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The biology and preying abilities of ladybird beetle (*Coccinella transversalis* Fabricius) on *Myzus persicae* (Homoptera: *Aphididae*)

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Abstract. The use of predators in biological control has been widely known to reduce pest populations. The research aim is to determine the biology and preying abilities ladybird beetle, a species of family Coccinellidae named *Coccinella transversalis* Fabricius which can be used to mass rearing on laboratory for augmentation and conservation purpose. This study directed at research facility at Methodist University of Indonesia with descriptive methods. Samples collecting from horticultural cultivation at Karo District, then kept in maintenance jar with substitute food and real food *Myzuz persicae* as standard mass rearing technique for the coccinellid. The results showed that egg incubation was 3.2±0.76 days. There are four instars of larval with lifetime 2.67±0.20 days, 2.87±0.26 days, 2.91±0.53 and 3.42±0.75 days respectively. Prepupae was 1.62±0.56 days and pupae was 3.11±0.81 days. Life period of female was 35.05±3.80 days and male 25.75±3.14 days. The female potential produce egg was 118.4±20.14 eggs and percentage of egg hatching 85.0±6.37%. The survival rate from larvae to imago was 48.8±5.84%, which means half of the larvae succeeded becoming an imago. Preying abilities for aphid at larva instar I until instar IV, female and male were 24.55±3.28, 44.55±6.63, 89.90±13.41, 174.50±27.7, 973.67±29.21 and 786.31±14.77 aphids respectively.

1. Introduction

Coccinelids or ladybird beetles (Coleoptera; Coccinellidae) consists of many species and some of them predatory on other insects [1]. In the world found 3000 types of the family distributed across many countries and most of coccinellids are predators on coccids and aphids, some of them feed on acarines or aleurodicus [2]. There are 5200 species of Coccinellidae predators that have been identified in the world [3] and estimates there are 5000 species of Coccinellidae predators worldwide [4]. It was recently reported that there are 6000 species of Coccinellidae predators are found in found in many places such as mountains, beaches even in urban areas [5]. The Coccinellids commonly preys insect pest on eggs or larvae stage. There is a specific relationship between predators and their prey [6].

The predator *Coccinella transversalis* Fabricius is a member of the family Coccinellids which ordinarily tracked down plentiful in Asia, benefiting insects to control aphids on horticultural plants like vegetables [7]. They are the most regularly referred to use as helpful insects because of their real role as a predator of pests in the larval and imago stages. The pests that become their prey are coccids, aphids and other delicate-bodied bugs [8]. In many countries, coccids and aphids are considered potential pests of plants. Both nymphs and adult stages can damage plants by sucking plant fluids on leaves, stems,

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buds, flowers, fruit and shoot. This causes the economic value of crop production to decrease in terms of quantity and quality. Various studies have reported that *C. transversalis* was found as a predator on coccids and aphids in various countries, among others Sri Lanka India, Indonesia, Nepal, New Zealand, Bangladesh, Indochina and Australia [9].

In Indonesia, *C. transversalis* is commonly found in vegetable plants such as chili, cabbage, tomato, and potato. It was reported that *C. transversalis* found in several production centers of chili in West Sumatra Province [10]. Meanwhile, there were found five species of ladybird beetles on chili plantations in Sleman District and one of them is *C. Transversalis* [11]. Previously reported that *C. transversalis* was found in several centers of chili, potato and cabbage cultivation in Sumatera Utara like Simalungun and Karo District, Sumatera Utara Province [12,13]. Besides having a cosmopolitan distribution pattern, *C. transversalis* is able to prey on many species of insects from the order Hemiptera or Homoptera, but in general it is a delicate-bodied insect such as aphids or mites.

C. transversalis preys on 12 species of aphids from order of Hemiptera and genus Aphididae such as *Aphis craccivora* Koch, *Aphis nerii* Boyer de Fonscolombe, *Aphis gossypii* Glover, *Lipaphis erysimi* Kaltenbach, *Hysteroneura setariae* Newstead, *Rhopalosiphum maidis* (Fitch), *Uroleucon compositae* Theobald, *Hyadaphis coriandri* Das, *Rhopalosiphum nymphae* Lin., *Myzus persicae*,Sulzer, *Macrosiphum rosae* Lin., and *Hyadaphis coriandri* Das [8,14,15]. *C. transversalis* also prey thrips, coccid and mites like *Bemisia tabacci, Thrips parvispinus, Lepidosaphes* beckii [15,16]. The preying abilities of *C. transversalis* both on larval or imago stages is high. Its reported that in one day, the imago of *C. transversalis* can prey the nymphs stage of *B. tabaci, M. persicae* and *A. gossypii* were 48, 20 and 23 respectively [16].

