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Life table of *Bracon hebetor* say. (Hymenoptera: Braconidae) reared on different hosts

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Abstract: The life table parameters of *Bracon hebetor* adult were studied when reared on three different hosts *Galleria mellonella* (The greater wax moth), *Ephestia kuehniella* (The Mediterranean Flour Moth) and *Corcyra cephalonica* Stainton (Rice moth). The statistical analysis of the data revealed that the host had great impact on some biological parameters of the parasitoid. The developmental time was significantly shortened when parasitoid reared on *G. mellonella*. The total number of eggs deposited by female of *B. hebetor* reached its maximum of (395.11 eggs) on *G. mellonella* comparing to (93.5 and 56 eggs) on E. kuehniella and *C. cephalonica* respectively. Similarly the finite rate of increase (λ) and the intrinsic rate of increase (rm) revealed significant differences among the tested hosts. Our results proved that Net reproduction rate of the parasitoid was (R0=152.7) which represent nearly 153-fold increase in generation time (T) 18.27days when reared on *G. mellonella*.

Key words: *Bracon hebetor*, life table parameters, developmental time.

Introduction

The increasing attention for environmental safety and global demand for pesticide free food necessitated the search for eco-friendly methods of pest management. As a result, interest in biological control has increased considerably as a response to the various effects of pesticides on the environment and as a result of new international trends, which favours conservation and the sustainable use of biological resources. Researchers on biological control have recognized interactions between parasitoid and host to ensure the success of biological control programs[1, 2] . *Bracon hebetor* (Say) is considered one of the potential biological control agents; it is a gregarious ectoparasitoid, which completes its larval development on different species of Lepidoptera host larvae, especially larvae of Pyralidae (Lepidoptera) larvae [3], and having been introduced in successful IPM programmes. Most of the species of Pyralidae are agricultural pests on some field crops and storage crops. The most important species of those insect pests are *Ephestia kuehniella* (Z.), *E. cautella* (Walk), *Galleria mellonella* (L.), *Achroia grisella* (F.), *Helocoverpa armigera* and *Corcyra cephalonica.*

The efficiency of biological control depends upon the ability of the production of relatively inexpensive biological control agents of insect pests. The production of beneficial insects, especially parasitoids, has improved substantially in recent years[4].

The life table is one of the tools, used in quantitative analysis and in estimation of populations. So the present study was mainly focused on the effect of different hosts on the developmental time, longevity, fecundity and life table parameters of *B. hebetor*. The aim was to find the most suitable hosts for rearing *B. hebetor* to use as effective biological control agent.

Experimental

Experimental conditions:

All experiments were carried out under controlled condition maintained at 28 ± 2 ^{o}C, 65 ± 5 % RH and 16:8 (L: D) photoperiod.

Insects culture:

Bracon hebetor:

The population of *B. hebetor* adults were used in this study originated from Desert Research Centre in Egypt, which was collected from Egyptian fields[5]. The parasitoids have been maintained in the laboratory with most rearing on *Galleria mellonella***.**

Galleria mellonella (Greater wax moth)

Adults of *G. mellonella* released in plastic jars (10 X 20 cm) for mating and comprised folded sheets for the deposition and collection of eggs. The hatched larvae were reared on a semi-natural diet according to [6]. These jars were incubated under the previously conditions till larvae reached the last instars.

Ephestia kuehniella (The Mediterranean Flour Moth)

E. kuehniella adults were obtained from infested flour. Newly emerged adults of *E. kuehniella* were collected and transferred to plastic containers containing cotton swabs soaked with 10% sugar solution[7]. The mouth of the container was wrapped with a plastic mesh [8] using a rubber band and inverted on a loosely affixed lid. Eggs laid were collected daily and transferred to rearing containers s provided with 200 mg of artificial diet according to [9].

Corcyra cephalonica (The rice moth)

C. cephalonica moths were obtained from naturally infested grains stored in a local warehouse. The collected moths held in 500 ml beakers half filled with wheat germ (97%) and yeast (3%) [10].

Experiment:

A newly emerged adults of *B. hebetor* were paired (male and female) in glass tube (2 cm diameter; 10 cm height). A small drop of honey was put on the tube wall as food. Release a full grown larva of each tested host individually into each tube and allowed the parasitoid to attack and oviposit on a host larva.

