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Original Research Article

Seasonal Variation of the Population of *Ootheca mutabilis* Sahlberg (Coleoptera: Chrysomelidae) on the Cowpea (*Vigna unguiculata* L.) in Adzopé, South of Côte d'Ivoire

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Abstract: *Ootheca mutabilis* which was considered as a minor pest of cowpea (*Vigna unguiculata* L. Walp) causes nowadays significant damages to this crop. In a perspective control of *Ootheca mutabilis* population, a monitoring of its population was conducted during two periods of time(from May 2014 to February 2015 and from May 2015 to February 2016) in Adzopé, south of Côte d'Ivoire. The catches were made twice a week to different phenological stages in traps made of yellow plates placed on racks placed at plant's height. The observations revealed the presence of adults of *O. mutabilis* crops grown during the different seasons of the two periods. Every season, the mean number of insects per subplot registered at the stage before flowering was higher than that of flowering. The mean number of insects harvested at fruiting stage was the lowest. During the cycle of cowpea, the highest mean numbers varying from 8.33±0.33 to 41.67±2.33 were observed at the end of the stage before flowering (41 days after sowing) or at the beginning of fruiting stage (45 days after sowing). The months of June and October that correspond to periods of heavy rainfall (rainy seasons) have recorded the highest mean numbers (31.26±1.09 to 38.33±2.92 adults per subplot). The lowest mean numbers were recorded in the dry season.
Keywords: *Ootheca mutabilis*, *Vigna unguiculata*, Seasons, Phenological stage, Numbers.

INTRODUCTION

Cowpea, *Vigna unguiculata* L. Walp. (Fabaceae) is an important legume in tropical and subtropical regions; particularly sub-Saharan's Africa which provides nearly all of the world production. It is grown annually on 14 million hectares with an annual production more than 4.5 millions tones [1]. These seeds constitute an important source of proteins that can fill the gaps in animal proteins of foods rations in sub-Saharan countries. Besides, cowpea is an important source of incomes for farmers in West Africa [2]. It is estimated that in Africa, 200 millions of people consume cowpea daily as a staple food [3]. Unfortunately, cowpea knows more and more difficulties that affect it level of production which are the diseases and pests. Among the pests, the insects which cause the most damage to the plant are: *Maruca vitrata* (Lepidoptera: Crambidae) *Megalurothrips sjostedti* (Thysanoptera: Thripidae) *Clavigralla tomentosicollis* (Heteroptera: Coreidae) and *Aphis craccivora* (Homoptera: Aphididae) [4]. Previous studies conducted in south of Côte d'Ivoire in 2004 by Seri-Kouassi on cowpea insect fauna revealed the presence of several insect pests in which it is included *O. mutabilis*. In fact, this insect considered minor pest was found in recent years as a major pest of cowpea. Its attacks have caused a decline of the production in the Democratic Republic of Congo [5], Sierra Leone [6], and Nigeria [7]. In Côte d'Ivoire, the literature does not mention any study on *O. mutabilis* which tends to become a major pest of cowpea. The objective of this work is to study the abundance of this insect according to the phenological stages during four seasons (two dry seasons and two rain seasons) in order to establish an effective control method against this pest.

MATERIALS AND METHODS

Study area

The study was conducted in the locality of Adzopé (Latitude: 6°10' N and longitude: 3°87'W) located in the south of Côte d'Ivoire. The relief is marked by hills and valleys more or less accentuated rarely exceeding 100 m. The sub-equatorial climate is characterized by four seasons [8, 9]: a long dry season from December to March; a long rainy season from April to mid-July; a small dry season from mid-July to mid-September; a small rainy season, from mid-

September to November. The studies took place with average temperatures varying from 24.7 to 28.6° C, relative humidity ranging between 74.4 – 90.4% and total rainfall of 1976.12 mm.

Materials

The plant material used is the variety "Touba" of cowpea (*Vigna unguiculata* L. Walp). This local variety is the best adapted to the climatic conditions of the south of Côte d'Ivoire. The animal material was composed of adults of *O. mutabilis* captured on the experimental plot.

