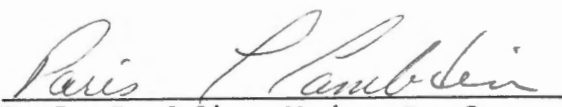
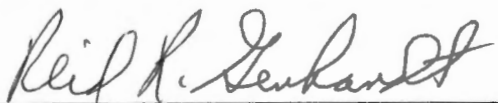


To the Graduate Council:

I am submitting herewith a thesis written by George Butler Wilson entitled "Longevity, Fertility, Sex Ratio and Host Preference of Diaeretiella rapae (McIntosh) (Hymenoptera:Aphidiidae)." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Entomology and Plant Pathology.

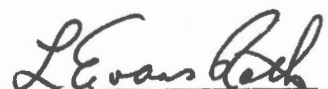

P. L. Lambdin, Major Professor

We have read this thesis
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Accepted for the Council:



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LONGEVITY, FERTILITY, SEX RATIO, AND HOST PREFERENCE
OF DIAERETIELLA RAPAE (MCINTOSH)
(HYMENOPTERA:APHIDIIDAE)

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

George Butler Wilson
June 1983

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ABSTRACT

Suitability of the green peach aphid, Myzus persicae (Sulzer), and the cabbage aphid, Brevicoryne brassicae (L.), as hosts for the parasite Diaeretiella rapae (McIntosh) was determined by comparing longevity and fertility of the adult female parasite and the sex ratio of the progeny on each of the host species. Preference was determined and its impact assessed.

Both aphid species were found to be suitable hosts with no significant differences in developmental or performance criteria. When given a choice, D. rapae oviposited more frequently in the cabbage aphid and a significantly greater percentage of female progeny was produced with that host.

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CHAPTER I

INTRODUCTION

Diaeretiella rapae was first described by Curtis (1885) and has been recorded as the only primary parasite of the cabbage aphid, Brevicoryne brassicae (L.), (George 1957; Hafez 1961; Chua 1977). D. rapae has alternately been considered important in the control of cabbage aphid infestations (Strickland 1916; Barns 1931) and insignificant (Prethbridge and Mellor 1936; Todd 1959).

Habitat selection by the Aphidiidae in general and D. rapae in particular was speculative until the work of Read et al. (1970) and Akinlosotu (1980). They demonstrated that D. rapae responded to olfactory cues in selecting habitat and then relied on random search to discover hosts. The mustard oil, allyl isothiocyanate, was determined to be the stimulus by which D. rapae oriented to habitat. It may also play a role in stimulation to oviposition (Read et al. 1970). D. rapae has been reported as parasitizing eight different aphid species but has been seldom encountered on aphids not on crucifers indicating that host association with habitat may be of more importance in determining host range than taxonomic affinity (Townes 1960).

D. rapae was reported to have four larval instars

(Couchman and King 1977) with each stadium lasting approximately 24 h. except the first which lasted 48. Developmental time varied with temperature and biotype (Campbell et al. 1974). The host was killed during the parasite's fourth instar by consumption of all remaining tissue and the aphid mummified (Couchman and King 1977). The adult emerged in 3-6 days by chewing a circular hole in a dorsoposterior abdominal segment of the mummified aphid (Hafez 1961; Campbell et al. 1974). D. rapae oviposited most frequently in third instar or older aphids (Hafez 1961; Simpson et al. 1975) and although Simpson et al. (1975) used the green peach aphid, Myzus persicae (Sulzer), to rear the parasite, it shows a preference for cabbage aphids (Hafez 1961). Host preference may affect the size of the progeny, fecundity, vigor and sex ratio (Salt 1935). The impact of D. rapae's preference has not been assessed.

