

UTILIZATION OF ENERGY SOURCE IN THE ADULTS
OF *COCCINELLA SEPTEMPUNCTATA*
BRUCKII MULSANT
(Coleoptera : Coccinellidae)

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In Aichi Prefecture, *Coccinella septempunctata* produces two generations in a year, and its reproducing season was mid-spring or -autumn. The adults of *C. septempunctata*, preying actively in the fields in winter, give clearly different ecological pattern from that in phytophagous coccinellids, which overwinter in the state of diapause. To understand such interesting life cycle in *C. septempunctata*, the analysis of energy metabolism would present any hold. Therefore in present paper, the vitality of *C. septempunctata* adults was studied, with special reference to the utilization of energy source.

Materials and methods

Insect materials

Newly emerged *C. septempunctata* adults taken from the fields of Anjo city to laboratory in late autumn, were used for study. Also *C. septempunctata* adults in reproducing stage, in which individuals active mating behavior being observed, were collected from the fields in November and used for experiments.

Respiration

O₂ uptake was measured by Warburg respirometer for one hour at 30°C, in which temperature the most active movement of Coccinellidae being observed (Hukushima and Sakurai, 1964). RQ was calculated from the value of O₂ uptake and CO₂ production determined by respirometer.

Lipid contents

Lipid was extracted following after the method of Folch et al. (1957). Insects were homogenized in presence of chloroform-methanol (2 : 1) and crude lipid was extracted. Extracted lipid fraction was washed in 0.1 N NaCl solution and the weight of it after drying up was measured as lipid contents.

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Glycogen, total sugar and trehalose contents

Carbohydrate contents were determined by the method of Wyatt and Kalf (1957). Total sugar was extracted from the homogenate of insects in presence of 80% ethanol and its contents were measured by anthrone method (Mokrasch, 1954). The contents of trehalose which was stable for acidic or alkalic degradation, were estimated in total sugar fraction after addition of H₂SO₄ and NaOH in order, and measured by anthrone method. Glycogen was estimated in 80% ethanol insoluble fraction, which contents were measured by anthrone method after addition of 5% trichloroacetic acid and subsequently boiling of it.

Results and discussion

Comparison of O₂ uptake in five species of adult Coccinellidae just after emergence, showed the remarkably highest value in *C. septempunctata* as given in Table 1. The active vitality of this one presumed from the measurement

Table 1. Comparison of O₂ uptake in newly emerged five Coccinellidae species.

Coccinellidae species	O ₂ uptake (μ l O ₂ /mg wet weight)	Remarks
<i>Coccinella septempunctata bruckii</i> M.	2.46 \pm 0.17*	emerged at October
<i>Harmonia axyridis</i> P.	1.76 \pm 0.26	emerged at May
<i>Rodolia cardinalis</i> M.	1.67 \pm 0.39	emerged at July
<i>Epilachna sparasa orientalis</i> D.	1.28 \pm 0.25	emerged at June
<i>Epilachna vigintioctomaculata</i> M.	1.58 \pm 0.09	emerged at June

* Means \pm standard deviation. The same illustration applies to other Tables. Each Coccinellidae was taken from fields to the laboratory at the stage of larvae or pupae. O₂ uptake was measured for 3 number of insects with 5 to 8 replication.

of O₂ uptake, agrees with dynamic preying behavior of it observed in the fields. In relation to active vitality in *C. septempunctata* adults, to understand the energy metabolism of them is very interesting. On this point of view, the changes of RQ, lipid and carbohydrate contents under such conditions as movement, feeding and starvation were studied.

C. septempunctata adults in reproducing stage collected in the fields in October were placed in respirometer flask at 30°C, after 1 day of the feeding of aphids, *Myzus persicae* Sulzer. At the temperature of 30°C, insects actively moved in the flask. Table 2 presents the change of RQ, lipid and carbohydrate contents under the starvation for 24 hrs. RQ at 0 hr being in about 1.1, indicates the dependence of energy source on carbohydrates. With lapse of time, RQ value shifted to lipid utilization. At 24th-hr lipid contents greatly decreased to the level of 14% in original one, being well agreed with tendency of RQ.

Table 2. *Effect of starvation of matured Coccinella septempunctata adults on RQ, lipid and carbohydrate contents.*

Duration of starvation (hr)	RQ	Lipid contents (mg/g wet weight)	Carbohydrate contents (mg glucose/g wet weight)		
			Glycogen	Total sugar	Trehalose
0	1.06±0.28	189.0± 3.8	6.36±0.57	1.90±0.09	1.02±0.30
12	0.82±0.20	113.0±10.5	5.26±0.51	1.42±0.08	0.72±0.06
24	0.60±0.32	29.5± 4.6	1.86±0.93	1.42±0.20	0.68±0.11

RQ was measured for 3 numbers of insects with 8 replication. Lipid and carbohydrate were measured for three number of insects with 4 replication.

