ENTOMOPHAGA, 20 (4), 1975, 393-402

THE EFFECTS OF VARIOUS APHIDS AS LARVAL PREY ON THE DEVELOPMENT OF *METASYRPHUS COROLLAE* [*DIPT.: SYRPHIDAE*]

Z. RŮŽIČKA

Institute of Entomology of the Czechoslovak Academy of Sciences, Prague

The suitability of thirteen aphid species for the polyphagous larvae of *Metasyrphus corollae* (FABR.) was investigated in laboratory tests. The length of larval and pupal development, weight of puparia, mortality during larval and pupal stages were compared. Cannibalism was not observed in the larvae reared in groups on suitable food. *Aphis sambuci* LINNAEUS was not a suitable prey for the larvae. *Cavariella theobaldi* (GILLETTE BRAGG) collected from *Pastinaca sativa* L. was toxic to larvae of *M. corollae*, although it was possible to rear the larvae on *Aphis fabae* SCOPOLI or *Anuraphis subterranea* (WALKER) from the same host plant.

A few species of aphidophagous syrphid larvae are highly specialised (DUŠEK & KRÍSTEK, 1959), but even with those commonly found species which feed on several species of aphids (OKUNO, 1967) some specialisation can be observed (EVENHUIS, 1966). This specialisation is influenced by the aphid species itself and by other ecological factors that determine the choice of oviposition sites by adult syrphids (CHANDLER, 1968). Detrimental effects of some aphid species on certain syrphids have been noted (SCHMUTTERER, 1972), the intensity of these effects being influenced by the host plants of the aphids.

The polyphagous *Metasyrphus corollae* is one of the commonest species in central Europe. In the field its larvae have been recorded in colonies of more than 30 aphid species (DUŠEK & LÁSKA, 1959; ŠTYS in: HODEK *et al.*, 1966; NAKAO, 1962; OKUNO, 1967; PELOV, 1972). It has been reared on several occasions under laboratory conditions on common aphid species or mixtures of these, but the suitability of the aphids for this syrphid has never been compared and to do so from the published records of authors on larvae reared under various environmental conditions is questionable. This present work, therefore, was undertaken to compare the developmental characteristics of *M. corollae* under standard conditions when the larvae were fed on various aphid species.

MATERIALS AND METHODS

The laboratory culture of *M. corollae* was established from adults caught in the vicinity of Prague in the summer of 1971 and reestablished in 1972 from adults collected in the same locality. The development of *M. corollae* on various aphid species was studied at 20°C, 55-70 % R.H. and 16 hours photoperiod. The source of light were white 25 W fluorescent tubes in six rows at 80 cm distance. The stock culture of *M. corollae* larvae was reared under these conditions on *Acyrthosiphon pisum* HARRIS. Before a test started, female *M. corollae* were induced to lay eggs on nylon bags containing *A. pisum*, the eggs giving rise to larvae 56 hours or so later.

Newly hatched larvae were placed individually into 25 cm³ glass tubes. In each rearing unit was a piece of the aphid host plant inserted in moist paper wool on the bottom and a surplus of the aphid species being tested. The opening of the tube was covered by nylon. The larvae were transferred every day to newly prepared tubes with fresh aphids.

Four aphids were cultured in the laboratory : *Acyrthosiphon pisum* HARRIS; *Aphis fabae* SCOPOLI and *Megoura viciae* BUCKTON on *Vicia faba* L. and *Brevicoryne brassicae* LINNAEUS on *Brassica oleracea* var. *gemmifera* DC. All the other aphids were collected in the field. They were : *Uroleucon cichorii* (KOCH) collected from *Crepis biennis* L., *Callaphis juglandis* (GOETZE) from *Juglans regia* L., *Impatientinum asiaticum* NEVSKY from *Impatiens parviflora* DC, *Aphis craccivora* KOCH from *Robinia pseudoacacia* L., *Myzus cerasi* (FABRICIUS) from *Prunus cerasus* L., *Phorodon humuli* (SCHRANK) from *Humulus lupulus* L., *Aphis sambuci* LINNAEUS from *Sambucus nigra* L., *Cavariella theobaldi* (GILLETTE BRAGG) from *Pastinaca sativa* L. and *Anuraphis subterranea* (WALKER) from *P. sativa*. Depending on the numbers of aphids available 20 or 30 replicates of each aphid species were used, except in case of *A. subterranea* on which only five larvae were reared because of a scarcity of this aphid in the field. Complementary tests in which the effects of *C. theobaldi* on the development of *M. corollae* were studied in detail are described in the results.