Every day the parasitoids were transferred to a new tube with their corresponding host larva. When the male was found to be dead, it was replaced by a male of similar age.

Total number of daily laid eggs and longevity of female and male *B. hebetor* adults were recorded.

The tube containing eggs of the parasitoid was held further at the same conditions, the developmental time of each stage was recorded. The life table data obtained from daily observations of immature and adult stages.

Twenty replicates were carried out for each tested host.

Data Analysis:

The duration of each stage, egg-to-adult, adult longevity, and fecundity of females were subjected to analysis of variance (ANOVA) using SPSS computer program; means were compared using Duncan's Multiple Range Test.

The data of life history of all individuals of this study were analyzed according to the age-stage, two-sex life table [11] and the method described by[12]. The means and standard errors of the population parameters were estimated with Jackknife method[13]. The Computer program, TWOSEX-MSChart[14], was used to facilitate analysis the data of life table, and the Jackknife method. It is available at http://140.120.197.

173/Ecology/download/TWOSEX-MSChart.zip (National Chung Hsing University, Taiwan) and http:// nhsbig.inhs.uiuc.edu/wes/chi.html (Illinois Natural History Survey, Urbana, IL).

The age-stage-specific survival rate (S_{xj}) (where x is the age and j is stage), the age-stage-specific fecundity (f_{xj}), the age-specific survival rate (l_x), the age-specific fecundity (m_x), were calculated from the daily records of the survival and fecundity of all individuals in. And the population parameters (r_m, the intrinsic rate of increase; λ, the finite rate of increase; *R0*, the net reproductive rate; *T*, the mean generation time is the time length that a population needs to increase to *R0* times of its size as the stable age distribution and the stable increase rate are reached Thus, it is calculated as $T = \ln R0/r$) was calculated accordingly.

In this studied, the intrinsic rate of increase was estimated by the iterative bisection method from the Euler-Lotka formula.

$$\sum_{x=0}^{\infty} e^{-(x+1)} lxmx = 1$$

Results and Discussion:

Results obtained in the present study assure that the hosts had significant effect on the developmental time of parasitoid; incubation period of eggs was shortest in case of *C. cephalonica* followed by *G.mellonella* (1.3 and 1.33 days respectively) while [15] registered the egg period of *B. hebetor* (0.9 and1.12days respectively) on *C. cephalonica*, *G.mellonella*. Significantly, short time was required to complete its immature stages in case of *G.mellonella* in comparison to rest of the host larvae used (Table 1).

Table (1): Mean duration (in days) of different developmental stages of *B. hebetor* reared on different hosts

Hosts	Incubation period	larval stage	Pupal stage	Total immature stage
G. menollela	1.33±0.089 a	2.07±0.07 b	5.89 ±0.13 b	9.42±0.20 b
E. Kuehniella	1.55±0.0979 a	2.56±0.11 a	6.79±0.15 a	11±0.03 a
C. cephalonica	1.3±0.053 a	2.51±0.1 a	6.57±0.2 a	10.47±0.21 a
F Sig	2.722* 0.093	7.8** 0.004	8.2** 0.003	20.340** 0

Means in a Column followed with the same letter(s) are not significantly different at 5% level of probability.
**= Highly significant *= significant

Male or female longevity of *B.hebetor* (9.2±0.66 and 19.11±1.8 days respectively) was longer when reared on *G.mellonella* hosts than other hosts. The Longevity of male was shorter than females at all hosts (Table 2), Similar results was reported by [16], and [17] on *Plodia interpunctella* HUbner and *E. cautella* respectively. On other hand that was in accordance with[18] where male longevity, female longevity was also found to be highest in case of *C. cephalonica* (15.28 and 44.30 days respectively).

Table (2): Mean longevity (in days) of adult stages of *B. hebetor* reared on different hosts.