However, environmental factors greatly affect the success of predators as biological control agents to reducing pest populations in agroecosystem. The meaning of biological control is the use of natural enemies of pests to control pest populations. Natural enemies of these pests can parasitoids, predators or pathogens [17]. In order to effectiveness using coccinellids as a natural agent in pest management programs, complete research on biological characteristics and preying abilities is urgently needed [18]. On pest management strategies, biological control is the main component. Pest management concept development is emphasized on non-chemical control systems by optimally utilizing the biotic mortality factors of insect pests. Optimization of natural enemies of insect pests is carried out through augmentation and conservation by releasing and providing a supportive environment for natural enemies to be able acting as biotic mortality factors, so that insect pest populations can be kept at a low level.

Many researches reported that *C. transversalis* can often be attributed to the same plants and feed on the same insect species both larval and imago stage [19]. According to the previous reports, the imago stage of *C. Transversalis* was fed both substitute foods and aphid as essential food. The larval stage more like feed aphid as essential food than substitute food, so development of larval was quickest and larval survival was highest. [20].

These biological characteristics study and preying abilities of *C. transversalis* will be useful to help us understand the characteristics of these predators so that their potential to be developed as biological control agents can be identified. The study about ecological factors that affect the life of predators, a life-cycle and others internal factor will be important information in understanding the population dynamics of these predators in agricultural ecosystem [21]. In another study, it was reported that *C. transversalis* is not potential as biological agent if compare to *Menochilus sexmaculatus* (Fabricius) to control *Aphis craccivora* (Koch) (Homoptera: Aphididae), *M. persicae* (Sulzer) (Homoptera: Aphididae) and *Aphis gossypii*. But in other case *C. transversalis* results functional responsiveness to prey *M. persicae* and *A. Gossypii*. Both of these predators have functional response as potential predator [22]. The study of aspect biology expected will provide information about the relationship between biological agents and pests as their prey which can be used as the basis for applications in field.

2. Materials and methods

This study was directed at research facility Faculty of Agriculture, Methodist University of Indonesia, Medan, North Sumatera, Indonesia during July until October 2021. Both larval and imago stage of C

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transversalis collected in large quantities from agricultural land which planted with potato, cabbage and chili field at Karo Highland. All larvae and imago of ladybird were collected from the field were reared in a glass jar covered (15L × 15W × 25H) with a muslin cloth to obtain the number of eggs needed in the study. The standard insect rearing technique adopted from research by Elekcioglu [23,24]. To supply the *M. persicae* population as a feed for predatory beetles, in the experimental area around the Laboratory, several eggplant (*Solanum melongena*) and chili (*Capsicum annum*) plants were planted that were already attacked by aphids.

Adult beetles, both male and female, were collected from designated farms, then separated and put into maintenance jars which filled with *Portulaca grandiflora* plant. This plant serves as a place to live for ladybird beetles. To obtain eggs, a pair imago put into each observation jar. The eggs produced from each observation jar were counted and placed in the Petri dish to observe the hatching time. There are totally 160 eggs collected. The data of hatching time indicates the period of egg incubation. The percentage of egg hatching also recorded. First instar of larvae obtained when the eggs hatch and then the larvae separated into another Petri dish to record the length of the first instar larval stage. The first instar duration calculated from the time of egg hatching to ecdysis. And then the survival larvae were recorded. The second instar recorded also like the same method. Similarly doing to other instar, pre-pupal period, pupal period and survival rate from first instar of larva until imago stage also recorded. To support the development of insects given the real food *M. persicae* and substitute food.