Simultaneously with 30 larvae being reared singly on *A. pisum* 30 more larvae were reared on this aphid in 160 cm³ plastic boxes, 10 larvae per box. These boxes were arranged similarly to the glass tubes.

The age difference between the larvae in each test was less than one hour. All the larvae left the egg shells between 5 and 6 p.m. (5 or 6 hours before the photoperiod ended). The rearing units were examined daily, the last time at 6 p.m. This enabled us to compare accurately the development on different aphid species.

The calculation of the mean values of the length of the larval development and the puparial weight did not include individuals which died during the pupal development or failed to emerge from the puparia. In the statistical evaluation differences are considered significant if $p < 0.05$. Otherwise the p-value is given.

RESULTS AND DISCUSSION

COMPARISON OF THE DEVELOPMENT ON DIFFERENT APHIDS

The development of the larvae of *M. corollae* on various aphid species is summarised in table 1. The differences in the weight of puparia or in the length of the development have to be evaluated together with the mortality of the individuals. In this respect the species *A. pisum*, *U. cichorii*, *C. juglandis*, *I. asiaticum*, *B. brassicae* and *A. fabae* can be regarded as suitable for the larvae. The mean pupal weight and the other developmental parameters of *M. corollae* in the tests could be partly affected by differences in relative humidity in the rearing units due to the aphid host plant or the quantity of the accessible food, which may depend on the mobility of the aphids or their mortality. In addition the results can be influenced by a possible decrease of nutritive value of aphids used as food, which apparently happened in the test with *A. fabae*, when these aphids were taken from overpopulated colonies, Apart from this the results could be affected by an adaptation to *A. pisum* on which larvae of *M. corollae* were reared in the stock culture. *A. fabae* was the last of 13 species tested, the test being done a few months later than the others. The decrease in weight of the puparia and the slight prolongation of the larval development in the second test with *B. brassicae*, where *M. corollae* larvae were reared on aphids from a laboratory culture is probably due to the lower quality of the food or distinctly smaller size of the aphids (see later in the test with *P. humuli*).

TABLE I

The influence of different aphids on the larval and pupal development of Metasyrphus corollae

Aphid species	No. of reared larvae	Mortality No. of individuals larvae	pupae	% total	Mean time of development in days larva	pupa	total	Mean weight and S.D. of puparia in mg
Acyrthosiphon pisum	30	5	6	36.6	8.1	7.8	15.9	32.4 ± 2.6
Acyrthosiphon pisum (a)	30	3	4	23.3	7.9	7.6	15.5	30.7 ± 3.7
Acyrthosiphon pisum (a, c)	30	12	3	50.0	7.8	7.8	15.6	30.5 ± 3.7
Uroleucon cichorii	30	5	0	16.6	8.1	8.0	16.1	33.0 ± 1.5
Callaphis juglandis	20	2	0	10.0	8.3	7.7	16.0	30.9 ± 1.5
Impatientinum asiaticum	30	1	6	23.3	8.0	8.0	16.0	32.1 ± 2.0
Aphis craccivora	30	8	3	36.6	7.9	7.8	15.7	31.2 ± 3.1
Brevicoryne brassicae	30	6	5	36.6	8.2	7.9	16.1	31.2 ± 2.6
Brevicoryne brassicae (b)	20	3	3	30.0	8.4	7.8	16.2	28.1 ± 2.0
Aphis fabae	30	0	4	13.3	9.0	7.6	16.6	27.6 ± 2.4
Myzus cerasi	20	10	0	50.0	8.5	8.0	16.5	30.5 ± 4.5
Megoura viciae	20	8	0	40.0	9.2	8.0	17.2	31.1 ± 3.9
Phorodon humuli	20	5	4	45.0	9.2	8.0	17.2	21.3 ± 3.9
Aphis sambuci	30	28	0	93.3	10.5	8.0	18.5	29.6
Aphis sambuci (c)	30	20	2	73.3	9.9	6.3	16.2	26.1 ± 2.8
Cavariella theobaldi	30	30	—	100	—	—	—	—
Anuraphis subterranea	5	1	1	40.0	8.7	8.0	16.7	29.5

(a) Larvae reared together 10 per one rearing unit.