Methods

Experimental field and implementation of cultures

The size of the experimental plot was 322.4 m² with 24.8 m at length and 13 m at wide. It was a Randomized Complete Block Design (RCBD) with three replications. It is divided into three blocks distant of two meters. Each block consisted of three subplots each measuring 5.4 m length and 3 m wide. Two consecutive subplots are separated by one meter. In each subplot, seedlings are arranged in six rows of 5.4 m length separated from each other by an interval of 0.6 m. The agricultural practice used is the seedling planting hole with a spacing of 0.60 m between the lines. Thinning to one plant by hole was realized 15 days after sowing [10, 11]. Each subplot was composed of 60 cowpea plants. The first weeding was done 15 days after sowing. No phytosanitary treatment was applied. The cultures were made during two periods: from May 2014 to February 2015 and from May 2015 to February 2016. At each period, four cultures were carried out during different seasons. The average time of the cycle variety used is 70 days.

Trapping

The trapping method used was that of colored traps. They were composed of three yellow plastic plates (22 cm at diameter and 8 cm at depth) arranged on three racks of a trap at different grade levels of soil: 10; 30 and 50 cm. These traps are placed in the center of the subplot in equilateral triangle form [12, 13] distant of two meters side (Figure 1). In total, 9 yellow traps were placed in subplots selected randomly (one subplot per block).The plates were filled up with soap water twice a week at 9 am, from 20th to 73rd day after sowing. The interval between the 2 days of the week selected for filling up the plates is four days. The content of the plates was emptied 24 hours later, and then *O. mutabilis* adults were counted. In order to study the evolution of numbers of *O. mutabilis* during the different months, eight surveys (twice a week) were carried out per month on three other subplots (one subplot per block). Then, the mean numbers of *O. mutabilis* captured per subplot per month were calculated.

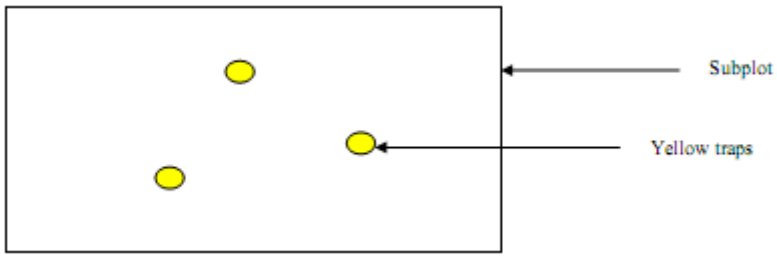

Fig-1: Arrangement of yellow traps on a subplot

Statistical Analysis

All data processing was performed using statistical software version 7.1. An analysis of variance (ANOVA) revealed significant differences between the data; the test Student Newman –Keuls at 5% was used for to separations the means.

RESULTS

Mean numbers of adults of *O. mutabilis* captured during different seasons following three phenological stages.

The mean numbers of adults trapped per subplot at stages before flowering of the grown crops in different seasons were higher than those of the two other phonological stages. During the period from May 2014 to February 2015, these mean numbers at stages before flowering were ranged between 77.33 ± 1.20 to 162.33 ± 3.48 and the lowest numbers recorded at fruiting stage have varied from 6 ± 1.15 to 45 ± 5.51 adults (Figure 2A). During the period of May 2015-February 2016, the mean numbers at stages before flowering were ranged between 177.33 ± 2.73 and 41.33 ± 0.88 and the lowest numbers recorded at fruiting stage ranged between 10.67 ± 0.88 to 83.67 ± 2.03 adults (Figure 2B). Statistical analysis showed significant differences between the mean numbers recorded at different phenological stages during the four seasons of the period of May 2014- February 2015 ($F= 111.08$; $ddl = 11$; $P< 0.001$) and of the period of May 2015- February 2016 ($F=53.81$; $ddl = 11$; $P< 0.001$).

