well chitinized and posterior face slightly chitinized; inner margin usually armed with 4 or 5 spinelike setae, but as many as six may be present and also a few long thin setae on each face; tarsus (F, G, *ta*) about two-thirds as long as tibia, ferrugineo-testaceous except at tip where it is somewhat piceous, falcate, strong but rather slender, inner surface facing backwards distally excavate, proximally enlarged with a round, rather soft-skinned region which bears, at base of excavation, a short but strong chitinous seta and on posterior face a minute thin seta.

Second and third pairs of legs (fig. 6, E; fig. 7, B) slightly more slender than prothoracic and inserted farther apart; proportions of articles and arrangement and number of setae varying somewhat from first pair, but the two pairs themselves nearly alike. Coxa (*cox*) about twice as long as wide, with many long setae arranged mainly along margins and a few minute hairs on posterior face; trochanter (*tr*) twice as long as wide, about half as thick as coxa, front margin about half as long as coxa, on inner margin distally armed with 2 spinelike setae as on prothoracic leg; on posterior face of second leg 2 long setae and sometimes 1 or 2 minute hairs, but on third leg armed with an additional spinelike seta, very rarely not present; femur (*fe*) twice as long as wide, posterior margin one-third longer and slightly wider than inner margin of trochanter, on inner margin usually armed with 2, sometimes 3, spinelike setae, between which is a long seta; on posterior face medianly armed with 2 additional spinelike setae and on both faces with a few thin setae; tibia (*ti*) nearly two-thirds as long as wide, outer margin about as long and slightly narrower than inner margin of trochanter, on inner margin usually armed with 4 spinelike setae, although number may vary from 3 to 5; on posterior face medianly 2 additional spinelike setae, occasionally only 1 present, and on anterior face about 5 thin setae; tarsus (*ta*) two-thirds as long and somewhat narrower than tibia, inner surface facing backwards distally excavate, proximally enlarged and with swelling and setae like those on prothoracic leg.

Presternal area between head and prothorax (fig. 7, C, *y*) with indication of a division into three parts; middle part about as wide as gula, bearing two setae on posterior margin; the two exterior parts each bearing two minute setae. Immediately below this middle part and well separated from it is an indication of a

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[10] The number and general position of these sensory punctures are constant in the species of *Tenebrio molitor*, *T. obscurus*, *T. opacus*, and *Neatus picipes*.

[11] The number of spines on trochanter of the prothoracic leg appear to be constant and can be used to separate this species from *Tenebrio obscurus* and *T. opacus*, each of which has one. *Neatus picipes* also has two, but this species can be separated easily by characters from the pygidium. See article published by the writer in 1926 (*26*). The spines on all the other articles of the legs vary in number even in the same specimens on opposite legs and sometimes on the trochanter of the mesothoracic and metathoracic legs.