Fisher (1958) predicted a 1:1 occurrence of the sexes when, in the apopulation as a whole, the effort required to produce the sexes was equal. This theorem is valid only when mate competition is on a population wide basis. It does not hold for haplodiploid populations because of the female's ability to determine the sex of her offspring (Hamilton 1967). Hamilton's (1967) local mate competition theory predicted a female biased sex ratio

when male offspring of a single female competed with each other for mates. Hartl and Browne (1970) predicted a 1:1 sex ratio for populations which had panmixia and in which most females were fertilized. They considered the Aphidiidae to fit this description and Hagen and van den Bosch (1968) supported their prediction with a report of a 1:1 sex ratio for an aphid parasite. However, their population was a lab colony and it is well established that more males may be produced in lab colonies than in the wild (Clausen 1939). Although the sex ratio of D. rapae varies through the season, no field population has been reported to consist of more than 50% males (Hafez 1961; Simpson et al. 1975; Chua 1977).

This study was undertaken to assess the suitability of green peach aphids and cabbage aphids as hosts for D. rapae and host preference of the parasite. Longevity, fertility of the female parasite and sex ratio of the progeny were used to determine suitability. The impact host preference had on these criteria was evaluated.

CHAPTER II

MATERIALS AND METHODS

Laboratory colonies of M. persicae and B. brassicae were maintained at 19 $\pm$ 0.5 C and 70% $\pm$ 10% RH with a photoperiod of 15L:9D. The parasite colony was maintained under greenhouse conditions. All colonies were established and maintained at the University of Tennessee, Knoxville.

Parasites used in this study were obtained from B. brassicae and were allowed to mate 0-24 h. after emergence. Female parasites were placed in individual cages at 19 $\pm$ 0.5 C and 70% $\pm$ 10% RH with a photoperiod of 15L:9D immediately after mating. Each day females were presented with at least fifty second and third instar aphids on broccoli leaves contained in water in a 24 ml. vial. After each 24 h. period, vials containing infested leaves were removed and held for mummy formation. When mummies formed, they were removed, counted and placed in individual 2 ml. vials until emergence of adult parasites. Time required for development, emergence success and sex ratio of the progeny was recorded. No effort was made to determine if mummies from which no parasites emerged contained dead or diapausing parasites. This procedure was repeated using M. persicae alone as

the host, B. brassicae alone as the host and with both available simultaneously. Each host group was replicated ten times.

Use of each aphid separately allowed the evaluation of the suitability of each species as a host for the parasite. Host preference was assessed by comparing the mean number of each species parasitized when both were available. Sex ratios from the three host groups were compared as was the sex ratio of the progeny from each aphid species when both were available. All mean comparisons were made with the t-test ($p=0.05$).

Sex ratio in this study was not the primary sex ratio but that of the progeny surviving to adulthood and successfully emerging.

CHAPTER III

RESULTS

Mean fertilities of D. rapae ovipositing in the three host groups were initially high with over 50% of all progeny produced by the fourth day. This was followed by a rapid decline in the rate of oviposition and no aphids were successfully parasitized after the seventh day (Fig. 1). Although individual fertilities ranged from 27 to 135 aphids parasitized, mean fertilities for the three host groups were not significantly different (Table 1). The rate at which each of the two aphid species was parasitized in the mixed colony was significantly different. These rates were not only significantly different from the other host groups but also from each other with the rate of parasitization of the cabbage aphid almost four times greater than that of the green peach aphid. The age specific fertilities of D. rapae on both aphid species in the three host groups were similar but the rate at which the green peach aphid was parasitized in the mixed colony was always significantly lower (Fig. 2).

The mean percentage females produced on the three host groups increased slowly from 55% on the first day to 85% on the fourth. It then declined steadily until the