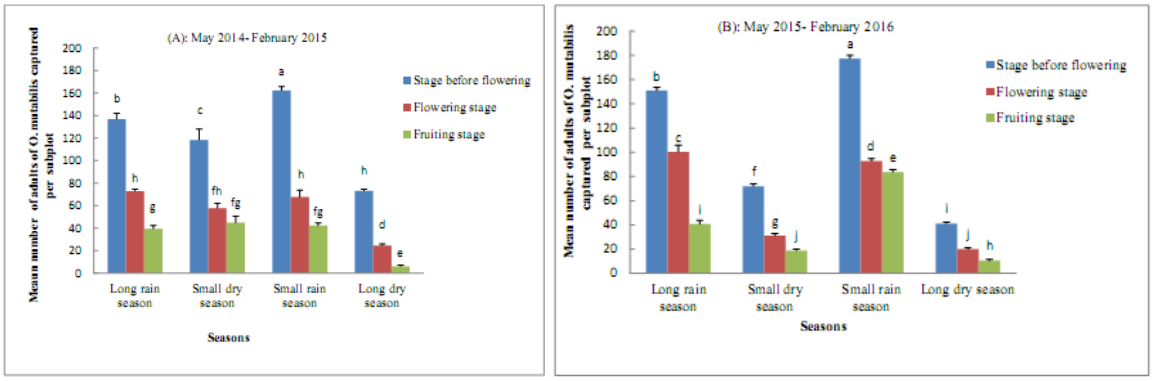

Fig-2: Mean numbers of adults of *O. mutabilis* captured following phenological stages in different seasons. A: from May 2014 to February 2015; B: from May 2015 to February 2016

Evolution of mean numbers of adults of *O. mutabilis* following phenological stages in different seasons.

Long rainy season

The mean number of adults captured per subplot has gradually increased during the stage before flowering. During the period from May 2014 to February 2015, the highest mean number (33 ± 3.21 adults per subplot) was recorded at 41st Days after sowing (DAS) corresponding to the end before flowering. This mean number has then decreased for to reach 23.67 ± 2.40 adults at 52nd DAS (flowering). Then, the mean number of adults has strongly decreased for to reach 2 ± 0.58 adults per subplot at 73rd DAS (ripening pods). During the period from May 2015 to February 2016, the highest mean number was recorded at 45th DAS (early flowering) with 41.67 ± 2.33 adults per subplot. The mean number has gradually decreased for to reach 3 ± 0.58 adults per subplot at 73rd DAS (ripening pods). The analysis of variance revealed highly significant differences between the mean number recorded during the period from May 2014 to February 2015 (F = 30; df = 15; P <0.001) and between those recorded in the period from May 2015 in February 2016 (F = 53.81, df = 15, P <0.001) at various days after sowing (Figure 3).

Small dry season

During the period from May 2014 to February 2015, the mean number of adults captured per subplot has varied from 14 ± 1.00 to 20 ± 2.08 at the stage before flowering. The highest mean number (21 ± 1.15 adults per subplot) was recorded at 45th DAS (beginning of flowering) and then decreased gradually for to reach 2 ± 0.58 adults per subplot to the 73 rd DAS (ripening pods).During the period from May 2015 to February 2016, the highest mean number (17.33 ± 0.33 adults per subplot) was recorded on the 41st DAS (end before flowering) following to a gradual increase of the mean number at the stage before flowering. This mean number has decreased during the fruiting stage for to reach 0.67 ± 0.33 adults per subplot to the 73rd DAS (ripening pods).The statistical analysis showed highly significant differences between the mean numbers recorded during the period from May 2014 to February 2015 (F = 5.12; df = 15; P <0.001) and between those recorded in the period from May 2015 to February 2016 (F = 40.62, df = 15; P <0.001) at various days after sowing (Figure 3).

Small rainy season

At the period from May 2014 to February 2015, the highest means number were recorded at the 24, 38, 45th DAS with respectively 29.33 ± 1.45; 28.33 ± 33 ± 1.76; 30.33 ± 1.85 adults per subplot. The mean number has gradually decreased from 45th DAS (beginning flowering) to the 73rd DAS (ripening pods) for to reach 2.67 ± 1.45.During the period of May 2015 to February 2016, the mean number recorded at20thDAS was 17 ± 1.15 adults per subplot. This number has increased gradually for to reach 29.67 ± 2.03 adults at the end of the stage before flowering (41st DAS). The highest mean number was recorded at 45th DAS (beginning flowering) with 35.33 ± 0.88 adults per subplot. This mean number has decreased gradually, reaching 13.67 ± 0.88 adults at 73rd DAS (ripening pods).The statistical analysis indicated highly significant differences between the mean numbers recorded during the period from May 2014 to February 2015 (F = 25.44, df = 15; P <0.001) and those of the period from May 2015 to February 2016 (F= 24.73; df = 15 ; P< 0,001) at various days after sowing (Figure 3).