The data about development period of every stage were recorded. Likewise, observation of the percentage of predators alive at each was calculated. After the larval stage is complete, it enters the prepupa stage and continues with the pupa stage. Observation pupae were kept undisturbed in Petri dish until the emergence to imago stage. The duration of the prepupae and pupal stages was recorded as well as the percentage of pupae that turned into imago. The results of these observational data will be used in compiling a life-specific table of *C. transversalis*. The adult characteristic also observed like mating activity, oviposition, fecundity and feeding activity. During the study the room temperature was maintained at 26±1^{0}C.

3. Results and discussion

3.1 Biology of predator C. transversalis

The female lays eggs on *portulaca grandiflora* plant leaves in observation jars in groups ranging from 5 to 26 eggs. Newly laid eggs are bright yellow, round in shape and laid in rows in groups, and then changes color to opaque yellow or grey before hatching. Egg size varies from the aspect of length and width. There are between 0.76 mm until 1.02 mm in length (0.85±0.06), and between 0.22 until to 0.43 mm in width (0.37±0.06 mm. The length of time for hatching eggs is between 2.2 until 5.4 days (3.2±0.76 days). Observations of the eggs showed that there are about 15 percent of the eggs did not hatch, while the percentage that hatched was 85.00±6.37 percent. In general the female lays eggs at night or early in the morning. Under laboratory condition reported that egg incubation period varied between 2 until 5 days with an average 2.80 ± 0.76 days at a temperature of 27°C and 79 % relative humidity [25]. Other research states that the hatching period of eggs is strongly influenced by environmental factors such as temperature and humidity. Another research shown reported that the incubation period of eggs is more influenced by environmental factors such as humidity and temperature, while the availability of food is less influential. The higher the temperature, the faster the incubation period [25].

There are four instars of the larvae of *C. transversalis*. The first out was the visible head of larvae, then his legs followed slowly out of the eggshell until all of the abdomen parts. It happened in the hatching process of eggs into larvae. For the larvae's first instar, it was dark at the head capsule and fine spines covered its thorax and abdomen. There are nine segments that compose the larvae. It was coming out black. For the larvae's second until fourth instars, fourth and sixth abdominal segments had yellowish spots with black as the base color. For the C. transversalis larvae's third instar, compared to the second instar, there was a larger spiny structure in the third instar. Except for the bigger size, the appearance of it was similar to the second instar generally. The dark black color was visible after the larvae's third instar was freshly molted. The more intensified color pattern was visible as well on the mid-dorsal line except prothorax with additional orange transverse patches development of other segments.

Because of larvae's body was coated in a layer of wax, the skin will be grey when it is time to exchange. From the first instar to the pupae, a larva's size gradually increased until it reached its largest size before contracting toward the pupae, known as stadia prepupae. The spines (seta) also became shorter as the larvae grew older. Table 1 shown the size and lifespan of each stage beginning with the first instar of larvae and continuing until the prepupae stage.

The newly formed adults had soft bodies, light yellow, but has no black spots yet. The more mature, the yellow color gets brighter towards orange and the black spots start to appear firm. The adult ladybird beetle was medium in size, had an elongate oval, convex shape to its body, and had a black head. Males were physically smaller than females. In order to lay eggs, the last abdominal segment of male beetles was rounded, whereas it was pointed in females. The measurements of the adult male and female bodies' length and width of *C. transversalis* displayed at Table 1.

Table 1. Body size and life period of *C. Transversalis*.

Stage	size average (mm)	period (day)	period average (days)
Male	4.76±0.17(length)	22 – 36	25.75±3.14
	3.11±0.15(width)	-	
Female	5.46±0.19(length)	32 – 48	35.05±3.80
	3.30±0.14(width)	-	
Pupae	4.76±0.16 (length)	1.8 – 4.1	3.11±0.81
	2.53±0.12 (width)	-	
Prepupae	-	1.0 – 2.0	1.62±0.56
Larvae instar I	1.50±0.08	2.3 – 3.2	2.67±0.20
Larvae instar II	2.96±0.12	2.4 – 3.5	2.87±0.26
Larvae instar III	4.50±0.47	2.1 – 4.4	2.91±0.53
Larvae instar IV	5.82±0.19	3.2 – 6.0	3.42±0.75

