MIXOGASTER BREVIVENTRIS Kahl.

M. breviventris Kahl, Kansas Univ. Quart., VI, p. 137, 1897.

A male and female of this interesting species were collected by Mr. Erich Daecke, at Lucaston, N. J., August 27, 1905. The type, a female, was described from Lawrence, Kans. The male differs but little from the female except that the fourth segment is nearly twice the length of the third, the posterior border on both being greatly dilated towards the lateral margins; the fifth segment and hypopygium (in the specimen before me) seem to be injured or forced within the abdomen, so that they cannot be accurately described.

TRICHOGRAMMA PRETIOSA RILEY: SEASONAL HISTORY.

BY A. A. GIRAULT, WASHINGTON, D. C.

THE paper here presented for publication is one of a series on this insect based on observations and studies made during the Cotton Bollworm Investigations in Texas in 1904, by the U. S. Department of Agriculture. The observations were made in the laboratory at Paris, latitude 33°, 45' north and the host of the parasite was *Heliothis obsoleta* Fabricius, unless otherwise stated in the text. In their report on the bollworm, Quaintance and Brues (1905) have already given the substance of much that is to follow, but I believe the observations of enough importance to justify elaboration, an impossibility in connection with an economic report of that kind.

NUMBER OF GENERATIONS.

The species under consideration is a remarkable example of an hymenopterous insect having multiple generations, and to this fact may be largely attributed its efficiency as a parasite. From the beginning to the end of the breeding season of 1904, it was under constant observation, and in the laboratory many successive generations were bred, so that actual records were obtained for fifteen consecutive cycles from the latter part of May to the first week in November. In addition to this direct evidence, there was also obtained much supplementary data, which warrants a positive statement to the effect that there were at least eighteen distinct generations of the little egg-parasite in the vicinity of Paris in 1904. The records show that the parasites began to appear about May 3rd, corresponding to the first noticeable

appearance of the host eggs on corn, and they were present throughout the season in increasing numbers until about November 20th. To obviate further unnecessary discussion and for the sake of clearness and convenience, the generations are tabulated as follows:

Table I. Generations at Paris, Texas, 1904.

Generation No.	Eggs deposited.	Adults out.	Approximate length of cycle.	Sums of effective temperature.
1.	May 3	May 16	13 days.	324.1° Fahr.
2.	May 16	May 26	10 "	313.2
3.	May 26	June 6	11 "	354.7
4.	June 4	June 14	10 "	318.4
5.	June 14	June 22	8 "	297.2
6.	June 22	July 1	9 "	330.9
7.	July 1	July 9	8 "	298.9
8.	July 11	July 20	9 "	365.7
9.	July 20	July 28	8 "	300.
10.	July 29	August 6	8 "	298.7
11.	August 6	August 14	8 "	298.4
12.	August 14	August 23	9 "	364.0
13.	August 25	September 2	8 "	308.4
14.	September 2	September 11	9 "	308.
15.	September 11	September 20	9 "	314.2
16.	September 21	September 30	9 "	323.1
17.	October 1	October 14	13 "	408.1
18.	October 14	November 2	19 "	365.0
18a.	October 14	November 7	24 "	449.
18b.	October 14	November 8	25 "	465.
18c.	October 14	November 10	27 "	480.

Sums	.	.	.	.	.	.	254 days.	7285.0
Averages	.	.	.	.	.	.	12 days.	346.6° Fahr.

LENGTH OF LIFE CYCLE.

By consulting table I, it is seen that the developmental period of a generation

varied considerably, from about 8 to 27 days, according to the season. Upon the approach of warm weather, it gradually decreased and remained practically constant from about the middle of June to about the middle of September, or during the warm summer months. In the fall, it rapidly increased in length, becoming twice as long in November as it was for the first generation in May, as would be expected from the fact that the mean daily effective temperature at that time of the year was very low. Table II is introduced to show as accurately as possible the lengths of the life cycles at different dates in 1904.

Table II. Lengths of the Life Cycle, Paris, Texas, 1904.

