

Journal of Agriculture.

VOL. 47.

WELLINGTON, 20TH SEPTEMBER, 1933.

No. 3.

THE WHITE BUTTERFLY (*PIERIS RAPAE*) AND ITS PARASITES.

A RECORD OF RECENT CONTROL WORK.

J. MUGGERIDGE, Entomologist, Plant Research Station, Palmerston North.

In the September, 1932, issue of this *Journal* it was mentioned that the white butterfly had spread from the vicinity of Hastings to such widely separated localities as Gisborne, Te Puke, Taurarunui, and Wellington. During the past season the spread of this pest was no less marked than formerly, and by the end of the season it had covered the North Island to as far north as Auckland; in the South Island it was observed near Christchurch and in the northern part of the Marlborough district, as well as in the vicinity of Timaru, at which latter place it was seen in the previous year. Coincident with the great increase and spread of the butterfly was the increase in its destructiveness to cruciferous crops. In the Hastings area during the past season it was particularly destructive of chou moellier—far more so, for instance, than was the diamond-back moth.

BIOLOGY OF *PIERIS RAPAE*.

A recent account of the butterfly by Querci (1932) is of interest as giving details on the number of broods and lengths of the different stages, &c. In this publication Querci states that *P. rapae* is ready to be prolific at any time of the year as soon as the temperature allows the eggs to hatch. From more than one hundred lots of eggs which he reared, the minimum time in completing the life cycle was eighteen days—four days for the eggs to hatch, seven days for larval development, and seven days for the chrysalis stage—and the maximum period was twenty-eight days, wide variations occurring within single broods reared under identical conditions and arising from one female.

Querci's experiments show that different stages of the butterfly vary considerably in length according to temperature conditions, and that temperatures over 90° F. in the field are fatal to many of the larvæ, but are not fatal to the eggs or the chrysalids. Butterflies continue to be plentiful for about a week after a heat

wave, and then they become scarce for about ten days, as the high temperature kills both small and big larvæ. In Philadelphia, where his experiments were conducted, eight broods emerged and a probable ninth. In southern Spain and Portugal, and in the southern portion of the United States, the possibility of fourteen broods is suggested.

In New Zealand it is found that a large proportion of *P. rapae* commence hibernation during late autumn, though a small percentage which are able to withstand frosts and cold weather continue on into the winter months. While the time for development of the egg and larval stages are largely governed by temperature conditions, the time for development of the pupal stage is not necessarily so influenced, as sometimes instead of the usual seven to fourteen days it may take months, even though held under favourable temperature conditions.

The numerical relationship of males to females obtained from 1,908 pupæ was in the proportion of 901 males to 1,007 females, or 47 per cent. of the former to 53 per cent. of the latter.

The number of eggs laid by one female has been variously stated at 200 and more, but the average number laid under glass-house conditions has been found to be considerably less than this, as from a total of 93 females, 2,230 eggs were laid, an average approximately of 24 eggs per female.

PARASITE INTRODUCTIONS.

Two species of parasites were liberated in the field last year—namely, (1) *Apanteles glomeratus* (larval parasite), and (2) *Pteromalus puparum* (pupal parasite). Apart from the small number of larval parasites reared at this Station during the previous winter, the whole of the material, both larval and pupal parasites, were from the parasite laboratory of the Imperial Institute of Entomology, Farnham Royal, England.

APANTELES GLOMERATUS (LARVAL PARASITE).

Three separate consignments of larval parasites were received, which for convenience may be designated A, B, and C. In Table 1, giving the number of parasites and hyperparasites which emerged, consignment A = A₁, A₂; consignment B = B₁, B₂, &c.; while C = C₁.

