

# STATUS OF THE PARASITES OF THE HESSIAN FLY, *PHYTOPHAGA DESTRUCTOR* (SAY), IN PENNSYLVANIA, MARYLAND, AND VIRGINIA<sup>1</sup>

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## INTRODUCTION

It has long been known that parasites play an important rôle in the natural control of the Hessian fly, *Phytophaga destructor* (Say), but most of the accounts so far published have contained little information concerning the relationships of the parasites to their host and to each other. Such knowledge, however, is important, not only in estimating the value of the parasites as a whole in the control of the Hessian fly, but also in determining the relative importance of the individual parasites.

To obtain information of this nature an intensive study of the parasites of the Hessian fly has been carried on for several years in the eastern part of the United States, and it is the purpose of this paper to set forth some of the results of this work.

The data here assembled are from material collected for 10 consecutive years from widely separated localities in the wheat-growing regions of Pennsylvania, Maryland, and Virginia, from Lycoming County, Pa., on the north, to Augusta County, Va., on the south.

## METHODS OF INVESTIGATION

In obtaining the records of the parasites attacking the Hessian fly of the spring generation, certain localities in which normal farm practice is followed were selected from the important wheat-growing counties within the area under observation. One or more collections of infested wheat plants were made from each of these points. These samples were examined in the laboratory, the Hessian fly puparia removed and classified, and the apparently sound puparia reared to obtain the parasites or flies that they might contain. In those cases where more than one collection was made in a locality, the data were consolidated and treated as a single collection. The number of puparia thus assembled from each county averaged 310.

In order that all the species of parasites might have a fair showing, collections made earlier than June 15 were not included in the table of relative abundance, and most of the collections were taken after the first of August. It was found necessary thus to take into consideration the time of collection because of the fact that certain of the parasites, for instance, *Platygaster vernalis* and *P. herrickii*, which oviposit in the egg of the host, obviously enter the host considerably earlier than the other parasites. If collections had been made before

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the later ovipositing parasites had entered the host there would have been undue discrimination in favor of those which oviposit early.

These parasites all belong to the order Hymenoptera. Of those mentioned in this paper 3 are serphoids of the genus *Platygaster* and 15 are chalcidoids.

The parasites were reared most successfully in shell vials inserted in plaster-of-Paris blocks. This holder was devised by W. R. McConnell early in the progress of the investigations. It consists of a block of plaster 18 inches long by 8 inches high by  $1\frac{1}{2}$  inches thick, with a substantial bulge at the back. Holes about 15 mm. deep and of sufficient diameter to receive 9 mm. by 33 mm. shell vials are spaced an inch apart each way, 119 in all, over the flat surface of the block. The block stands on one long side, and a shallow trough is excavated along the top. Four vertical holes evenly spaced along the bottom of the trough are drilled slightly more than half way to the bottom of the slab. This allows water poured in the trough to penetrate the plaster quickly and uniformly. The puparia are placed in the vials, 10 to each vial, the mouth of the vial is plugged snugly with a piece of cotton, and this end is fitted into one of the holes in the front of the block.

#### PARASITISM OF THE HESSIAN FLY OF THE SPRING GENERATION

From Table 1 it may be seen that in the territory under observation the average annual parasitism of the Hessian fly of the spring generation was 62 per cent.

It was interesting to observe that the average mortality of the Hessian fly amounted to 96 per cent, which is considerably in excess of the mortality that was positively determined as caused by parasites. There is evidence, however, to indicate that some of this additional mortality was the result of parasitism, the traces of which had become obliterated. This was shown to be the case by dissections of Hessian fly puparia taken from selected areas in fields near the beginning and again near the end of the season. Three such sets of observations were made in different localities and in different years and the results in each case showed a greater total parasitism in the first collection than in the last. At the same time, in the last collection an increase was found in the number of puparia dead from undetermined causes. As the number of individual flies remained the same throughout the season, the total amount of parasitism could not actually have decreased, and the difference must be looked for in unrecognizable material. It might be added that in a great many cases, in the course of examining Hessian fly puparia, traces of dead chalcidoids or *Platygaster* larvae were found in an almost unrecognizable state, which also indicates that some of the unrecognizable material within dead puparia was of such origin.

Table 1 also shows the relative abundance of the 18 species of parasites found to prey on the Hessian fly in this section. Three of these parasites belonging to the genus *Platygaster* of the superfamily Serphoidea are *herrickii*, *hiemalis*, and *vernalis*. The remaining 15 species belong to the superfamily Chalcidoidea. *P. vernalis* was more efficient than any one of the other parasites. The other two *Platygaster*s were of insignificant importance, because *hiemalis* normally attacks only the fall generation instead of the spring generation of the fly, and *herrickii* is prolific only in a more southern climate.