(b) Aphids from a laboratory culture in Ascot (England).

(c) Test with *M. corollae* from a new culture one year later.

High mortality was found on *M. cerasi* and *M. viciae*. In colonies of *M. cerasi* aphidophagous larvae of *Itonididae* were noticed and could account for some of the mortality. The larvae of *M. corollae* occur in colonies of this aphid in the field. The laboratory culture of *M. viciae* died out two weeks after the experiment ended. These aphids showed low vitality and inability to reproduce. Nevertheless where *M. corollae* larvae were reared on *M. viciae* the adult syrphids hatched from all puparia and the mean weight of the puparia was only slightly lower that that in the test with *A. pisum*.

The successful development of the larva and pupa on a particular aphid does not necessarily mean that the aphid is completely suitable for the predator, for the latter's vitality and reproduction in adulthood may be affected (HODEK, 1967). However, this kind of prey may be regarded as possible alternative food when more suitable food is scarce.

Larval development was considerably retarded and puparia were much lighter in weight when the larvae fed on *P. humuli*. Although the ubiquitous *M. corollae* was not found to be a predator of this aphid on *H. lupulus* a few syrphid species regularly feed on it (ZELENÝ unpublished). The weight of the adult aphids from the summer population of *P. humuli* on which *M. corollae* larvae were fed was only 1/8-1/6 of the weight of adults of *A. pisum*. Their size could cause a partial starvation of the larvae especially during the third instar. The larvae though constantly preying did not necessarily obtain the optimum quantity of food. The third instar larvae of *M. corollae* have a lower capture efficiency of young compared with adult *M. persicae* (BENESTAD-HÅGVAR, 1974). Presumably this was an important factor in our case. Whatever the cause, however, *P. humuli* was a distinctly less suitable food than the other species of aphids mentioned above.

The majority of the larvae reared on *A. sambuci* died during the 1st days of the development. The high mortality of the larvae of *M. corollae* also corresponds to the unsuitability of these aphids for some other predators. HODEK (1957, 1960) found *A. sambuci* to be an unsuitable or toxic food for some coccinellids. The author's presumption being that in these aphids the glycosid sambunigrin (from the host plant *Sambucus nigra*) occurs which can split enzymatically into hydrocyanic acid in the body of predators.

A further 20 larvae of *M. corollae* were reared for the first 3 days on *A. pisum* and then transferred on *A. sambuci*. Only 5 of them formed puparia from which 2 adults hatched.

Thirty larvae of *M. corollae* from a new culture of this hover fly one year later were reared entirely on *A. sambuci*. The mortality was somewhat lower, but the aphid still proved to be unsuitable food for the larvae (table 1). The adults, 4 males and 4 females, that hatched were reared on a diet consisting of 20 % fructose solution, water and *Corylus avellana* pollen. Three of these females failed to oviposit and died within 9 days, the 4th female which was stimulated on the 9th day by the presence of *A. pisum* also failed to lay during the 4 hours of stimulation. This female, however, laid 126 eggs on the paper in the rearing unit during the next 2 days. Only 22.2 % of these eggs hatched.

Simultaneously 7 males and 8 females, the larvae of which previously fed on *A. pisum*, were reared on the same fructose and pollen diet. Six females (two females died earlier) were stimulated to oviposit for 4 hours after 10 days. All the females laid an average of 61 $\pm$ 8.0 eggs with a mean hatch of 55.6 $\pm$ 18.3 %. The percentage hatch of the eggs laid by these females on the paper in the rearing unit during the 2 following days was 70.8.