From a perusal of this table it will be noted that only 43 per cent. of the parasites emerged, though this number would have been slightly higher were it not for the presence of hyperparasites. Great care was exercised to see that all hyperparasites which emerged were killed. Three different types of emergence containers were used. Consignments A₁ to B₃ inclusive were placed in a series of large test tubes which were kept plugged with cotton-wool, and all of the insects which emerged were removed at short intervals. While the use of large test tubes was very satisfactory in many ways, the removal of parasites from them became a difficult problem if big numbers of both parasites and hyperparasites emerged at the one time. Consignment C₁ was placed in a standard type of emergence box. This was found unsuitable, mainly on account

Table 1.—Parasite Emergences.

Consign- ment No.	Date received from Cold Store.	Number of Cocoons.	First Parasite emerged.	Last Parasite emerged.	Total Number emerged.	Percent- age of Parasites emerged.	Hyperparasites.	
							<i>Mesocho- rus pecto- ralis.</i>	<i>Tetrast- ichus vapo.</i>
A ₁	28/10/32	1,000	7/11/32	18/1/33	325	32.5	..	15
A ₂	29/11/32	11,000	9/12/32	22/2/33	4,166	38.0	25	639
B ₁	2/12/32	9,000	15/12/32	22/2/33	3,360	37.3	75	233
B ₂	6/12/32	9,000	17/12/32	21/2/33	3,821	42.5	19	50
B ₃	12/12/32	12,000	17/12/32	10/3/33	4,627	39.7	28	257
B ₄	16/12/32	14,000	28/12/32	8/3/33	6,898	55.0	28	57
				+ 803*				
C ₁	29/12/32	44,000	3/1/33	15/3/33	20,133	51.8	51	66
				+ 2,700*				
Totals and averages		100,000	43,330	43.0	226	1,317

* Dead.

of the fact that a large number of parasites which emerged never found their way to the emergence tubes. Consignment B₄ was placed in a special cylindrical type of emergence container (Fig. 1) with gauze above and below to permit air circulation, and also

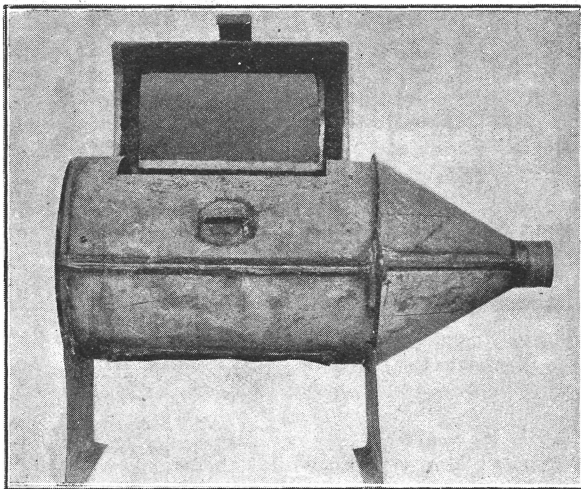


FIG. 1. SPECIAL CYLINDRICAL EMERGENCE TIN USED IN THE PARASITE WORK.

[Photo by H. Drake.]

the damping of the contents without inconvenience when necessary. The emergence table shows 803 dead in this container. This is attributed to the fact that the first parasites which emerged in it were unfortunately overlooked.

The material for despatch into the field was placed in 6 in. by 1 in. test tubes, about 100 parasites to a tube. The mouth of

the tube was closed with fine muslin to which a honey-soaked blotting-paper pad was pinned, the whole being held in place by a rubber band. These tubes were then wrapped in paper, and packed in shavings in small boxes convenient for despatch through the post. This method of despatch was quite successful, according to subsequent reports from farmers to whom the parasites were sent. On receipt of the tubes it was only necessary to take them to the place of liberation, remove the rubber bands, and shake out the parasites. Mating readily took place in the tubes—a distinct advantage when liberating insects in a new environment.

Of the 43,330 parasites which emerged, 37,682 were liberated in the field in the Hawke's Bay localities shown on the map (Fig. 2).