TABLE 1.—Relative value of the parasites of the Hessian fly of the spring generation in the wheat regions of Pennsylvania, Maryland, and Virginia, and their relation to the total mortality of the host, 1915 to 1924

Year	Number of collections	Total number of puparia	Average number of puparia per collection	Parasitism of the Hessian fly by—																										Total parasitism	Hessian flies dead from unrecognizable causes	Total mortality of Hessian flies
				Chalcidoids																	Platygaster											
				Eupelmus alysi (French)	Mersus destructor (Say)	Pleurotropis epigynus (Walker)	Mersus febrilis Girault	Tetrastichus carinae Forbes	Eupermatus minor (Lindemann)	Cheltonurus elegans (Dalman)	Centrodora speciosissima (Girault)	Nemtoromelus fulvipes (Forbes)	Eupelmus saltator (Lindemann)	Polyscelus modestus Gahan	Ditropinotus aureoviridis Crawford	Callitula bicolor Spinola	Eurytoma phebous Girault	Eurytoma n. sp.	Undetermined chalcidoids	Total chalcidoids	Platygaster herrickii Packard	Platygaster hiemalis Forbes	Platygaster ventralis (Myers)									
1915	5	1,882	376	1.51	2.79	1.45	0.37	1.42	1.72	0.25	0.06	0.12	0.81	0.02	0.10	0.09	0.11	0.04	0.03	0.08	0.04	0.08	0.04	0.03	0.08	0.06	22.99	16.39	34.02	87.01	36.27	93.23
1916	7	4,947	707	6.77	6.18	4.46	1.42	3.59	1.42	0.25	0.06	0.12	0.81	0.02	0.10	0.09	0.11	0.04	0.03	0.08	0.04	0.08	0.04	0.03	0.08	0.06	22.99	16.39	34.02	87.01	36.27	93.23
1917	12	1,658	138	6.03	3.02	3.59	1.42	1.72	0.25	0.06	0.12	0.81	0.02	0.10	0.09	0.11	0.04	0.03	0.08	0.04	0.08	0.04	0.03	0.08	0.06	22.99	16.39	34.02	87.01	36.27	93.23	
1918	5	1,825	365	3.39	2.97	1.81	1.65	0.92	0.04	0.06	0.12	0.81	0.02	0.10	0.09	0.11	0.04	0.03	0.08	0.04	0.08	0.04	0.03	0.08	0.06	22.99	16.39	34.02	87.01	36.27	93.23	
1919	16	6,225	327	3.19	5.72	1.35	1.03	1.65	0.04	0.06	0.12	0.81	0.02	0.10	0.09	0.11	0.04	0.03	0.08	0.04	0.08	0.04	0.03	0.08	0.06	22.99	16.39	34.02	87.01	36.27	93.23	
1920	23	6,278	273	2.93	3.19	1.26	1.35	1.81	0.06	0.06	0.12	0.81	0.02	0.10	0.09	0.11	0.04	0.03	0.08	0.04	0.08	0.04	0.03	0.08	0.06	22.99	16.39	34.02	87.01	36.27	93.23	
1921	15	5,909	394	3.34	3.33	1.8	2.25	1.79	0.02	0.06	0.12	0.81	0.02	0.10	0.09	0.11	0.04	0.03	0.08	0.04	0.08	0.04	0.03	0.08	0.06	22.99	16.39	34.02	87.01	36.27	93.23	
1922	15	4,455	287	4.14	6.74	1.2	3.1	0.4	0.02	0.08	0.04	0.04	0.02	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	29.04	39.16	68.86	141.67	50.82	94.99
1923	10	2,852	285	2.82	3.39	2.7	0.99	0.4	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	29.04	39.16	68.86	141.67	50.82	94.99
1924	15	3,136	209	4.03	2.64	0.84	0.54	2.07	0.06	0.04	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	29.04	39.16	68.86	141.67	50.82	94.99
Average	12.3	3,817	310	4.02	4.00	1.13	0.63	0.57	0.03	0.06	0.11	0.02	0.11	0.02	0.11	0.02	0.11	0.02	0.11	0.02	0.11	0.02	0.11	0.02	0.11	0.02	36.72	26.07	61.66	133.91	66.33	95.57

Of the chalcidoids, five species were found attacking the Hessian fly every year. These were, in order of importance, *Eupelmus allynii*, *Merisus destructor*, *Pleurotropis epigonus*, *M. febriculosus*, and *Tetrastichus carinatus*. The remaining 10 species were comparatively scarce, and in some years a few of them were not recovered at all.

The percentage of the individual chalcidoids is relative rather than absolute because some parasites had emerged at the time of collection. Their occurrence as such, however, could be determined by the emergence holes and pupal remains. These have been classified in the table under the heading "Undetermined chalcidoids," and when they are added to the chalcidoids which were reared and determined there is shown an annual average total parasitism of chalcidoids of 37 per cent.