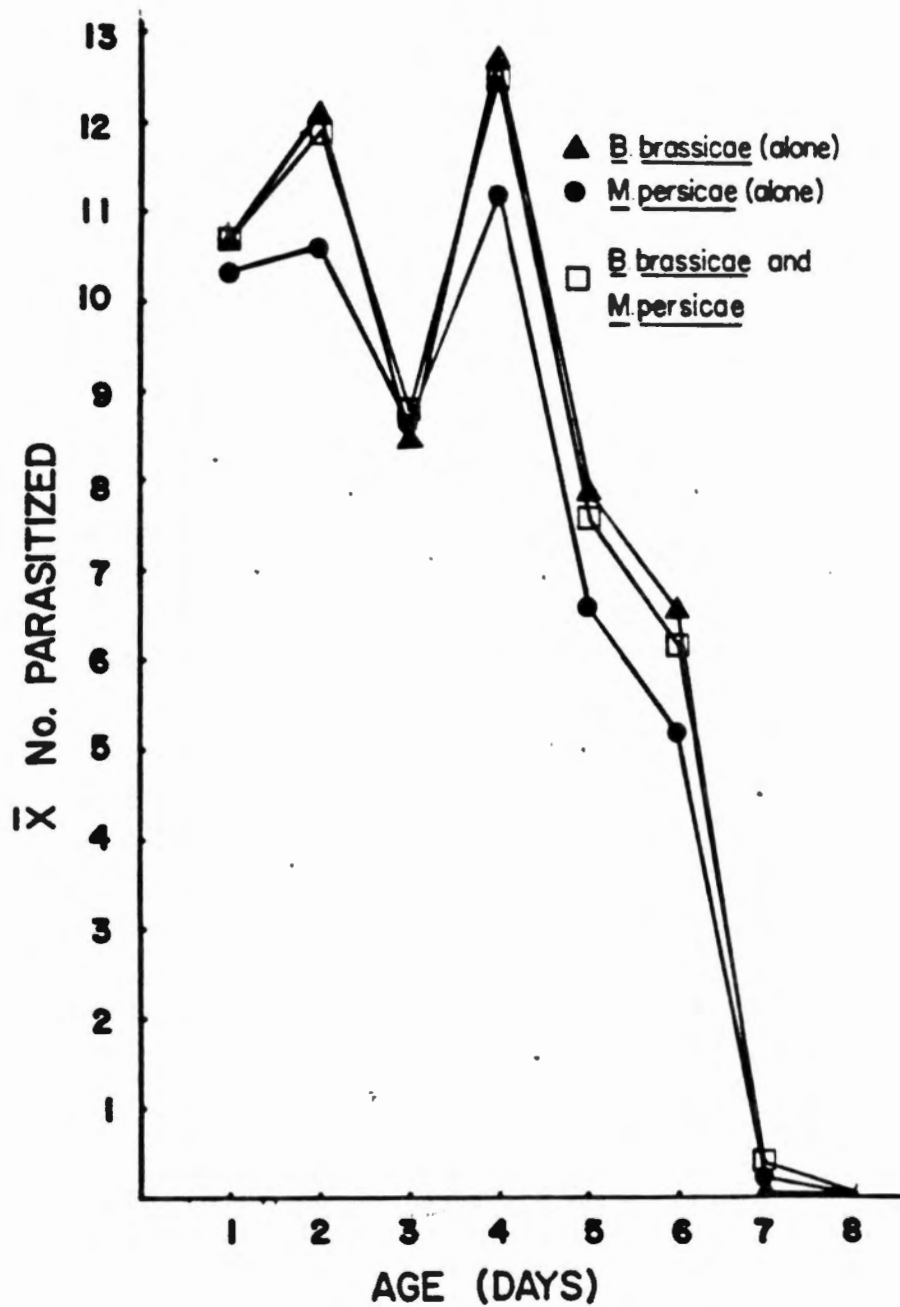


FIGURE 1. Mean number of aphids parasitized daily in the three host groups.

TABLE 1. Mean fertility, sex ratio and longevity for D. rapae on the two aphid species in the three host groups.