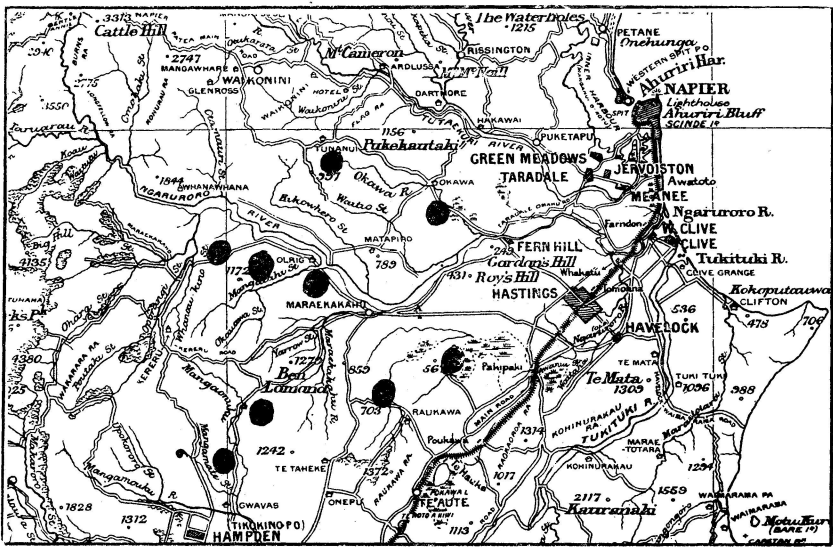


FIG. 2. MAP SHOWING THE LOCALITIES IN HAWKE'S BAY (MARKED BY BLACK DOTS) WHERE THE PARASITES WERE LIBERATED.

About one-third was liberated by Mr. J. Graham in his chou moellier crop near Mangatahi, while the rest was distributed as nearly as possible circumjacent to this central area. The idea underlying mass liberations in this fashion was to ensure as far as possible the establishment of the parasite. This was successfully accomplished, as dissections of a number of larvæ collected in the field showed a small percentage parasitized. During a recent visit to Mangatahi no signs of hibernating larval parasites were found. This is not surprising, as it is too early yet to expect results. Liberations of these parasites commenced on the 19th December, 1932, and were almost continuous until 1st March, 1933.

PTEROMALUS PUPARUM (PUPAL PARASITE).

Pteromalus puparum (Fig. 3), though referred to in the earlier article, was not then discussed, and it is proposed to deal here with some of the salient features concerning its appearance, biology, introduction, and liberation. The adult is a small, four clear winged insect showing considerable variation in size, the larger specimens measuring slightly more than $\frac{1}{8}$ in. in length, the smaller specimens being approximately half this size or less. There are marked differences in the appearance of the sexes, the male generally being much smaller, with the abdominal portion much narrower in relation to its length than is the case in the female. In colour the body of the female is black, the male differing in that the head and thorax are shiny green.

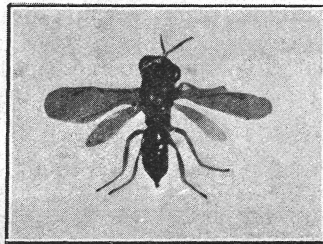


FIG. 3. MALE ADULT OF THE PARASITE PTEROMALUS PUPARUM. ENLARGED APPROXIMATELY 12 DIAMETERS.

[Photo by H. Drake.]

P. puparum is polyphagous in habit, having been reared by numerous writers from various hosts. The number of eggs laid by one parasite varies considerably. Zorin (1930) states that the number of offspring produced by individual females varied from 194 to 697, according to their age. He states also that polyembryony does not occur, and that unfertilized females produced males exclusively. The maximum number of offspring the writer obtained from one female was 399, and the greatest number of *P. rapae* hosts successfully attacked by a single parasite was 18. The largest number of parasites emerging from one host was 48, the smallest number 1, and the average number in the vicinity of 20. It is stated by some writers that one hundred or more parasites may emerge from one *P. rapae* host. This must be a rare occurrence, however, and the statement is most likely based on mistaken host identity when *P. brassicae* has been mistaken for *P. rapae*.