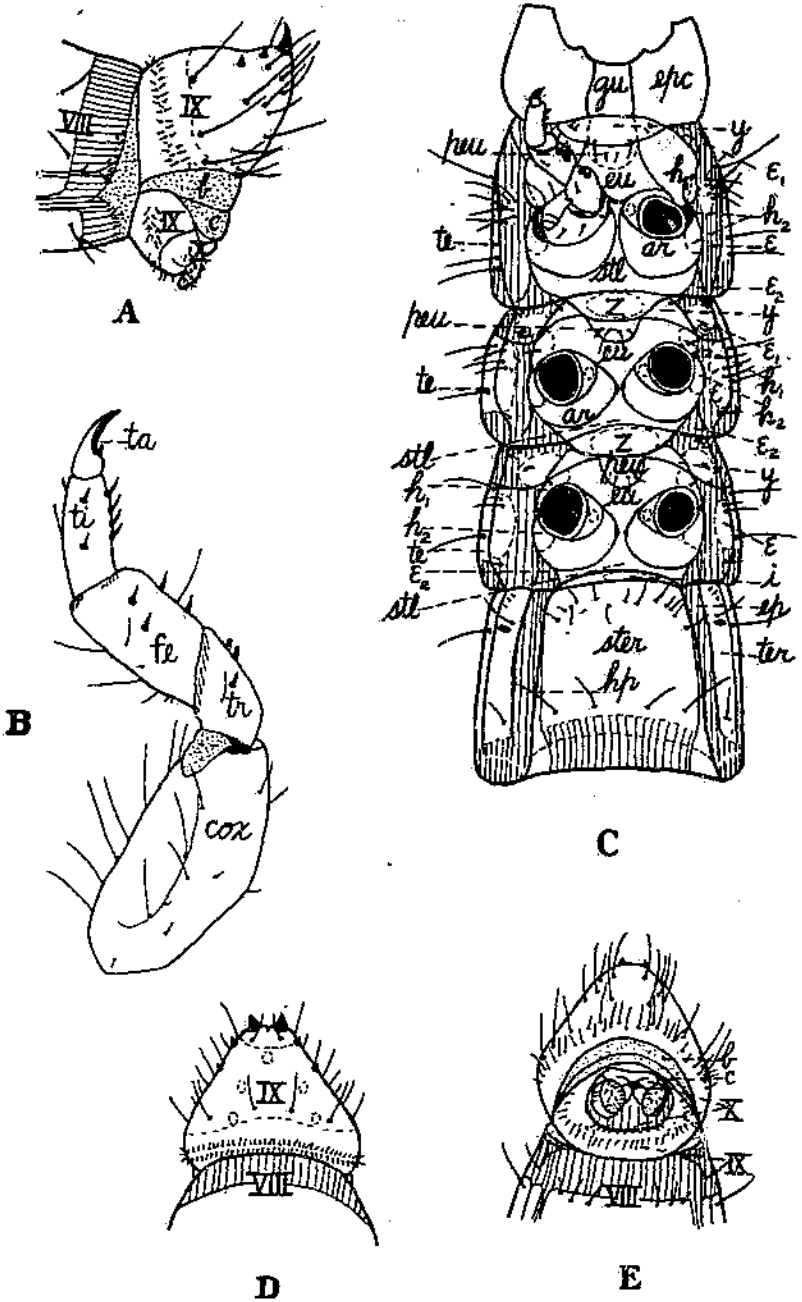

FIG. 7.—*Tenebrio molitor*, parts of mature larva: A, Pygidium, side view, × 10; B, right metathoracic leg, showing posterior face, × 25; C, ventral view of part of head, of thoracic segments, and of first abdominal segment, × 10; D, pygidium, dorsal view, × 10; E, pygidium, ventral view, × 10. (Magnifications are approximate.) *ar*, Articulating membrane of leg; *b*, *c*, twofold articulating membrane between ninth and tenth segments; *cox*, coxa; *e*, epipleurum; e_1, preepipleurum; e_2, postepipleurum; *ep*, abdominal epipleurum; *epc*, epicranium; *eu*, eusternum; *fe*, femur; *gu*, gula; h_1, prehypopleurum; h_2, posthypopleurum; *hp*, abdominal hypopleurum; *l*, membranous area on metathorax; *peu*, presternal subdivision of eusternum; *ster*, sternal shield of abdominal segment; *stl*, sternellum; *ta*, tarsus; *te*, thoracic tergite; *ter*, tergal shield of abdominal segment; *ti*, tibia; *tr*, trochanter; *y*, presternal areas; *z*, poststernellum; VIII, IX, X, abdominal segments

chitinous, suboval single area bearing two very short thin setae. This suboval area is probably a preeusternal subdivision (*peu*) of the eusternum [12] (*eu*).

Ventral intersegmental region between prothorax and mesothorax, and between mesothorax and metathorax, testaceous, composed of distinct poststernellar, preepipleural, and presternal areas.