The table 1 showed the duration every stage of *C. transversalis*. The female and male of imago have a different length of life. This observation shows different from the other the study reported that the larval stage instar I are 2.43 ± 0.19 days; instar II are 2.53 ±0.19 days; instar III are 2.64 ± 0.04 days and instar IV are 2.77 ± 0.21 days. While the life period of female is 15.14±1.90 days and male is 13.63±1.00 days [22]. Relatively similar result was reported that if given prey is *A. nerii*, the life period of female 42.5 days and male is 35.8 days [17]. It appears that the type of prey or food greatly affects development of the larval stage and life period of imago *C. transversalis*. Each prey provides different nutrients for larvae and imago. However, food with good nutrition will support larval development and oviposition. Both imago and larvae prey pests. Based on the predator development data above, it shows that there are good prospects to be developed as potential biological agent to control aphids. Both larval stage and imago stage have a long life period. The survival rate of *C. transversalis* life from first instar of larvae until imago is 48.8±5.84%. There are 126 larvae first instar obtained from 160 eggs. At each instar change, the larvae are very susceptible to death during ecdysis. The larval and egg stages have the highest mortality rates. This demonstrates how environmental variables like humidity and temperature strongly affected for every stage of insect. There were 36 female and 25 male imagoes out of the total 61 imagoes produced during maintenance, ranging from egg to imago. The sex ratio recorded about 1.0: 1.54, it means there were more females than males, which indicates that population growth may occur quickly because imago males can reproduce with multiple female imagoes, and each female can lay fertile eggs. The stadia of *C. transversalis* show at Figure 1.

Figure 1. Development stage of *C. transversalis* (a) eggs (b) larvae (c) pupae (d) imago.

The results also showed that the pre-oviposition period of female is 3.26 ± 0.45 days, longer than another research 2.67 ± 0.58 days [22], and faster when compared on different prey such as *M. persicae A. craccivora, and L. erysimi* which is 5.74 days, 5.50 days; and 5.22 days respectively [8]. During their lifetime, the female has potential to produce eggs named fecundity about 118.40±20.14 eggs. The fecundity strongly affected by genetics and environments like microclimate, amount and quality of feds. Research reported that capability *Coccinella* sp. producing eggs about 150 eggs during the female life [26]. The cause of not achieving the potential to produce eggs in female beetles is caused by the condition of rearing jar inadequate to the development of these predators. With natural feeding, *Coccinella transversalis* producing 234 – 467 eggs under maintained conditions in the laboratory [8]. Female beetle can lay as many eggs as 90.44 ± 14.38 eggs with an oviposition period that is 8.97± 0.89 days [22]. It is clear that the ability to produce eggs is strongly influenced by natural food and the length of the oviposition period.

3.2 Preying abilities of C. transversalis

The preying ability of every stage are distinct from one to another. The first, second, third, and fourth instars all had predatory potential that ranged from 19.5 to 29.0 aphids, 38.5 to 55.5 aphids, 64.8 to 122.6 aphids, and 128.0 to 256.5 aphids, respectively. Total preying ability of all larval stage was between 299.5 to 471.8 aphids. In comparison to larvae, the adults showed more response during feeding the prey. Compare to the male, the female prey on more aphids overall. The preying ability of female and male were 973.67±29.21 aphids and 786.31±14.77 aphids, respectively. The average preying ability by predator at each stage describe at figure 2.

In comparison with other research, the total prey consumption by imago is greater than all larval stages. Preying ability by larval stage, female and male during their lifetime was maximum 665.30 ± 5.75; 5412.30 ± 94.51, and 4831.10 ± 123.54 respectively on prey *A. gossypii* and 434.80 ± 4.03 ; 905.20 ± 52.48, and 802.80 ± 34.37 and respectively on prey *A. nerii* [27].

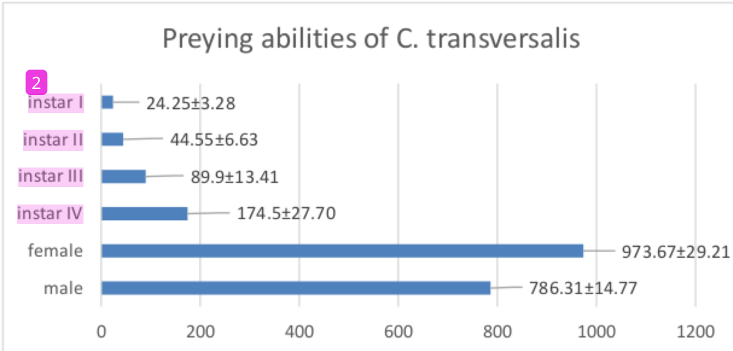

Figure 2. Average prey number of predators for each stage *C. transversalis*.