The length of life of an adult parasite is variable. Under laboratory conditions in the presence of a suitable food supply some will live only for a week or two, others for two or three months. The length of the life cycle is also extremely variable, though the minimum time occupied from eggs to adult stage observed by the writer is twenty-one to twenty-five days. The maximum time occupied has not been observed, as many of the larvæ pass through a delayed development or diapause phase which takes months to complete.

The earliest stage at which *P. puparum* attacks its host is not known, though Pickett (1919) has stated that it attacks the larvæ in the later stages, and the chrysalids just after the larval skin is cast. The writer has found that it will attack pupæ from one to five days old and dormant pupæ of any age. Parasitized chrysalids are readily distinguishable from unparasitized chrysalids by their dry and brittle appearance. It is asserted by some writers that parasitized chrysalids are darker in appearance than are unparasitized ones. This is not necessarily so, however, and often the reverse is just as true. Colour of the chrysalid appears to be an inherent factor, and not subject to environment such as background or parasitism. A live chrysalid is more soft and flexible than a parasitized one.

The whole of the life cycle, including the overwintering larval, but excepting the adult stage, of the parasite is spent within its host, pupation even taking place within the host skeleton. On reaching the adult stage the parasite cuts a small round hole through the host pupal case, and emerges to the exterior in search of further hosts. *P. rapae* pupæ from which parasites have emerged are readily detected by the small hole through the pupal case (Fig. 4).

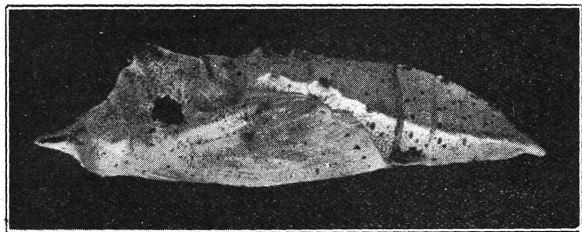


FIG. 4. PUPA OF *PIERIS RAPAE*, SHOWING EMERGENCE HOLES OF PARASITES. ENLARGED APPROXIMATELY 3 DIAMETERS.

[Photo by H. Drake.]

The number of broods of *P. puparum* is unknown, but apparently, like that of the butterfly, it is governed largely by climatic conditions; in all probability for each brood of butterflies there will be a brood of the parasites.

During the past season large numbers of the pupal parasites were liberated in the field. All of these were received from Farnham Royal. Table 2 gives details (at date of writing in August) concerning the material imported.

All of these parasites sent into the field were concentrated in the same localities as were the larval parasites. The writer is aware that certain authorities consider this inadvisable, but as there was an abundance of food supply it should not hinder either species liberated from becoming established.

From a recent survey of the locality where *P. puparum* was liberated, it was found that out of a total of 415 butterfly pupæ collected—taken at random from among old vegetation, and from

Table 2.

	First Consignment.	Second Consignment.
Date consignment received	5/1/33	27/1/33
Date consignment placed for emergence	5/1/33	27/1/33
Number of butterfly pupæ from which parasites emerged ..	209	300
Number of butterfly pupæ from which nothing emerged ..	429	582
Number of butterfly puparia from which butterflies emerged	..	64
Number of butterfly puparia from which butterflies are likely to emerge	..	3
Number of butterfly puparia parasitized by fungus	85
Number of butterfly puparia parasitized but from which parasites have not yet emerged	..	12
Number of butterfly pupæ in soft and pulpy condition on arrival	66	..
Total number of parasites emerged	5,197	7,189
Total number parasites sent into field	4,437	6,375
Main periods of emergence	25/1/33 to 6/2/33	20/2/33 to 6/3/33

fencing posts and gates, &c.—58 per cent. were parasitized. At least one generation of the parasite in the field had been completed, and their distribution in the crops where liberated was general.

While the survey indicates a rapid increase of the parasite and a high percentage of parasitism, it is certain that the full effects of their presence will not be obtained before distribution throughout the whole of the area affected becomes general.