THE EFFECTS OF *Cavariella theobaldi* ON THE DEVELOPMENT

None of the 30 larvae reared on *C. theobaldi* completed its development. The larvae survived on this food for a few days, their growth, however, was considerably

TABLE 2

Effects of brief diet of Cavariella theobaldi *and* Aphis fabae *from* Pastinaca sativa *compared with brief starvation on the larval and pupal development of* Metasyrphus corollae *reared on* Acyrthosiphon pisum

Diet in addition to *A. pisum*	Feeding period on additional diet or when starved		No. of reared larvae	Mortality No. of indiv. larvae	pupae	% total	Mean time of development in days larva	pupa	total	Mean weight and S.D. of puparia in mg
None (control)		(a)	10	1	1	20.0	8.0	8.0	16.0	31.5 ± 2.3
Cavariella theobaldi	5th day (20 hrs)	(a)	20	9	6	75.0	10.8	8.0	18.8	25.2 ± 3.3
None (starved)	4th day (20 hrs)	(b)	20	10	2	60.0	10.6	8.0	18.6	29.4 ± 3.0
None (starved)	6th day (20 hrs)	(b)	20	4	7	55.0	10.3	7.6	17.9	29.7 ± 3.0
Aphis fabae (from *P. sativa*)	1th - 4 th day	(c, b)	10	1	2	30.0	9.0	7.6	16.6	25.9 ± 2.0

(a) Mortality from the 5 th day of the larval development. (Mean mortality of 100 *M. corollae* larvae individualy reared on *A. pisum* in surplus was 15 % after first four days.)

(b) Larval mortality total.

(c) Later reared on *A. fabae* from *Vicia faba.*

suppressed compared with that of larvae reared on all the other aphids. Most of the larvae died on reaching the size which those reared on *A. pisum* achieved on the second day. No larva had grown to the size which the larvae feeding on *A. pisum* reached on the fourth day. Fully sucked out *C. theobaldi* in the rearing units were very rare, presumably because they were repelent food to the larvae. The consumption of *C. theobaldi* by the larvae of *M. corollae* and the detrimental effects of this were studied in detail in the following experiments.

The first experiment was undertaken to verify the unsuitability of *C. theobaldi* and to observe closely predation, food searching behaviour and the mortality rate of the larvae preying on this aphid. In this experiment the food consumption of 20 larvae was observed twice every day. After eclosion each larva was provided with 20 aphids (adult apterae, mean weight 0.6 mg) which were settled on a piece of *P. sativa* stem one hour earlier. The syrphid larvae were placed near the aphids to promote early contact with the food. Adult aphids were chosen in order to supply a relatively constant number of the 1st instar young which would be easier for the larvae to catch. Although the 1st instar larvae were able to capture adult aphids of *A. pisum* feeding on plants in our earlier experiments, they failed on their day of emergence to capture adult *M. persicae* placed near them on moist paper (BENESTAD-HÅGVAR, 1974).

On the first day the larvae attacked only 1st instar aphids. The total number of the 1st instars of *C. theobaldi* in a unit was then about 50. On the 2nd day fresh parts of *P. sativa* stem were added into the rearing units. To prevent disturbances of the youngest larvae the daily exchange of the aphids starded only after 48 hours (1).

Larval mortality in *M. corollae* reached 50 % on the 4th day of the experiment and the last larva was found dead on the 8th day. The larvae generally showed little activity, their movements forward became slower and their food searching movements made by the front part of the body were repeated from the same spot more often than normally.

In the second experiment we studied the effects on the development of *M. corollae* when its feeding time on *C. theobaldi* was limited. The experiment was conducted to find whether the harmful effect of *C. theobaldi* is caused by larval starvation, by the aphid being nutritionally deficient for the larvae or by a toxic substance contained in the aphid. In this experiment 20 larvae of *M. corollae* were reared individually for the 1st 4 days on *A. pisum*, then they were transferred for 20 hours to the tubes with 20 aphids *C. theobaldi*, of the same size as in the first experiment, and again returned to their previous diet. All the larvae started to attack *C. theobaldi*. The mean preying activity after 20 hours was 2.3 ± 0.9 completely and 4.8 ± 2.0 partly sucked out aphids per larva. The partly sucked aphids were often only noticably marked by the larval mouthpart; the actual sucking was not clearly determinable. The number of dead aphids without marks was 8.4 ± 2.5. The mean number of dead aphids in 10 control tubes without larvae was 6.6 ± 1.5. The higher mortality could have been caused accidentally when larvae crawled over the aphids. Disturbance of feeding aphids by the larvae themselves could also increase the mortality.