Lot No.	Dates.	Eggs deposited.	Adults out.	Approximate length of cycle.	
				Days.	Hours.
1.	May 3–May 16	May 3	May 16	13	
2.	May 26–June 6	P. M. May 26	Noon, June 6	10	21
3.	May 27–June 7	P. M. May 27	A. M. June 7	10	17
4.	June 1–June 12	A. M. June 1	A. M., June 12	10	17
5.	June 4–June 14	P. M., June 4	Noon, June 14	9	20
6.	June 14–June 22	A. M., June 14	A. M., June 22	7	22
7.	June 14–June 22	A. M., June 14	A. M., June 22	7	15
8.	June 20–June 28	A. M., June 20	P. M., June 28	8	6
9.	June 22–June 30	Noon, June 22	Noon, June 30	8	0
10.	June 22–July 1	P. M., June 22	A. M., July 1	8	14
11.	July 1–July 9	A. M., July 1	A. M., July 9	8	0
12.	July 20–July 28	P. M., July 20	A. M., July 28	7	19
13.	July 29–August 6	Noon, July 29	A. M., August 6	7	20
14.	Sept. 12–Sept. 20	P. M., Sept. 12	P. M., Sept. 20	8	0
15.	Sept. 21–Sept. 30	A. M., Sept. 21	A. M., Sept. 30	8	23
16.	Sept. 26–Oct. 4	A. M., Sept. 26	A. M., Oct. 4	8	6
17.	Sept. 28–Oct. 6	A. M., Sept. 28	P. M., Oct. 6	8	9
18.	Oct. 1–Oct. 14	Noon, Oct. 1	Noon, Oct. 14	13	0
19.	Oct. 14–Nov. 2	A. M., Oct. 14	A. M., Nov. 2	19	3
20.	Oct. 14–Nov. 7	A. M., Oct. 14	P. M., Nov. 7	24	6
21.	Oct. 14–Nov. 8	Oct. 14	Nov. 8	25	0
22.	Oct. 14–Nov. 10	P. M., Oct. 14	P. M., Nov. 10	27	0

The length of the life cycle was first recorded by Hubbard (Howard, 1892) in 1885 as being 7 days, the host being *Alabama argillacea* Hübner.

HIBERNATION.

Very little is known in regard to the mode of hibernation of many of the smaller parasitic hymenoptera, especially the more minute egg-parasites, and for this reason the following account will be of interest.

About two years before these observations were made, the method of hibernation of this species of *Trichogramma* was stated by W. A. Boucher whose account has not been accessible. However, Froggatt (1906) quotes Mr. Boucher as follows:—“ . . . As the parasite remains dormant in the egg of the Codling Moth¹ during the winter and spring months, it is evident that the number of parasites that will again be present at the commencement of each fruit season to continue the destruction of the Codling Moth's eggs will depend upon the number of parasitized eggs that remain uninjured during the winter, the proportion of which, under ordinary circumstances, and without artificial assistance, will be very small; . . . ”

Mr. Boucher apparently gives no evidence to show upon what his assertion is based and hence it needs confirmation. The following data obtained in the latter part of 1904 seems to indicate that his view is correct.

As shown in table II, the length of the life cycle increased rapidly in the fall from 8 days in late September to from 13 to 19 days in October, up to 27 days by the second week in November. In fact, the last or eighteenth generation varied unusually from 19 to 27 days, and the records show that this generation was a small or scattering one, the last principal generation being the seventeenth (adult about October 14). After about this date it is believed that hibernation commenced, though adults continued to be present, in rapidly decreasing numbers, for a month later (to November 19). In about the middle of October, and later, parasitized hosts in the field (including also *Alabama argillacea* Hübner) on corn and cotton were tagged and watched for emergence of the adults. Many of these were on dried and withered leaves when tagged, and when last examined after heavy killing frosts on November 20th, were found on these shriveled leaves, which were either hanging to the plants or were on the ground. Some of the parasitized hosts, however, had been washed from the leaves to the ground by the rain. The results are shown in the attached tables.

---

¹ *Carpocapsa pomonella* Linnaeus.

Table III. Hibernation Statistics, Oct. 11-20, 1904.

Host, Lot No.	No. hosts.	Location.	Date tagged and known parasitized.	Hosts excluding parasites and date.	Hosts not excluding parasites by Nov. 20.	Total hibernating.	Condition when last examined (Nov. 20.)
1	2	Cotton leaves	October 11	2 — Oct. 19	0	0	Healthy.
2	5	Dead corn leaves	12	0	5	5	Healthy.
3	3	Dead corn leaves	14	1 — Oct. 18	2	2	“
4	3	Cotton leaves	14	3 — Oct. 21	0	0	“
5	4	Cotton leaves	14	3 — Nov. 2-6	1	1	“
6	11	Corn leaves	14	11 — Nov. 2-15	0	0	“
7	5	Corn leaves	14	5 — Nov. 7-10	0	0	“
8	9	Corn leaves	17	8 — Oct. 20-Nov. 4	1	1	On ground; healthy.
9	4	Young corn ¹	17	2 — Nov. 6	2	2	On ground.
10	3	Young corn ¹	19	0	3	3	Healthy.
11	4	Corn	19	3 — Oct. 23-Nov. 4	1	1	“
Totals	53			38 — Oct. 18-Nov. 15	15	15 ²	Foliage wilted and dead.