OTHER NATURAL ENEMIES.

During surveys in the field in connection with this work, the writer met with other natural enemies of the white butterfly—namely, (a) insects, (b) disease, (c) birds.

Insects.—Of the insects, two predacious species were met with—*Oechalia consocialis* and *Heliothis obsoleta*. The first named (Fig. 5) is a brownish bug with a sharp spine on each side of the prothorax.

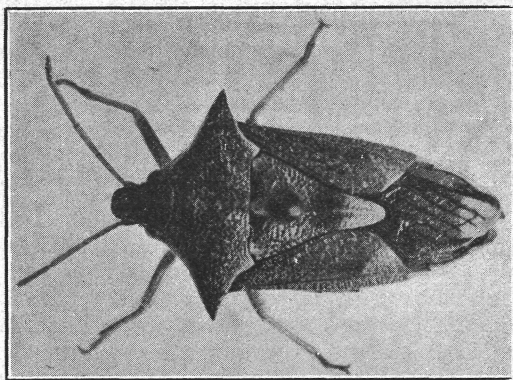


FIG. 5. OECHALIA CONSOCIALIS, PREDACIOUS ON PIERIS RAPAE. ENLARGED APPROXIMATELY 5 DIAMETERS.

[Photo by H. Drake.

It is widely distributed in Australia, and is a closely allied species of the genus which was imported into Hawaii for the control of the sugarcane leaf-hopper. The adult insect was observed to attack both larval and pupal stages of the butterfly. It was not sufficiently prevalent, however, to be considered important from the point of view of control. The larva of *H. obsoleta*, like *O. con-socialis*, was observed feeding on both stages of the butterfly. It is a voracious feeder and consumes large numbers of caterpillars. Any good that it might do, however, is offset by the fact that it is itself a serious pest.

Disease.—It was observed both in the insectary and in the field that many caterpillars became soft and wrinkled, eventually turned a dark colour, and finally became black and wilted. The symptoms were typical of the “flacherie” or “wilt” described by Wilson (1919). Again, numerous pupæ were killed by some unknown disease. A pupa suffering from attack was darker in colour and had a slightly greasy appearance when compared with a healthy specimen. Later it became soft, and when squeezed a dark fluid was emitted, until finally only the empty soft pupal case remained. Large numbers of both larval and pupal stages of the butterfly were killed in the field during the past season in this fashion.

Birds.—During a visit of inspection in the early autumn to one of the crops where parasite liberations had taken place, very few white butterfly caterpillars could be found, though on previous visits they were present in enormous numbers. The owner of the crop, Mr. J. Graham, stated that the absence of the pest was due to a visitation of starlings, which had appeared in thousands and had left the crop practically clean. Birds, on account of their slow reproductive rate as compared with insects, are not capable of overcoming an insect outbreak. Nevertheless they are capable of performing much good work, and accordingly should be encouraged.

The writer wishes to thank all those farmers who have kindly assisted in the liberation of parasites in connection with this work.

REFERENCES.

- WILSON, H. F., PICKETT, R. C., and GENTER, L. G. (1919): The Common Cabbage Worm in Wisconsin. *Agr. Exp. Sta. of the University of Wisconsin Research Bulletin* 45, August, 1919.
- QUERCI, O. (1932): An Account of My Studies in the Biology of *Pieris rapae*. *Entomologist's Record and Journal of Variation*, Vol. 44, December, 1932, p. 168.
- ZORIN, P. V. (1930): Some Features of Reproduction and Fertility of *Pteromalus puparum*. *Plant Protection*, VII, Nos. 1-3, pp. 53-67.

Fowl Manure for Rye-grass Seed Production.—A Twyford farmer last season top-dressed a 4½ acre paddock of rye-grass with fowl manure at the rate of about 2 tons per acre. The paddock, which had been down for some ten years, yielded over 54 bushels per acre of excellent seed.