The preying activity of 10 *M. corollae* larvae of the same age and the same previous feeding conditions was checked in a control series on *A. pisum* (mean weight 0.6 mg). The larvae preyed much more on their suitable food : 8.8 ± 2.8 aphids were completely sucked out. The average number of aphids which were sucked out partly was 0.1. The growth of the larvae transferred to *C. theobaldi* was clearly retarded after 20 hours but

(1) The total number of the adult aphids in 20 control units without syrphid larvae decreased to 51.5 %, and in the units with larvae to only 54.5 % of the initial quantity.

there was no apparent difference between the larvae transferred for 20 hours to a limited number of *A. pisum* and those reared on *A. pisum* in surplus. The puparial weight of the insects transferred from *A. pisum* to *C. theobaldi* for a short period compared with the control individuals which fed only on *A. pisum* decreased significantly ($p < 0.002$).

Comparison of the preying activity on *C. theobaldi* and *A. pisum* shows that *C. theobaldi* is repelent to the larvae of *M. corollae*. The possibility that the increase in mortality and length of the development in the insects transferred briefly to *C. theobaldi* was caused only by the action of a repellent substance, can be excluded when we compare the developmental parameters of *M. corollae* in this and another experiment in which the larvae reared on *A. pisum* in surplus were left for 20 hours without food on the 4th and 6th day (table 2). The decrease of the puparial weight, although few aphids were eaten, indicates that *C. theobaldi* had a marked effect on the larvae of *M. corollae*. Therefore this aphid can not even be an alternative food (HODEK, 1962). The substance which is toxic for *M. corollae* is not toxic for some other syrphid species which can complete succesfully their development on this aphid (own observations).

In order to determine the origin of this substance we reared, in a third experiment, 10 larvae of *M. corollae* on the aphid *Aphis fabae* cultured on *P. sativa*. The larvae were kept on these aphids the 1st 4 days, which corresponds to half of the normal development on suitable food, and then they were transferred to *A. fabae* from *Vicia faba*. This was necessary because of limited aphid progeny obtained on *P. sativa*. During the 1st 4 days no larva died, while in the experiment where the larvae were kept on *C. theobaldi* only half of the initial number of the larvae survived. Also the growth of the larvae in this experiment was not retarded compared with the growth of the larvae reared entirely on *A. fabae* from *V. faba* (tables 1 and 2).

Larvae of *M. corollae* were also able to complete their development successfully on the aphid *Anuraphis subterranea* which was collected on the roots of *P. sativa*. The limited quantity of these aphids did not allow more than 5 larvae to be reared. For the same reason the daily food supply was marginal for optimum intake and due to this the dates in table 1 must be considered approximate.

All this indicates that the detrimental substance is not sucked by the aphid from its host plant but rather produced in the aphid body. *M. corollae* larvae sucked out significantly less individuals of *C. theobaldi* than of other (suitable) aphid prey. This was observed both in the experiment where the syrphid larvae were fed exclusively with *C. theobaldi* and in the experiment where the larvae were fed previously with *A. pisum*. This evidence shows the detrimental substance possessed by *C. theobaldi* to be repulsive. This does not preclude the possibility that a toxic substance is combined with a repellent substance, acting as a signal of unsuitable food.

DIFFERENCES IN THE DEVELOPMENT OF MALES AND FEMALES

The length of the larval and pupal development and the weight of the puparia was compared in both sexes of *M. corollae* reared on the aphids *A. pisum*, *U. cichorii*, *C. juglandis*, *I. asiaticum*, *A. craccivora* and *B. brassicae*. All these aphid species were suitable food for the larvae as mentioned above. When the individually kept larvae fed on these aphids the mortality of the immature stages was less than 40 % and the mean puparial weight was higher than 30 mg. The results are summarized in table 3. Both, the larval and pupal development of the males was a little shorter which corresponds to the results published by BARLOW (1961) who reared the larvae of this syrphid on a mixture of aphids *A. pisum* and *A. fabae*. BENESTAD (1970) confirmed the shorter pupal development in the males. She reared *M. corollae* larvae on *M. persicae*. In our results the difference in the length of the larval development between the sexes (average time 8.03 days in males

TABLE 3

Differences in the development of males and females of M. corollae *from larvae fed on suitable aphid species*