Host	$\bar{X}$ No. Parasitized	$\bar{X}$ % Female	Longevity (Days)
<u>Myzus persicae</u> (alone)	57.2	66.0	6.7
<u>Brevicoryne brassicae</u> (alone)	58.2	73.5	6.4
Combination	58.0	70.9	6.5
∞ <u>Myzus persicae</u> (mixed)	12.3	8.3	-
<u>Brevicoryne brassicae</u> (mixed)	45.9	70.9	-

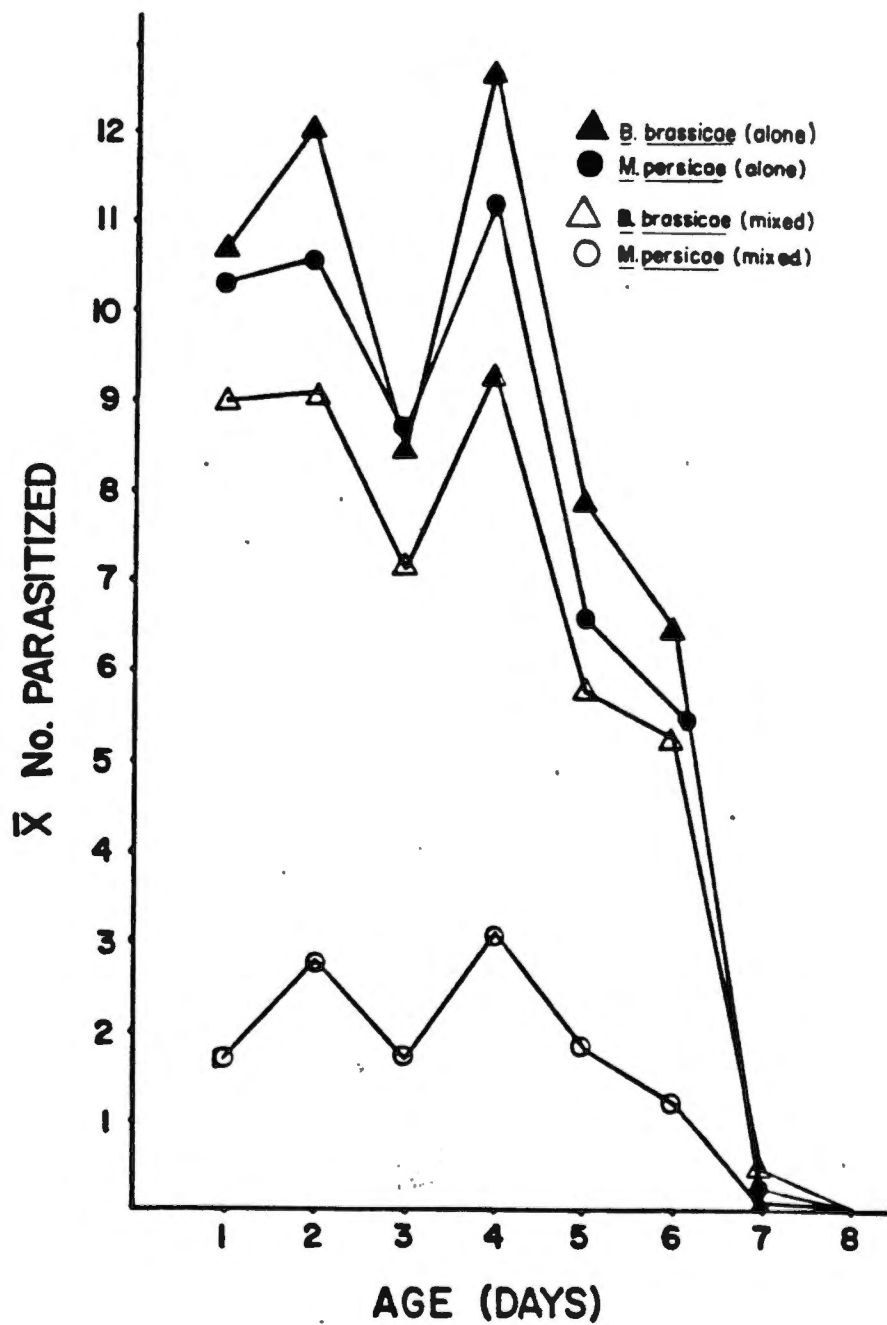


FIGURE 2. Mean number of aphids in each species parasitized daily.