Long dry season

During the period from May 2014 to February 2015, the mean number of adults captured by the subplot at 20th DAS was 6.67 ± 0.67.The mean number has increased to 14.67 ± 0.33 adults at 41st JAS (end before flowering) and then decreased gradually to reach only 0.33 ± 0.33 adults per subplot at 73rdDAS (ripening pods).During the period from May 2015 to February 2016, the highest mean number also recorded at 41st DAS (end before flowering) was 8.33 ± 0.33 adults per subplot. This mean number has dropped for to reach (0.33 ± 0.33) adults per subplot at 73rd DAS (ripening pods). The analysis of variance showed highly significant differences between the mean numbers

recorded in the period from May 2014 to February 2015 (F = 31.43, df = 15; P <0.001) and between those recorded in the period from May 2015to February 2016 (F = 11.58, df = 15; P <0.001) at various days after sowing (Figure 3).

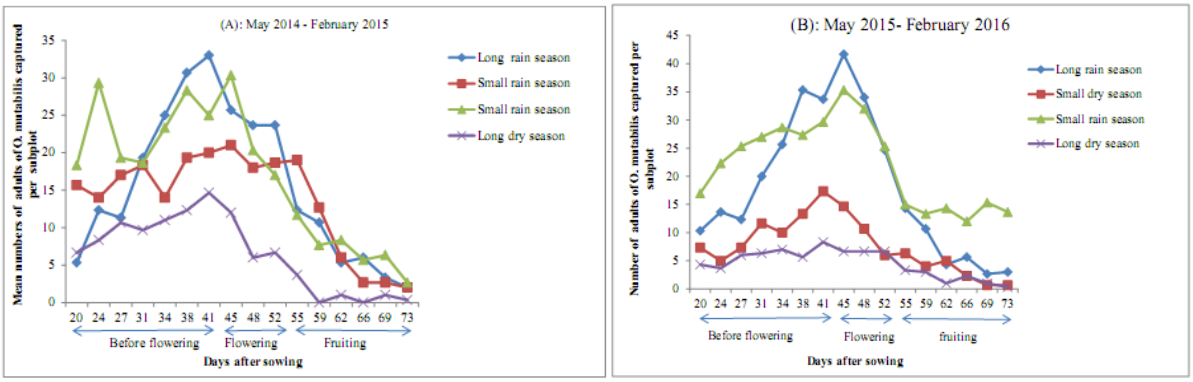

Fig-3: Fluctuations of number of *O. mutabilis* captured at various days after sowing (DAS) in the four seasons. A: from May 2014 to February 2015; B. and from May 2015 to February 2016

Variation of mean number of *O. mutabilis* during the period from May 2014 to February 2015

The mean number of adults captured in May 2014 which was 19.25±1.09 increased to reach its peak of evolution (35.62±1.49 adults) in June 2014. Then, this number has decreased reaching 17.20±1.35 adults in July. A new decreased was recorded in October and November 2014 varying from 31.26±1.09 to 14.21±0.79 adults. The number of *O. mutabilis* which was 4.62±0.59 adults in December decreased to reach 1.37±0.48 adults in February 2015. The Analysis of the ombrothermic curve indicated December, January and February correspond to the dry season with average temperatures ranged between 27.5 and 28.6 ° C and rainfall from 0 to 76.60 mm. The months of June and October that correspond to periods of heavy rainfall (rainy seasons) with respectively 327.4 and 168.8 mm have recorded the highest numbers (35.62±1.49 and 31.26±1.09 adults). The analysis of variance revealed highly significant differences between the mean numbers of *O. mutabilis* during different months (F = 142.48; df = 9; P =0.00) (Figure 4).