¹ Planted for experimental purposes.

² 28.3 per cent.

Table IV. Hibernation Statistics, Oct. 21-Nov. 3, 1904.

Host, Lot No.	No. hosts.	Location.	Date tagged and known parasitized.	Hosts excluding parasites and date.	Hosts not excluding parasites by Nov. 20.	Total hibernating.	Condition when last examined (Nov. 20.)
1	6	Cotton leaves	October 21	1 — Oct. 23	5	5	Healthy
2	8	“	22	1 — Nov. 15	7	7	6 healthy; 1 washed off.
3	12	“	22	10 — Oct. 29, Nov. 14	2	2	Healthy.
4	12	“	22	4 — Nov. 4-7	8	8	“
5	14	“	24	0	14	14	11 healthy; 3 washed off
6	14	Young corn ¹	24	1 — Nov. 6	13	13	Healthy; 7 on ground.
7	1	“	24	0	1	1	On ground
8	1	Cotton leaves	24	0	1	1	Healthy.
9	3	“	25	0	3	3	“
10	6	“	28	0	6	6	“
11	10	“	Nov. 1	2 — Nov. 16	8	8	“
12	1	“	3	0	1	1	“
Totals	88			19 — Oct. 23-Nov. 16	69	69 ²	

¹ Planted for experimental purposes.

² 78.4 per cent.

Summary of Tables III and IV.

23	141		57	84	84	Healthy.

The tables serve to make clear the fact that at least as early as October 12th, hibernation had commenced, but that by October 20th only 28.3 percent were in that state, the remaining eventually emerging as adults. After October 20th, however, table IV shows that nearly 80 per cent of the parasites had not emerged up to the time of killing frosts (Nov. 20th and a few days earlier), or were hibernating. The data is not as conclusive as desirable, for it may be urged that the observations were not continued late enough to state definitely whether or not the adults issued after November 20th, and then hibernated. But as evidence against this, I offer the fact that adults failed to issue from 10 of these tagged hosts up to the middle of December, they having been carried to Washington, D. C., in vials and confined in the laboratory.

Another fact indicating hibernation as a larva in the host, is that no material increase in length of life could be noticed in the adults in the late part of October and in November. In reality, they seemed to perish more easily at that time than in the summer. During the observations, most of the adults issued during warm spells.

INCREASE IN NUMBERS DURING A SEASON.

Assuming that the average number of eggs deposited by a female is 30, a conservative estimate, and that at least half of these will produce other females, the progeny of a single pair for such a season as 1904 in Texas would total to the unthinkable number of 3, 031, 721, 260, 073, 800, 781, 250, as shown in the accompanying table by generations.

Table V. Progeny of a Single Pair, by Generations.

Generation No.	No. of descendants.	Remarks.
1	30	Descendants of hibernating female.
2	450	
3	6750	
4	101, 250	
5	1, 518, 750	
6	22, 781, 250	
7	341, 718, 750	
8	5,125, 781, 250	
9	76, 886, 718, 750	
10	1, 153, 300, 781, 250	
11	17, 299, 511, 718, 750	
12	259, 492, 675, 781, 250	
13	3, 892, 390, 136, 718, 750	
14	59, 885, 852, 050, 781, 250	
15	898, 287, 780, 761, 718, 750	
16	13, 474, 316, 711, 425, 781, 250	
17	202, 114, 750, 671, 386, 718, 750	
18	3, 031, 721, 260, 073, 800, 781, 250	

All of this, of course, is purely speculation, for we have no means of actually obtaining vital statistics of this kind. No allowances have been made for mortality in the reproducing females, or in the young, and in order to make the calculation as conservative as possible, the totals should probably be halved, on the theory that but half of the female descendants in any one generation survive to reproduce. This would still leave us in a maze of unthinkable totals. The figures are merely introduced to show the possibilities in rapid reproduction present in this important egg-parasite, and no claim is made that they represent anything like actual fact.

LITERATURE REFERRED TO.

1892. Howard, 'Leland Ossian. Proc. U. S. Nat. Museum, Washington, XIV (1891), p. 577.
1905. Quaintance, Altus Lacy and Charles Thomas Brues. The Cotton Boll-worm. Bull. No. 50, Bureau Ent., U. S. Dep. Agric., Washington, p. 117.
1906. Froggatt, Walter. Agric. Gazette New South Wales, Sydney, XVII, pp. 390-391.