Prothoracic eusternum (fig. 7, C, *eu*) well chitinized, large, subtrapezoidal; prehypopleural and posthypopleural areas (h_1, h_2) both present, well chitinized, prehypopleural area particularly well developed, internally adjacent to presternal and eusternal areas; sternellar region (*stl*), behind the front legs, well chitinized, almost fused with eusternum, forming together with it an hourglass-shaped region; poststernellum (*z*) trapezoidal, widest anteriorly, with an elliptical, raised, rather membranous area in center, around which it is chitinized; prothoracic tergal shield (*te*) subquadrate, with anterior and posterior margins as mentioned above; right back of anterior margin a transverse series of 4 setae (2 on each side) and just before posterior margin a similar series composed of 10 setae (5 on each side) (fig. 5, C); epipleurum (fig. 7, C, *e*) with a few setae grouped anteriorly.

Mesothorax and metathorax with a large chitinous eusternal region (fig. 7, C, *eu*) and with a separation of a rather membranous preeusternal subdivision (*peu*) indicated,[13] the latter area bearing two long and two very short setae. Presternal areas (*y*) distant, chitinized, subtriangular, bearing a single seta medianly; prehypopleurum (h_1) well developed, slightly testaceous, with small chitinization near condyle for articulation of leg, usually bearing a single seta; sternellum (*stl*) of mesothorax and metathorax and poststernellum (*z*) of mesothorax similar to that of prothorax; poststernellum of metathorax not present, but in intersegmental region an elliptical, rather membranous area (*i*), somewhat like that present in poststernellum in preceding segments, which might constitute an element of poststernellum. Preepipleurum (e_1) of mesothorax and metathorax partly chitinized, subrectangular; the former carrying the first thoracic spiracle, the latter the rudimentary second thoracic spiracle; anterior to each spiracle, a few minute setae; epipleurum (*e*) of both segments well developed and chitinized, with median portion only thinly chitinized; usually with 1 seta placed posteriorly and 2 or 3 setae grouped anteriorly; postepipleurum (e_2) chitinized, triangular, without setae. Mesothoracic and metathoracic tergal shields (fig. 7, C, *te*; fig. 5 ,C) transverse, about four times as wide as long; right behind anterior margin a transverse chitinous line (fig. 5, C, *l*), back of which and contiguous to it is a narrow chitinous band; posterior margin longitudinally finely striated, anterior to margin a transverse series of 4 setae (2 on each side), lateral margin usually with 2 or 3 additional setae. The first abdominal tergum also has a transverse chitinous line and a band similar to that on the mesothorax and metathorax, the rest of the abdominal segments being without the line.

Typical abdominal segment (that is, one of the eight anterior segments) with fused sternal areas (fig. 7, C, *ster*) covered by a transversely rectanular shield (*ter*) with a median longitudinal line, anteriorly with a transverse slight chitinization which extends farther back in each succeeding segment, so that the terga of the seventh, eighth, and ninth segments are almost covered (fig. 5, C); near distal margin of each of the eight anterior segments are five distinct but faint impressions [14] on each side; above the spiracle, which is carried by the tergal shield (*ter*), is a longitudinal chitinous line [15] which extends from the posterior band to, or slightly beyond, the spiracle.

Setae on each side of first abdominal tergum. Below the longitudinal line, a few minute setae placed anterior to the spiracle (fig. 5, C) and in addition two others, both long, one below the spiracle, the other in front of the transverse band; above the longitudinal line, two setae in front of the band and one near anterior lateral margin over the spiracle. Setae on second to seventh abdominal terga arranged as on the first, except that no seta is developed below the spiracle. Setae on eighth tergum arranged as in preceding segments, except that an additional seta is present in the series in front of the band (fig. 5, C) and several minute

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[12] This area is plainly indicated in a closely allied form, *Merinus laevis* (Olivier). See article by the writer (*55, p. 41*).

[13] A separation is also indicated by Wade and the writer (*32*) in the closely allied form *Merinus laevis* (Olivier) and to some extent in *Eleodes suturalis* Say of the Blapstinae group. In this reference a correction should be made on page 554; instead of reading, "no separation of a preeusternal subdivision indicated," it should read, "separation of a preeusternal subdivision slightly indicated;" and the footnote 7 should be changed accordingly, reading, "Separation of a preeusternal region indicated but not as distinct as in *Merinus laevis* (Olivier)."