Among carbohydrates, glycogen and total sugar diminished about 20 to 25 % at 12th-hr, afterwards glycogen remarkably declined to the level of 30 % at the original contents. The contents of sugar trehalose showed similar pattern of decrease as total sugar and continuously occupied about half amounts of total sugar. Higher utilization of glycogen in last 12 hrs might be induced by depletion of lipid storage. Obtained results point out that matured adult of *C. septempunctata* utilizes carbohydrate as the energy source in normal state inferring from the value of RQ, then with passing the time of starvation lipid is utilized and at last glycogen is employed to the energy source as the result of lipid depletion.

The effect of feeding on carbohydrate contents in newly emerged *C. septempunctata* was studied. Table 3 shows the effect of feeding of aphids, *Myzus*

Table 3. *Effect of feeding of aphids, Myzus persicae Sulzer on the carbohydrate contents in newly emerged Coccinella septempunctata. Carbohydrate contents were expressed as the unit in mg glucose/g wet weight. Same illustration applies to Table 4.*

Carbohydrate	Duration of feeding (day)			
	0	1	3	5
Glycogen	1.89±0.34	2.46±0.69	2.64±0.47	2.62±0.47
Total sugar	2.09±1.22	1.95±0.68	1.55±0.74	1.27±0.62
Trehalose	0.64±0.27	0.55±0.08	0.56±0.19	0.77±0.44

Measurement was carried out for 3 number of insects with 4 replication at 0-day and with 3 replication at 1st-, 3rd- and 5th-day.

persicae on carbohydrate contents. Glycogen contents just after emergence was about 1.9 (mg glucose/g wet weight), being equivalent to the value of matured one starved for 24 hrs shown in Table 2. This value of glycogen contents might correspond to the basal metabolic level of them to keep the life of *C.*

septempunctata adults. With passing the time of feeding to 3rd-day, about 40 % of increase of glycogen was observed, afterwards settled in the same value. Increased glycogen contents 2.62 (mg glucose/g wet weight) at 5th-day correspond to about 40 % of them in matured adults shown at 0 hr in Table 2. To accumulate glycogen reaching the amounts in matured ones, more longer duration of feeding than 5 days may be required. While total sugar contents, although trehalose was nearly in fixed level, was continuously decreasing till 5th-day of feeding. The decrease in total sugar may reflect the conversion of it into glycogen through glycogen synthesis pathway or the consumption of it as the energy source through trehalose on the metabolic pathway. Trehalose is known as the blood sugar in insects and the fixed value in *C. septempunctata* may elucidate the homeostatic nature of it.

The effect of starvation on carbohydrate contents of newly emerged *C. septempunctata* was given in Table 4. *C. septempunctata* adults died at 7th-day of

Table 4. Effect of starvation on carbohydrate contents in newly emerged *Coccinella septempunctata*.

Carbohydrate	Duration of starvation (day)		
	0	2	5
Glycogen	1.89±0.34	1.68	1.38
Total sugar	2.09±1.22	1.94	2.20
Trehalose	0.64±0.27	0.87	0.72

Measurement was carried out for 3 number of insects with 4 replication at 0-day and for the homogenates of 5 to 8 number of insects at 2nd- and 5th-day. Insects died at 7th-day of starvation performed after emergence.

starvation, being performed after emergence. The decreased amounts in glycogen at 5th-day was 27 % in original contents. Such little amounts of decrease in glycogen contents might cause the death of this insects.

In generally insects utilize lipid and glycogen as the energy source with their action or during dormancy. Also in present study, lipid and glycogen were actively utilized as the energy source with action. Concerning to the function of glycogen, its utilization as the energy source during overwinter was observed in *C. septempunctata* adults (Sakurai, 1965). For detailed comprehension of the life cycle of *C. septempunctata*, further more study involving biochemical approach would be required.

Summary

To understand the life cycle of *C. septempunctata*, the energy metabolism in the adults was studied. O₂ uptake of *C. septempunctata* showed remarkably active vitality among five Coccinellidae species. Measurements of RQ, lipid and carbohy-

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drate contents of matured ones in reproducing stage showed active utilization of carbohydrate as the energy source in normal time and lipid under the starvation. Glycogen contents just after emergence were equivalent to the value of matured ones starved for 24 hrs, which value might be considered as the basal metabolic one to keep its life. Starvation of newly emerged ones caused the death after 7 days, and 5 days of feeding or starvation resulted on about 40 % of increase or 30 % of decrease in glycogen contents. In total sugar and trehalose fraction, so much change as glycogen was not observed.

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