Hosts	Female Longevity	Male Longevity
G. menollela	19.11±1.8 a	9.2±0.66 a
E. Kuehniella	13.8±0.7 b	7.6±0. 6 a
C. cephalonica	9.7±0.71 b	8.2±0.6 a
F	12. 67**	1.6*
Sig	0	0.239

Means in a Column followed with the same letter(s) are not significantly different at 5% level of probability. **= Highly significant *= significant

The type of host also had a great impact on the fecundity of *B. hebetor*, where daily and total deposited eggs were significantly higher when reared on *G.mellonella*, on the other hand it significantly less on *Ephestia kuehniella* and *C. cephalonica* (Table 3), this disagreed with [19] who found that progeny production more on *E.*

vittella and *C. Cephalonica*, and with [18] who recorded that significantly highest fecundity was registered in case of *C. cephalonica.*

Table (3): Mean of total and daily deposited eggs of *B. hebetor* reared on different diets.

Hosts	Total Eggs	Daily
G. menollela	395.11±79.7a	19.31±2.9 a
E. Kuehniella	93.5±8.11 b	6. 9±0.8 b
C. cephalonica	56.0±6.3 b	5.8±0.58 b
F	11.44**	13.309**
Sig	0.001	0

Means in a Column followed with the same letter(s) are not significantly different at 5% level of probability. **= Highly significant

Table (4) Life table parameters (mean ± SE) of *B. hebetor* reared on different hosts.

Hosts	The intrinsic rate(*rm*)	the finite rate of increase (*λ*)	the net reproductive rate (*R0*)	the mean generation time (*T*)
G. menollela	0.2784±0.0195	1.3225±0.0252	152.7±50.92	18.27±0.48
E. Kuehniella	0.1816±0.0224	1.2013±0.0263	24.67±8.83	18.02±0.39
C. cephalonica	0.1942±0.0237	1.2133±0.0285	30.6±12.12	18.09±0.5

The data of Life table parameters was detailed in (Table 4). Our resulted registered that parameter of Life table varied significantly with parasitoid hosts. A significant difference was observed in intrinsic rate of increase (r_m). When parasitoid reared on *G. mellonella* (r_m=0.2784/ female /day) that was higher than that recorded by [20] (r_m= 0.15) when reared *B. hebetor* on the same host.

The intrinsic rate of increase was (r_m=0.1816) on *E. kuehniella*, that was not matched with [21, 22] (0.137 and 0.269 respectively). Also, disagree with current study was done by [23-24] reared *B. hebetor* on *Corcyra cephalonica* Staint and recorded r_m (0.215and 0.27521) respectively.

The finite rate of increase (λ) was 1.2133 female daughters / female / day; when reared on *C. cephalonica* while[24] recorded (λ= 1.3168) when reared *B.hebetor* on the same host at 30 ^{0}C.

The net reproduction rate (R_0) of parasitoid reached the maximum value of 152.7 times of multiplication within the generation time (*T*) of 18.27 days on *G .mellonella,* while the parasitoid multiply (24.67 and 30.6 times) during nearly the same generation time on *E. kuehniella* and *C. cephalonica* Staint respectively. Other studies have reared parasitoid on different hosts [16] recorded net reproduction rate (R_0= 136.21) when reared *B.hebetor* on *Plodia interpunctella.*

The results in (Fig. 1) showed that the age-stage specific survival rate (s_{xj}), the probability that a newly deposited egg of *B. hebetor* will survive to age *x* and develop to stage *j*. The overlap of stages during the developmental period can also be observed during stage differentiation among the tested individuals. It indicated that the longevity of female parasitoid was longest on *G. mellonella* which present up to 40 days while male to 20 days. The female age-stage specific fecundity (f_{xj}) is plotted in (Fig. 2), it referred to the daily mean number of fertile eggs produced by *B. hebetor* of age *x* and stage *j*. The female only of parasitoid can produce offspring; so there is only a single curve of the female age-stage specific fecundity (f_{xj}). When all individuals of age *x* are included, it is expressed as the age-specific fecundity of the total population (m_x), (Fig. 3). The ages specific survival rate (*l x*) is a simplified curve of (*sxj*) of all stages of parasitoid on each hosts, which describes the change in the survival rate of the population with age (Fig. 4). The highest peaks for (f_{xj}) and (m_x) were observed on *G. mellonella.* From the aforementioned results, can conclude that the hosts affect the biology of the *B. hebetor*. *G. mellonella* is considered more suitable hosts for the parasitoid than the others hosts.