[14] A detailed discussion of these impressions and their importance as a taxonomic character is given by Arendsen Hein (*3*).

[15] This line is called a "lateral line" by Arendsen Hein and is used as a character in separating the species of Tenebrio. The present writer has found that this character is sometimes variable.

setae are developed along the posterior margin of the band both above and below the longitudinal line (fig. 7, A). Setae on each side of the sterna of first to eighth abdominal segments. Sternum of first abdominal segment anteriorly densely beset with setae (fig. 7, C, *ster*), similar arrangement lacking on other typical abdominal segments; posterior margin of first to seventh segments with two setae along anterior margin of transverse band; eighth sternum (fig. 7, A, E) with three quite long setae similarly placed, and in addition several minute setae on posterior margin of band. Hypopleural region (fig. 7, C, *hp*) narrow, slightly chitinous; epipleural region (*ep*) somewhat broader and more strongly chitinous, both regions without setae. First six abdominal segments transverse, the seventh and eighth subquadrate.

Ninth abdominal segment (fig. 7, A, D, E, IX) smaller than preceding; dorsal part, or pygidium, well chitinized, subconically produced; wider (at base) than long; bicornute, with the cerci curved upward to the extent that their longitudinal axes are perpendicular to surface of tergum; cerci at bases separated by a distance less than twice their diameter at that point, only slightly recurved and somewhat piceous; on each side, anterior to cerci, two short chitinous spines;[16] tergum in front of cerci with a slight depression; punctations quite far apart; anterior margin of segment slightly chitinized, bearing a transverse series of short hairs; anteriorly on well-chitinized part a transverse series of four long thin setae, one placed dorsally and one laterally on each side; on lateral and posterior margin right above tenth segment a series of long setae. Ventral part of ninth segment small, transverse, soft, and bearing many short setae.

Tenth abdominal (anal) segment (fig. 7, A, E, X) ventral, small, separated from ninth by a large, two-fold, articulating membrane, with an upper and lower transverse, membranous anal lip and on each side of this a short, conical, robust and (except at tip) setose ambulatory papilla.

Spiracles (fig. 5, C. E) oval, transversely directed, cup-shaped, at bottom, with a linear opening protected by hairs. Prothoracic spiracle more narrowly oval than abdominal spiracles.

DESCRIPTION OF THE MATURE LARVA OF TENEBRIO OBSCURUS FABRICIUS[17]

Length 35 mm.; color castaneo-testaceous, with head and tergum of thorax somewhat darker; anterior and posterior margins of pronotum, posterior margins of the following segments, and terga of the seventh, eighth, and ninth abdominal segments dark brown to brownish black. Surface punctate, punctures closer together than in *Tenebrio molitor;* pygidium (fig. 8, G) longer and more slender than in *T. molitor*.

Cranium (fig. 8, B) slightly more than half as long as wide (from epistomal margin (*epi*) to occipital foramen).

Frons (*f*) three-fifths length of cranium, nearly as long as wide with extreme width anteriorly, side margins convex.

Labrum on anterior corners on ventral surface usually with three short, chitinous, slightly curved setae (fig. 8, A).

Ocelli (fig. 8, B, C) arranged as in *T. molitor* but more prominent.

Antenna (fig. 8. E) with proportions of basal (E, *1*) and apical (E, *3*) articles about as in *Tenebrio molitor*, but the second article (E, *2*) differing by being four instead of three times as long as wide.[18]

Mentum about one-fourth longer than wide.

Prothoracic leg (fig. 8, F) with trochanter (*tr*), on inner margin distally, armed with 1 strong spinelike seta; femur (*fe*), on inner margin, usually armed with 2 spinelike setae but sometimes as many as 3 may be present; tibia (*ti*), on inner margin, usually armed with 4 spinelike setae, but as many as 3, 5, or 6 may be present occasionally.