4. Conclusion

Ladybird beetle *C. transversalis* has the potential to be developed and employed as biological agents, according to the biological study and preying abilities because of the *C. transversalis* female has a longer lifetime than the male. For female, it was 54.15±10.31 days, while for male, it was 43.35±6.97 days. The *C. transversalis* has 48.8±5.84% chance of surviving life from first instar of larvae until imago stage. The female able to laying eggs as much as 116.40±20.14 eggs during the lifetime. Compared to the larvae, the adults showed a greater response during feeding. Preying abilities of female and male was 973.67±29.21 and 786.31±14.77 aphids respectively. The female consumed more aphids than the male.

References

[1] Efendi S, Yaherwandi and Novri N 2018 Biology and demographic statistics of *Coccinella transversalis* Thunberg (Coleoptera: Coccinellidae) the predator of aphis gossypii glover (Homoptera: Aphididae) *Jurnal Perlindungan Tanaman Indonesia* [*Indonesian Journal of Plant Protection*] **22**(1) pp 91-7

[2] Kundo AA and Khan AA 2017 Coccinellids as biological control agents of soft bodied insects: A review *Journal of Entomology and Zoology Studies* **5**(5) pp 1362-73

[3] Fiaboe KKM, Gondim MGC, Moraes GJ, Ogoland CK and Knapp M 2007 Bionomics of the acarophagous ladybird beetle *Stethorus tridens* fed *Tetranychus evansi*. *J Appl Entomol* **13**(1) pp 355-36

[4] Foltz JL 2002 *Coleoptera:Coccinellidae* (Departement of Entomology and Nematology University of Florida)

[5] Vandenberg NJ 2009 The new world genus *Cycloneda* (Coleoptera: Coccinellidae:Coccinellini): historical review, new diagnosis, new generic and specific synonyms, and an improved key to North American species *Entomological Society of Washington* **104**(1) pp 221-36

[6] Santos SAP, Pereira PA, Rodrigues MD, Torres LM, Pereira AMN and Nogueira AJA 2009 Identification of predator–prey relationships between *Coccinellids* and *Saissetia oleae* (Hemiptera: Coccidae) in oolive groves using an enzyme-linked immunosorbent assay *Journal of Pest Science* **82**(2) pp 101-8

[7] Ahmed KS, Muhammad ZN, Muhammad R, Fatima S and Muhammad A 2017 Biodiversity and species distribution of *Coccinellids* (Coccinellidae: Coleoptera) in district Sargodha (Punjab) Pakistan *Pakistan J Zool* **49**(5) pp 1749-59

[8] Shukla A and Jadhav DS 2014 Biology of *Coccinella* transversalis (Fabricus) on different aphid species the bioscan **9**(1) pp 17-22

[9] Poorani J 2002 An annotated checklist of *Coccinellidae* (Coleoptera) excluding epilachninae of Indian subregion *J Oriental Insects* **3**(6) pp 307-83