Aphid species	No. of males	females	Mean time of development in days larvae males	larvae females	pupae males	pupae females	Mean weight and S.D. of puparia in mg males	females
Acyrthosiphon pisum	10	9	8.0	8.2	7.6	8.0	33.3 ± 2.8	31.4 ± 2.1
Uroleucon cichorii	11	14	8.0	8.1	8.0	8.0	33.4 ± 2.0	32.7 ± 1.1
Callaphis juglandis	11	7	8.2	8.4	7.5	8.0	31.0 ± 1.4	30.8 ± 1.7
Impatientinum asiaticum	10	13	8.0	8.1	7.9	8.1	32.4 ± 2.8	32.0 ± 1.2
Aphis craccivora	11	8	7.8	8.0	7.6	8.0	31.0 ± 3.3	31.4 ± 3.0
Brevicoryne brassicae	10	9	8.2	8.2	7.9	8.0	31.7 ± 2.5	30.7 ± 2.6

and 8,15 days in females) was never significant. The pupal development of the males was significantly shorter on *A. pisum*, *C. juglandis* and *A. craccivora*. The present results show that the puparia of the males (mean weight 32.1 mg) are slightly heavier than the female puparia (mean weight 31.6 mg), but the difference was not significant in any series.

COMPARISON OF THE DEVELOPMENT OF INDIVIDUALLY AND IN GROUPS REARED LARVAE

Cannibalism among syrphid larvae was often reported. In simultaneously conducted experiments the mortality of the larvae which were reared in groups of 10 per one rearing unit was even lower than with larvae reared individually though all the larvae were supplied with *A. pisum* in surplus during their development. The development of the larvae reared in groups was slightly quicker and the puparia were lighter in weight than in those reared separately (table 1, 1st and 2nd line), however, the differences were not significant. Shorter time of larval development accompanied with decrease of the mean weight of the puparia in the larvae reared in groups could possibly be explained by the regular contact among the larvae which had a stimulating effect.

RÉSUMÉ

Influence de divers pucerons sur le développement
de *Metasyrphus corollae* [*Dipt. : Syrphidae*].

Le développement pré-imaginal de *Metasyrphus corollae* (FABRICIUS) se déroule bien dans les conditions expérimentales si l'on nourrit les larves avec les pucerons *Acyrthosiphon pisum* HARRIS récoltés sur *Vicia faba*, *Uroleucon cichorii* (KOCH) sur *Crepis biennis*, *Callaphis juglandis* (GOETZE) sur *Juglans regia*, *Impatientinum asiaticum* NEVSKY sur *Impatiens parviflora*, *Aphis craccivora* KOCH sur *Robinia pseudoacacia*, *Brevicoryne brassicae* LINNAEUS sur *Brassica oleracea* et *Aphis fabae* SCOPOLI sur *V. faba*. Aussi les pucerons *Myzus cerasi* (FABRICIUS) sur *Prunus cerasus* et *Megoura viciae* BUCKTON sur *V. faba* peuvent être considérés comme une nourriture favorable, mais le développement des larves de l'espèce étudiée est un peu prolongé, et la mortalité élevée, inférieure à 50 %. L'élevage sur *Phorodon humuli* (SCHRANK) produit, en plus, des pupes beaucoup plus petites.

Aphis sambuci LINNAEUS sur *Sambucus nigra* ne peut pas être considéré comme une alimentation favorable pour les larves de *M. corollae :* la plupart des individus est morte déjà dans les stades pré-imaginaux, même quand ils sont alimentés préalablement, pendant les premiers jours de la vie larvaire, avec une nourriture favorable. La vitalité des adultes et la fécondité des femelles diminuent.

Les larves de *M. corollae* ne peuvent pas se développer quand elles sont alimentées avec *Cavariella theobaldi* (GILLETTE BRAGG) sur *Pastinaca sativa*. Cette espèce de pucerons est toxique et répulsive pour les larves. La substance toxique contenue dans *C. theobaldi* ne semble pas être directement tirée de la plante-hôte (*P. sativa*). Le développement des larves de *M. corollae* est possible sur *Anuraphis subterranea* (WALKER) qui forme des colonies sur les racines de cette plante, de même que pour *A. fabae* élevé sur *P. sativa*.