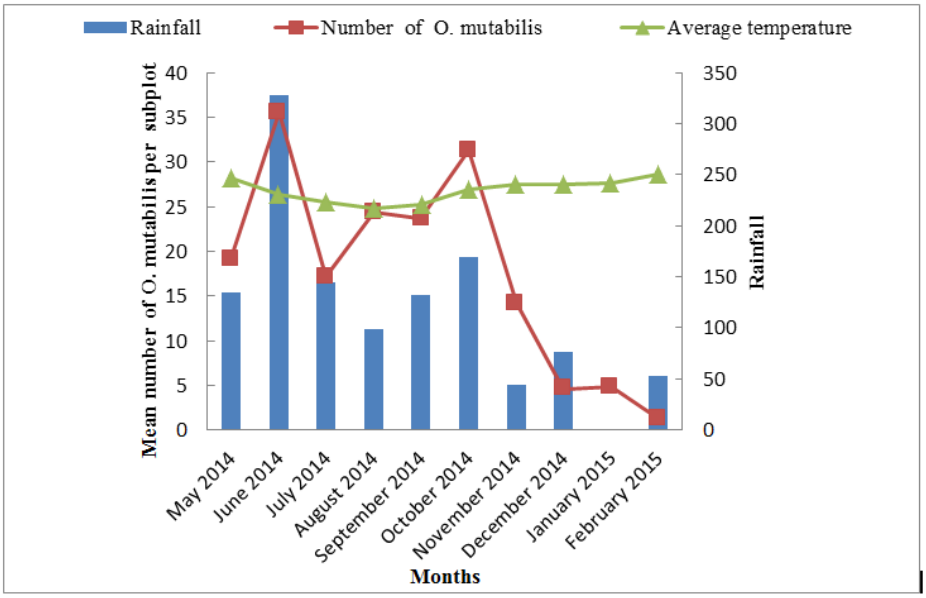

Fig-4: Fluctuation of *O. mutabilis* population during the period from May 2014 to February 2015

Variation of mean number of *O. mutabilis* during the period from May 2015 to February 2016

The highest mean numbers were recorded in June 2015 (36.42 ± 2.27 adults per subplot) and October 2015 (38.33±2.92 adults). These months correspond to periods of heavy rainfall (212.8 and 243.5 mm) and lower temperatures (26.5° C and 26.3° C). The lower mean number per subplot ranged between 1.62±0.60 to 18.70±0.82 adults were obtained in the months of July, August, December 2015, January and February 2016.

The analysis of ombrothermic curve showed that these months correspond to the dry seasons with average temperatures ranged between 24.7 and 28.2 ° C and lowest rainfall from 11 to 35.3 mm. The highest mean numbers were observed in rainy season and the lowest mean numbers in the dry season. The analysis of variance revealed highly significant differences between the mean numbers of *O. mutabilis* (F = 69.99; df = 9; P = 0.00) (Figure 5).

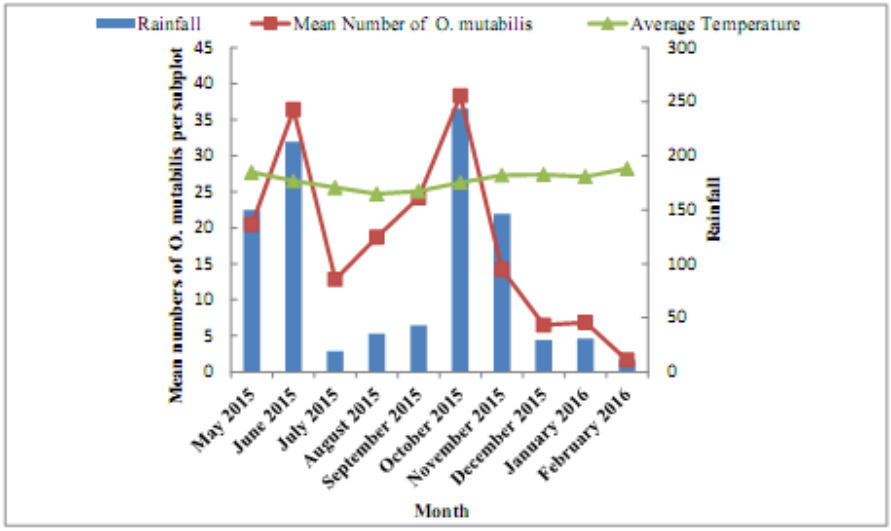

Fig-5: Fluctuation of *O. mutabilis* population during the period from May 2015 to February 2016