[10] Efendi S, Yaherwandi and Nelly N 2016 Analisis keanekaragaman *Coccinellidae* predator dan kutu daun (*Aphididae spp*) pada ekosistem pertanaman cabai [Analysis of the diversity of predatory Coccinellidae and aphids (*Aphididae spp*) in the chili ecosystem] *Jurnal Bibiet [Bibiet's Journal]* **1**(2) pp 67−80
[11] Hendrival P H and Nurmansyah A 2011 Keanekaragaman dan Kelimpahan Musuh Alami Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae) pada Pertanaman Cabai Merah di Kecamatan Pakem, Kabupaten Sleman, Daerah IstimewaYogyakarta *Jurnal Entomologi Indonesia* **8** 96−109
[12] Sidauruk L and Panjaitan E 2016 Biological aspect of *Coccinella* transversalis fabricus (Coleoptera: Coccinellidae) as potential predator on aphid in Karo *Biological Sciences* **7**(3) pp 74-7
[13] Sidauruk L, Bakti D, Kuswardani RA and Chairani H 2016 *Potato Intercropping Design to Suppress Pest Infestation in Organic Farming Systems* Disertation pp 213
[14] Chakraborty D and Korat DM 2014 Biology morphometry and feeding potential of Coccinella transversalis fabricious *Thebioscan* **9**(3) pp 1101−5
[15] Ali A, Rizvi PQ and Pathak M 2009 Reproductive performance of Coccinella transversalis fabricius (Coleoptera: Coccinellidae) on different aphid species *Biosystematica* **3**(1) pp 37−41
[16] Udiarto BK, Hidayat K, Rauf H, Pudjianto and Hidayat SH 2011 Kajian potensi *Coccinellidae* predator untuk pengendalian *Bemisia tabaci* (Gennadius) pada tanaman cabai merah [Study of the potential of *Coccinellidae* predators for controlling *Bemisia tabaci* (Gennadius) on red chili plants] *Jurnal Hortikultura* **22**(1) pp 76−84
[17] Bukero A, Lanjar AG, Solangi AW, Memon AA, Thebo G, Nahyo SA and Riaz AB 2014 Voracity rate and development period of *Coccinella transversalis* (Fabricius) on three aphid species *Sci Int (Lahore)* **26**(5) pp 2255-7
[18] Singh K and Singh NN 2014 Biology and devouring propensity of lady bird beetle *Coccinella septempunctata* Linnaeus on repessed mustard aphid, lipaphis erysimi Kaltenbach *African Journal of Agricultural* **9**(1) pp 61-4
[19] Pervez A and Omkar 2005 Functional responses of *Coccinellid* predators: an illustration of a logistic approach *Journal of Insect Science* **5**(5) pp 6
[20] Navodita M, Pervez A, Kumar A and Ramteke AM 2011 Duration of development and survival of larvae of C*occinella transversalis* fed on essential and alternative foods *European Journal of Environmental Sciences* **1**(1) pp 24-7
[21] Kuldeep S and Singh SS 2014 Biology and devouring propensity of lady bird beetle *Coccinella septempunctata* Linnaeus on rapeseed mustard aphid *Lipaphis erysimi* Kaltenbac *African Journal of Agricultural Research* **9**(1) pp 61-4
[22] Efendi S, Yaherwandi and Nelly N 2018 Biology and demographic statistics of *Coccinella transversalis* Thunberg (Coleoptera:Coccinellidae) the predator of aphis *Gossypii Glover* (Homoptera:Aphididae) *Jurnal Perlindungan Tanaman Indonesia* [*Indonesian Journal of Plant Protection*] **22**(1) pp 91-7
[23] Hesler LS, Ginger MN, Michael AC, Jhon EL, Eric AB, Leobard S, Damielle MB and Pamella BB 2012 Method for continuously rearing *Coccinella lady* Beetles (Coleoptera: Coccinellidae) *The Open Entomology Journal* **6**(2012) pp 42-8
[24] Elekcioğlu NZ 2020 Species composition of Coccinellidae (Coleoptera) and their preys in Adana (Turkey) with observations on potential host medicinal and aromatic plants Applied *Ecology and Environmental Research* **18**(1) pp 369-88
[25] Lyla KR, Sheena and Bhasker H 2008 Biology and feeding preference of the coccinellid predator *Coccinella transversalis* Fab. *Insect Environment* **14**(2) pp 75-6
[26] Kalshoven LGE 1981 *Pests of Crops In Indonesia* (Jakarta: Ichtiar Baru- Van Hoeve) pp 398- 410
[27] Omkar and James BE 2002 Influence of prey species on immature survival, development predationand reproduction of *Coccinella transversalis* Fabricius (Col. Coccinellidae) *J Appl Ent* **128**(2) pp 150–7

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12 Bottenberg, H., and M. E. Irwin. "Canopy Structure in Soybean Monocultures and Soybean--Sorghum Mixtures: Impact on Aphid (Homoptera: Aphididae) Landing Rates", Environmental Entomology, 1992.
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