Une différence significative entre la durée du développement nymphal des mâles et des femelles peut être trouvée seulement lorsque les larves sont alimentées avec *A. pisum*, *C. juglandis* et *A. craccivora*. On n'observe aucun cas de cannibalisme dans les élevages groupés (10 individus) quand une quantité satisfaisante d'une nourriture favorable est assurée.

REFERENCES

BARLOW, C.A. — 1961. On the biology and reproductive capacity of *Syrphus corollae* FAB. [*Syrphidae*] in the laboratory. — *Entomol. Exp. Appl.*, 4, 91-100.

BENESTAD, E. — 1970. Laboratory experiments on the biology of *Syrphus corollae* (FABR.) [*Dipt., Syrphidae*]. — *Norsk Entomol. Tidsskr.*, 17, 77-85.

BENESTAD-HÅGVAR, E. — 1974. Effectiveness of larvae of *Syrphus ribesii* and *S. corollae* [*Diptera : Syrphidae*] as predators on *Myzus persicae* [*Homoptera : Aphididae*]. — *Entomophaga*, 19, 123-134,

CHANDLER, A.E.F. — 1968. Some host-plant factors affecting oviposition by aphidophagous *Syrphidae* [*Diptera*]. — *Ann. Appl. Biol.*, 61, 415-423.

— 1968. The relationship between aphid infestations and oviposition by aphidophagous *Syrphidae* [*Diptera*]. — *Ann. Appl. Biol.*, 61, 425-434.

— 1968. Some factors influencing the occurrence and site of oviposition by aphidophagous *Syrphidae* [*Diptera*]. — *Ann. Appl. Biol.*, 61, 435-446.

DUŠEK, J. & KRÍSTEK, J. — 1959. Zum Auftreten und zur Bionomie der Syrphidenlarven [*Syrphidae, Dipt.*] in den Cecidien der Pappelblattläuse. — *Folia Zool.*, 8, 229-308, (In Czech., German summ.)

DUŠEK, J. & LÁSKA, P. — 1959. Beitrag zur Kenntnis der Schwebfliegen-Larven [*Syrphidae, Diptera*]. — *Acta Rerum Nat. Dist. Sileiae*, 20, 273-287, (In Czechs., German summ.).

EVENHUIS, H.H. — 1966. Syrphid predators of apple aphids and their parasites. In : Ecology of Aphidophagous Insects. Proc. Symp. Liblice near Prague 1965. — *Academia, Prague*, 191-193.

HODEK, I. — 1957. The influence of *Aphis sambuci* L. as food for *Coccinella 7-punctata* L. II. — *Acta Soc. Entomol. Čechoslov.*, 54, 10-17, (In Czech., English summ.).

— 1960. The influence of various aphid species as food for the lady-birds *Coccinella 7-punctata* L. and *Adalia bipunctata* L. In : The Ontogeny of Insects, Acta Symp. Prague 1959. — *Publ. House Acad. Sci., Prague*, 314-316.

— 1962. Essential and alternative food in insects. — *Verh.* 11. *Int. Kongr. Entomol. Wien*, 1960, 2, 696-697.

— 1967. Bionomics and ecology of predaceous *Coccinellidae*. — *Annu. Rev. Entomol.*, 12, 79-104.

HODEK, I., HOLMAN, J., STARÝ, P., ŠTYS, P. & ZELENÝ, J. — 1966. Natural enemies of *Aphis fabae* SCOP. in Czechoslovakia. — *Academia, Prague*, 126 pp. (In Czech., English summ.).

NAKAO, S. — 1962. A list of insects collected in a citrus grove near Fukuoka City. Ecological studies on the insect community of citrus groves. IV. — *Kontyu*, 30, 50-71.(In Japanese, English summ.).

OKUNO, T. — 1967. On the syrphid larvae attacking the aphids in Japan [*Diptera*]. — *Mushi*, 41, 123-141.

PELOV, V. — 1972. Entomophages of aphids on alfalfa in the Dobroudja. — *Studies on the Biological control of Plant Pests*, Sofia, 1, 49-66, (In Bulgarian, English summ.).

SCHMUTTERER, H. — 1972. Zur Beutespezifizität polyphager, rauberischer Syrphiden Ostafrikas. — *Z. Angew. Entomol.*, 71, 278-286.