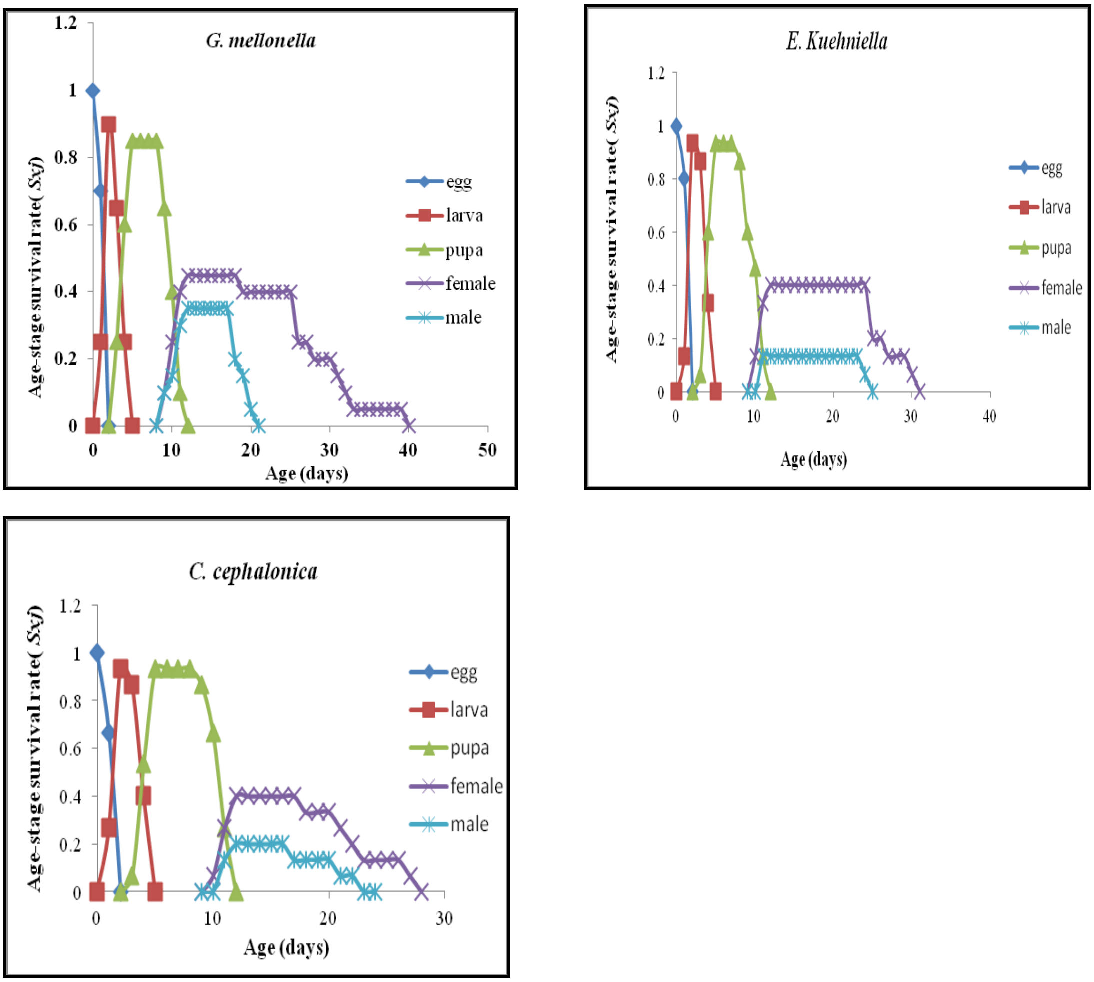

Fig (1) Age-stage specific survival rate (*sxj*) of *B. hebetor* reared on different