Mesothoracic and metathoracic legs (fig. 8, C) usually with the same number of spinelike setae on inner margin as on prothoracic leg, but this sometimes varying as follows: Three or four spinelike setae may be present on the femur, and three to five on the tibia. The posterior face of these legs usually carries

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[16] According to Arendsen Hein (3), in exceptional cases specimens have only one spine on each side. The writer has found such a specimen, but on the one side the seta was placed near the cerci and on the other side anteriorly so that they were not opposite each other.

[17] By R. A. St. George. The material on which this description is based was reared by R. T. Cotton and has been placed in the National Museum collection under the Hopk. U. S. No. 10642.

[18] This character will also separate this species from *Tenebrio opacus* and *Neatus picipes*, both of which are like *T. molitor* in this respect.

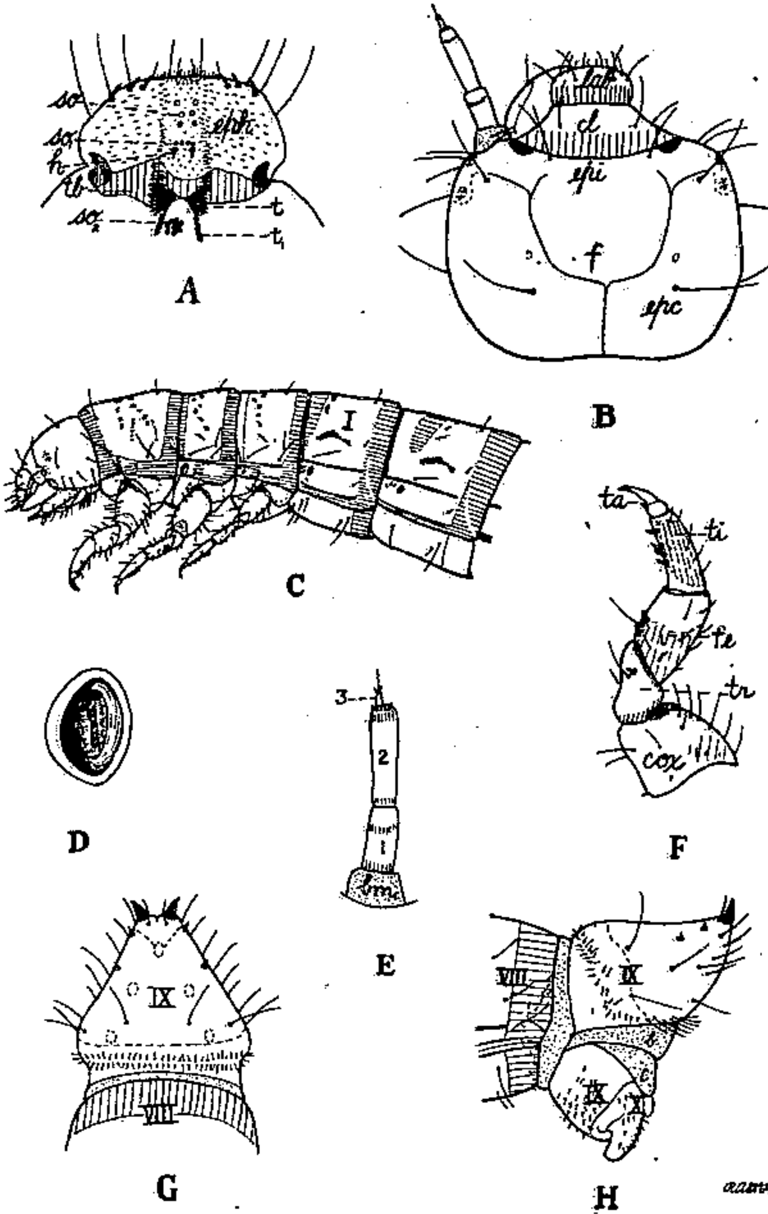

FIG. 8.—*Tenebrio obscurus*, parts of mature larva: A, Epipharynx and anterior margin of labrum, × 32; B, head of larva from above, × 12; C, lateral view, showing head, thorax, and first two abdominal segments, × 5; D, first abdominal spiracle, × 62; E, antenna, × 18; F, right prothoracic leg, anterior view, × 15; G, pygidium, dorsal view, × 10; H, pygidium, side view, × 10. (Magnifications are approximate.) *b, c*, Two-fold articulating membrane between ninth and tenth segments; *bm*, basal membrane of antenna; *cl*, clypeus; *cox*, coxa; *epc*, epicranium; *eph*, epipharynx; *epi*, epistoma; *f*, frons; *fe*, femur; *h*, median hook; *lab*, labrum; *so*, so_1, so_2, sensory organs; *t*, t_1, teeth; *ta*, tarsus; *tb*, transverse band; *ti*, tibia; *tr*, trochanter; I, VIII, IX, X, abdominal segments; *1, 2, 3*, articles of antenna

the same number of additional spines as on *Tenebrio molitor*, that is, none present on the trochanter, two present on the femur, and two on the tibia.[19]

Posthypopleurum of prothorax (fig. 8, C) usually without setae, rarely with one seta.

Prothoracic tergal shield (fig. 8, C) transverse, subrectangular, about twice as wide as long.

Mesothoracic and metathoracic epipleurum usually with only one seta anteriorly and none posteriorly, but with minute setae anterior to the spiracle.

Typical abdominal segment (one of the eight anterior) with tergal shield chitinized and with each segment slightly darker than preceding; near anterior margin, between lateral and median longitudinal lines, five distinct and somewhat prominent impressions[20] on each side (fig. 8, C); longitudinal line on lateral side of tergum just above spiracle extending from the posterior band far beyond spiracle into lightly colored marginal band which encircles the segments anteriorly.[20]