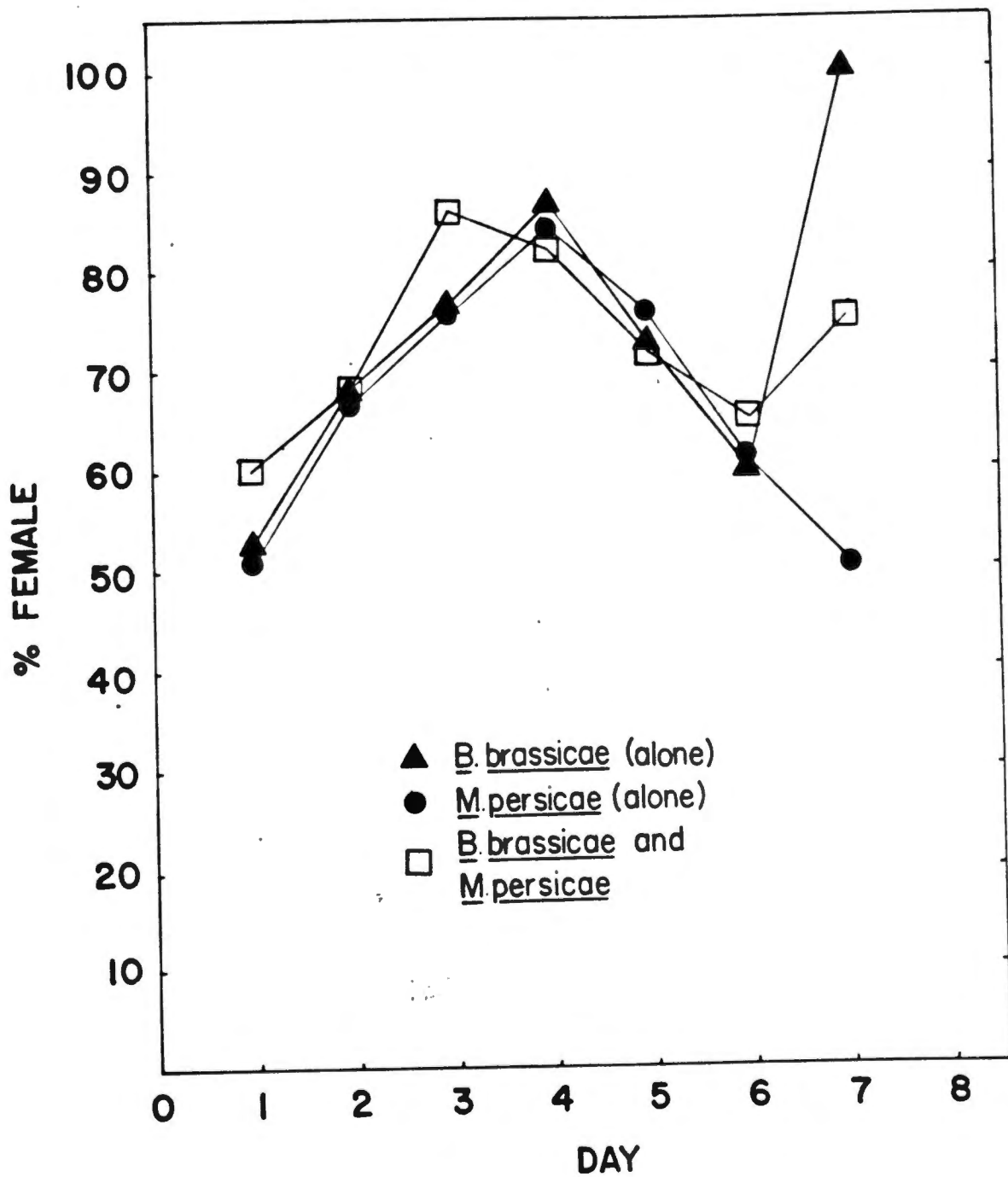


FIGURE 3. Mean percentage female progeny produced in the three host groups.

sixth day (Fig. 3). Because only eight progeny emerged on the seventh day, the sex ratio for that day is distorted. The mean number of females from each of the three host groups was not significantly different (Table 1). However, the mean number of females reared from green peach aphids in the mixed colony was significantly lower than the number of females reared from cabbage aphids in that group and from the other groups. The percentage females produced on green peach aphids in the mixed colony was significantly lower than the percentage produced on green peach aphids presented alone and cabbage aphids alone or mixed (Fig. 4).