In order to check the rearing records by actual field conditions, dissections were made of Hessian fly puparia as they were found in the field. This eliminated any modifying effect which might result from unnatural confinement in rearing cages. The combined results of two such dissection records of 99 Hessian fly puparia taken from a field in Carlisle, Pa., in 1918 showed a total parasitism of 70 per cent and a total mortality of 95 per cent. Six such observations, based on 950 puparia collected from a field in Mount Holly Springs, Pa., in 1919, showed a total parasitism of 71 per cent and a total mortality of 92 per cent. Four such observations, based on 586 puparia collected from a field in Mount Holly Springs in 1920, showed a total parasitism of 52 per cent and a total mortality of 99 per cent. Five similar observations, based on 510 puparia collected at New Windsor, Md., in 1921, showed a total parasitism of 53 per cent and a total mortality of 97 per cent. An average of these figures shows a total parasitism of 62 per cent and a total mortality of 96 per cent, which is very close to the average figures obtained in the rearing records shown in Table 1.

#### PARASITISM OF THE HESSIAN FLY OF THE FALL GENERATION

The Hessian fly of the fall generation was found to be attacked almost solely by the serphoid parasite *Platygaster hiemalis*. During the nine years from 1914 to 1922, inclusive, in the wheat-growing regions covered by these investigations, the annual mortality of the Hessian fly of the fall generation caused by this parasite ranged from 16 to 40 per cent with a yearly average of 28 per cent.<sup>3</sup>

Records from material gathered in 10 counties in Pennsylvania, in 1923, showed an average of 55 per cent of parasitism by *hiemalis*. Data obtained during this year from other localities were unreliable owing to the scarcity of the Hessian fly.

#### HYPERPARASITISM

Hyperparasitism is prevalent among the parasites of the Hessian fly, but there is no evidence that any discrimination is made between parasite and fly in the selection of a host.

*Platygaster vernalis* is especially subject to hyperparasitism owing to its occurrence in the host very early in the season. The following parasites have been reared from cocoons of *Platygaster vernalis*: *Eupelmus allynii*, *Merisus destructor*, *M. febriculosus*, *Tetrastichus*

<sup>3</sup> HILL, C. C. PLATYGASTER HIEMALIS FORBES, A PARASITE OF THE HESSIAN FLY. Jour. Agr. Research 32: 261-275, illus. 1926.

*carinatus*, *Cheiloneurus elegans*, *Callitula bicolor*, *Nemicromelus fulvipes*, *Eupteromalus micropterus*, *Eupelminus saltator*, *Centrodora speciosissimus*, and *Polyscelis modestus*.

There is evidence which indicates that the chalcidoids prey on one another, as dissection records have shown the presence of more than one chalcidoid larva in a host. Owing to the unrecognizable condition of the parasite killed, it was usually impossible to determine the species and therefore only a few records have been made. *Merisus destructor* was found to have been parasitized by one of its own species and by *Eupelmus allynii*. *Tetrastichus carinatus* was found parasitized by *E. allynii*, *E. allynii* by *T. carinatus*, and an internal parasite considered to be *Pleurotropis epigonus* by *E. allynii*.

The *Platygaster* parasites, *vernalis*, *hiemalis*, and *herrickii*, always oviposit directly in the egg of the fly, and are, therefore, usually primary in their parasitic habits.

It may be assumed that any one of the other parasites is capable of being hyperparasitic. For this reason such parasites as are of little importance as controlling factors because of their scarcity might be considered as detrimental rather than beneficial to the attainment of biological control of the Hessian fly.

#### SUMMARY AND CONCLUSION

The average annual parasitization of the spring generation of the Hessian fly, based on 10 consecutive years of observation, in the region in Pennsylvania, Maryland, and Virginia, from Lycoming County, Pa., to Augusta County, Va., was found to be 62 per cent.

The average total mortality amounted to 96 per cent. The cause of the mortality additional to the 62 per cent mentioned above was unrecognizable at the time of examination. Part of this additional mortality, however, was undoubtedly the result of parasitism.

Eighteen species of parasites were found to attack the Hessian fly in these regions.

The most abundant parasite of the spring generation was *Platygaster vernalis*. Next to this one in order of abundance came *Eupelmus allynii*, *Merisus destructor*, *Pleurotropis epigonus*, *M. febriculosus*, and *Tetrastichus carinatus*. The remaining parasites attacking the Hessian fly of the spring generation were comparatively scarce.

The fall generation in this region was found to be normally parasitized only by *Platygaster hiemalis*. The average annual mortality of the Hessian fly from this source during the years from 1914 to 1922 amounted to 28 per cent. In 1923 records showed an average of 55 per cent for the State of Pennsylvania.

In this section of the country the two species *Platygaster hiemalis* and *P. vernalis* were the most efficient parasites. *P. hiemalis* should be ranked first in importance owing to its abundance and to the fact that if it were absent there would be no other parasite to attack the fly of the fall generation.

The effectiveness of the remaining parasites, with the exception of *Platygaster herrickii*, is somewhat offset by the likelihood that they may prey on one another and on the *Platygaster*s.

Complete control of the Hessian fly by parasites can not be expected, but it is evident that in the regions under observation they are an important factor in checking its increase.