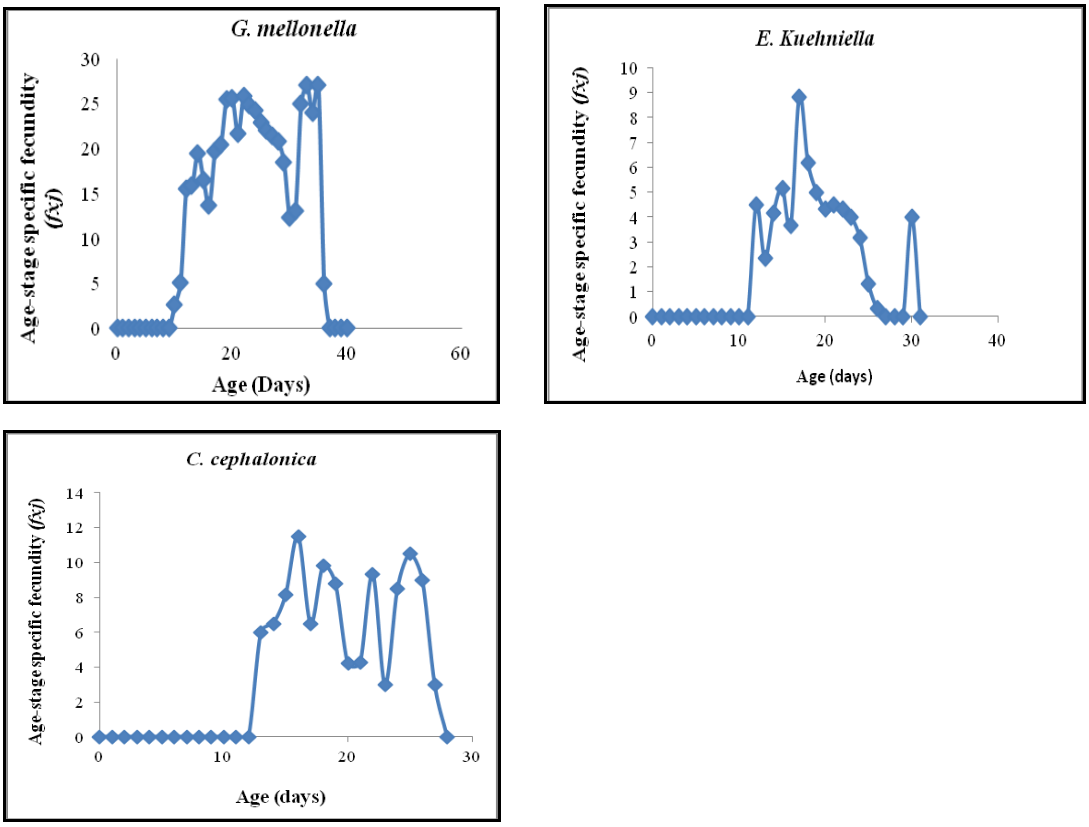

Fig.(2) The age-stage specific fecundity (f_{xj}) of *B. hebetor* reared on different hosts