Longevity of ovipositing females varied by less than one day on the two aphid species and that difference was not significant (Table 1). Developmental time for the parasite on the two hosts did not differ significantly. Average time from oviposition to emergence was 13 days.

There was an insignificant difference in the percentage successful emergence of D. rapae from the two aphid species in the three host groups (Table 2).

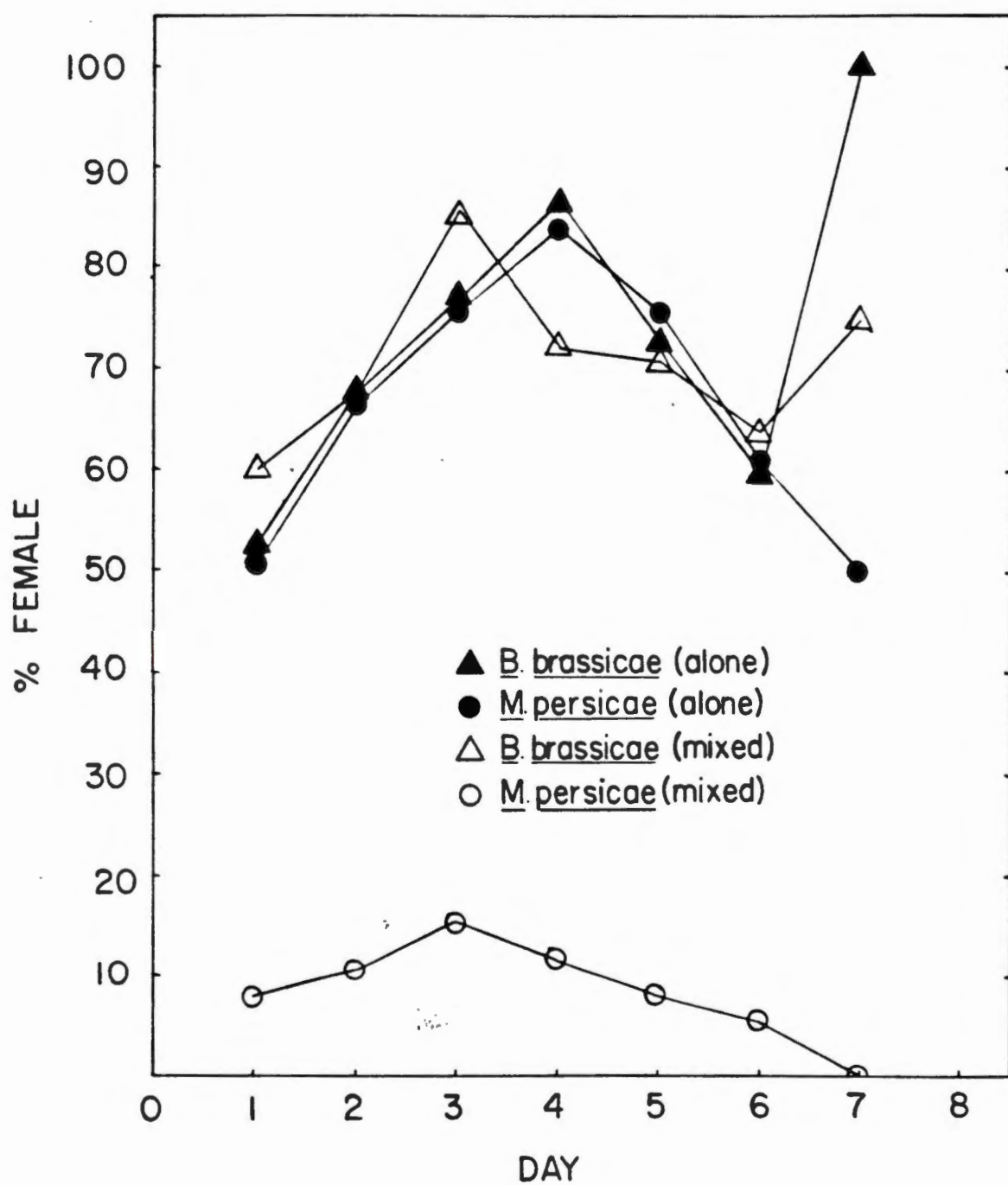


FIGURE 4. Mean percentage progeny produced on each of the aphid species.

TABLE 2. Percent successful emergence of D. rapae from the two aphid species.

Host	No. Parasitized	% Emergence		$\bar{X}$ % Emergence
		Male	Female	
<u>Myzus persicae</u> (alone)	572	98.0	97.2	97.6
<u>Brevicoryne brassicae</u> (alone)	582	98.4	98.5	98.4
<u>Myzus persicae</u> (mixed)	120	98.4	98.3	98.3
<u>Brevicoryne brassicae</u> (mixed)	460	98.4	97.9	98.0

CHAPTER IV

DISCUSSION

Once a host has been selected by a female parasite, development of the next generation depends on the suitability of the selected host (Vinson 1976).

Presentation of the two aphid species in a homogenous environment and at equal densities eliminated two of the four steps necessary for successful parasitization (Salt 1935; Flanders 1953; Doutt 1959) leaving only host acceptance and suitability as determining factors.

The lack of a significant difference in mean fertility, developmental time, sex ratio or percent successful emergence for D. rapae on either of the two aphid species presented alone suggests their equal suitability as hosts.

Hafez (1961) found that D. rapae averaged 10.3 eggs per day per female when parasitizing cabbage aphids. This rate took superparasitism into account. The rate of parasitization in this study, 8.3 aphids per female per day, agrees well with Hafez's because superparasitism was not taken into account.

The general concept of different requirements for different biotypes of a single species is well established (Smith 1980) and has been reported for D.