DISCUSSION

The mean number of adults of *O. mutabilis* captured per subplot has varied following phenological stages. During the different seasons, the mean numbers of *O. mutabilis* obtained at the stage before flowering were higher than the two other phenological stages. These high numbers are justified by the fact that the stage before flowering maybe the stage in which *O. mutabilis* is attracted in large numbers by the substances emitted by the host plant. This argument is similar to those of [14, 15] who indicated that the host plant develops substances which attract insects. Our results corroborate those of [5] who revealed high numbers of *O. mutabilis* at the stage before flowering of three varieties of cowpea. For these authors, these high numbers are due to the stage before laying where females are actively and imperatively eat. For each season, the low numbers registered at the fruiting stage is due to the advanced age of the plants that should have more lignified leaves and so very difficult to be consumed. Insects would then have left the plot in search of more nutritious host plant. These results are in agreement with those of [16] who noted a gradual decrease of flea beetles (*Podagrica decolorata* and *Nisotra dilecta*) on the cultivation of okra because of the advanced age of the plant. These results are similar to those of [17] who reported that the small number of larvae *Leucinodes orbonalis* on the plants of eggplant at the end of the cycle is due to their ageing. During the crop grown in the long rain season, gradually increasing the number of adults of *O. mutabilis* trapped at the stage before flowering could be explained by the fact that the culture began several weeks after the first rains. The beetles have left them to other hosts and / or weeds to colonize progressively the plot. The highest recorded mean number at 41st DAS coincides with the end of the stage before flowering variety of Touba with a large number of leaves. This study results rejoin those of [18] who indicated that there before flowering cowpea an accelerated growth phase with a high biomass production and growth in plant height. The high mean number of adults of *O. mutabilis* at 45th DAS coinciding with the flowering stage is due to the significant presence of foliage and flowers. A small dry season, the mean number was low compared to those of the rainy season. During the small rain season, the high mean number of adults of *O. mutabilis* registered on 24, 38, 45th DAS during the period from May 2014 to February 2015 and the high effective at period from May 2015 to February 2016 could be explained by the fact that abiotic factors especially the rain would have favored the emergence of adults. During the dry seasons (from May 2014 to February 2015 and from May 2015 to February 2016), the low numbers recorded are due to unfavorable weather conditions at the pululation of *O mutabilis*. Indeed, during this period, high temperatures and declining precipitation levels have caused the departure of individuals in the plot to other host plants or weeds or caused a death in the population of the pest. This argument is similar to that of Hala *et al*. [19], who mentioned that the high temperatures and low hygrometries reduce beetle populations.

During the two periods (from May 2014 to February 2015 and from May 2015 to February 2016),

the highest monthly mean numbers of *O. mutabilis* were recorded in June and October respectively in the long and small rainy seasons. These months correspond to periods of heavy rainfall and lower temperatures. The rains would have improved the growth and development of cowpea plants during rainy seasons and adults were attracted in large numbers by these plants. These results are similar to those of [20, 19] which indicated that the rain indirectly influences fluctuations of flea beetles that are attracted to plants with young and abundant foliage. These results are similar to those of [21] who reported that the rain creates favorable conditions in the population fluctuations of *Eulophonotus myrmeleon* cocoa stem borer. The high numbers could also be explained by the fact that rainfall would have resulted in the emergence of adults of *O. mutabilis* ground. Indeed, the work done by [22] reported that the insect life cycle takes place in the soil and adults emergence coincides with the first rains. For this author, the teneral adult can undergo diapause until the onset of the rain season. The low monthly numbers recorded during dry spells and high temperatures could be explained by the fact that the plants during this period are poor in nutrients and less attractive substances for *O mutabilis*.

CONCLUSION

The study of the seasonal variation in the population of *O. mutabilis* showed that the number varied depending on phenological stages and seasons. The highest numbers of adults were obtained during the stage before flowering. During the season, the number of adults increases gradually to reach a peak at the end of the stage before flowering and flowering. It corresponds to the period when the population level of *O. mutabilis* is highest during the cowpea. A small rainy season, a high number of individuals was recorded. Culture performed at that time would have coincided with the emergence of adults of *O. mutabilis* ground. The lowest numbers were obtained at fruiting stage crops grown during the four seasons of each period. The adults of the pest have been present during the four seasons with higher monthly numbers large and small rainy seasons specifically the months of June and October. The rain is a factor abiotic that would promote the abundance of this insect. These results should to enable establish an appropriate timetable of fight against *O. mutabilis*.

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