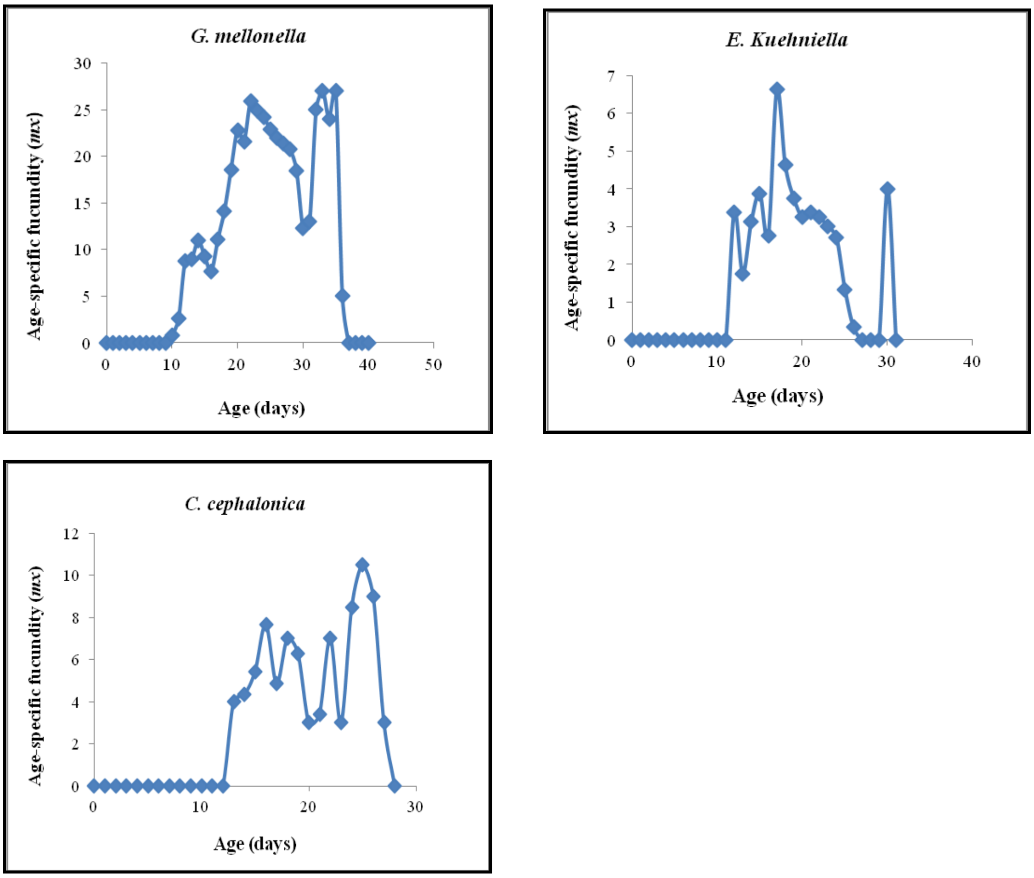

Fig. (3) Age-specific fecundity of the total population (*mx*) of *B. hebetor* reared on different hosts

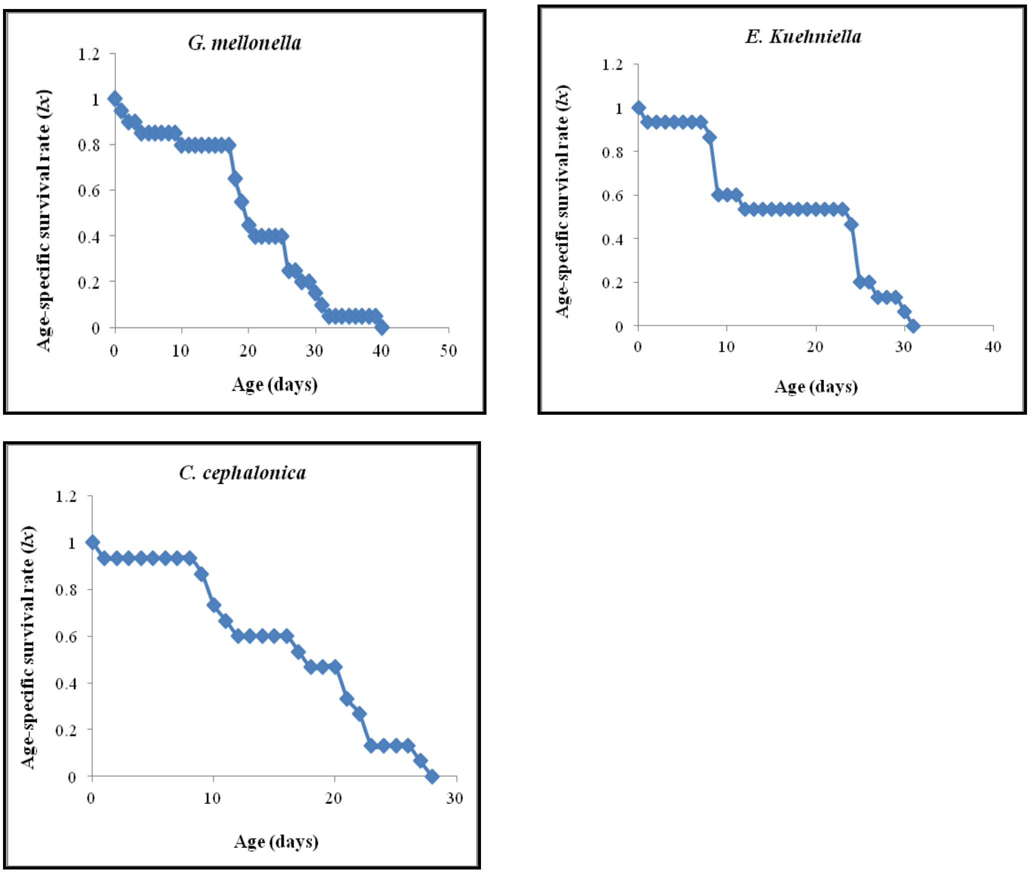

Fig.(4) Age-specific survival rate (*lx*) of *B. hebetor* reared on different hosts

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