rapae (Campbell et al. 1974). Reported longevity for females in an insectary at 20 C varied from 4.8 days (Akinlosotu 1980) to 15 days (Hafez 1961); however, mean longevity more closely approximates this study's finding of 6.5 days (Hafez 1961; Simpson et al. 1975; Chua 1977). Nutritional stability of a host may have an affect on developmental time of the parasite and successful emergence (Vinson and Iwantsch 1980) and different hosts may have different affects. Mean developmental time for D. rapae was 13 days in this study which falls between the minimum of 11 days on the green peach aphid (Simpson et al. 1975) and the maximum of 15 days on the cabbage aphid (Akinlosotu 1977). The variation in percent successful emergence was 0.8% which indicates no substantial difference in the stability of either host. Sex ratios in the parasitic Hymenoptera vary through the summer and with the size of the host (Clausen 1939). Reports of sex ratios for D. rapae in the field vary from 60% (Hafez 1961) to 82% (George 1957) and lab data are similar ranging from 60% females (Simpson et al. 1975) to 73.4% (Hafez 1961). This closely approximates the range in this study of 66% females on the green peach aphid to 73.5% on the cabbage aphid.

In the mixed colony of green peach aphids and cabbage aphids there was a significant difference in the

rate of parasitization of the two species. Host discrimination also had an impact on sex ratio of the progeny. Parasitization of the green peach aphid dropped 77.7% from its level when the aphid was the only available host and the percentage of female progeny dropped 87.5%. Conversely, the rate of parasitization of the cabbage aphid dropped 21.2% and the percentage of female progeny dropped 3.6%.

Although each aphid species was equally suitable as a host for D. rapae, the parasite oviposited more frequently in cabbage aphids when given a choice and more female progeny were produced with this host. These significant differences demonstrate the parasite's preference for the cabbage aphid as a host (Heong 1981).

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VITA

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