Epipleural region (fig. 8, C) usually without a minute seta near the posterior margin.

Ninth abdominal segment (fig. 8, G, H) with pygidium subconically produced, not wider (at the base) than long, bicornute, with the cerci curved upward, but not so much as in *Tenebrio molitor*, so their longitudinal axes are not perpendicular, but oblique to surface of tergum (H, IX); cerci separated at bases to a distance of about twice their basic diameters, quite strongly recurved (G, IX); punctures not very far apart, closer than in *T. molitor*.

Spiracles broadly oval (fig. 8, D), broader than in *T. molitor*.

SUMMARY

The meal worms have long attracted the attention of both scientists and laymen by reason of their use as food for birds and small animals and because of their destructiveness in stores of flour and meal. They have figured in entomological literature since 1634, and both are probably of European or Asiatic origin. *Tenebrio molitor* does not thrive in the warmer parts of the United States.

They are found in greatest abundance in accumulations of refuse meal, grain, and sweepings in mills and under the litter of chicken houses. They are often reared and sold for bird food.

Under natural conditions there is one generation a year, though some individuals may require two years to complete their development. The female beetles oviposit over an extended period, ranging from 22 to 137 days, *T. molitor* laying in laboratory rearings an average of 276 eggs, with a maximum of 576, and *T. obscurus* an average of 463, with a maximum of 970. The larval period of *T. obscurus* was found to range from 79 to 642 days and that of *T. molitor* from 281 to 629 days. The complete life cycle of *T. obscurus* ranged from 114 to 675 days, that of *T. molitor* from 311 to 649 days.

Meal worms can pass long periods without food (a maximum of nine months was recorded for *T. obscurus*). They can not stand temperatures as high as 125° F.; they survive freezing temperatures, but not those as low as 10°.

They are almost entirely free of parasitic enemies. Artificial control is easily secured through periodic cleaning up of the refuse in mills, warehouses, and granaries, or by fumigation with carbon disulphide.

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[19] On the posterior face of the metathoracic leg of an anomalous specimen, there was present only one additional spinelike seta on femur and on tibia, while in this same region of the mesothoracic leg the number was constant. Also, on the inner margin of this same metathoracic leg there were only two spines on tibia instead of the usual four.

[20] This was first pointed out by Arendsen Hein (3).

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