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# Water Quality and Plankton Composition of *Amblypharyngodon mola* Monoculture Fish Pond in Bangladesh

Authors

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**ABSTRACT**

*A study was conducted to assess the water quality and plankton composition in Amblypharyngodon mola fish pond for a period of 4 months in Bangladesh. Nine earthen pond each with three treatments, viz. $T_1$, $T_2$ and $T_3$ were stocked with A. mola at the density of 145,000; 73,000 and 36,500 individual $ha^{-1}$, respectively. Water quality parameters such as water temperature, transparency, total alkalinity, pH, dissolved oxygen, Nitrate-nitrogen, ammonia-nitrogen, phosphate-phosphorus and chlorophyll-a of the ponds water were measured. Water quality parameters (except transparency and chlorophyll-a) did not show any significant differences ($P>0.05$) among the treatments. The lowest $PO_4$-P and chlorophyll-a concentration were observed in treatment $T_1$ where 145,000 individual $ha^{-1}$ of A. mola was cultured. Plankton samples were also collected and identified throughout the study period. A total of 38 genera of phytoplankton and 13 genera of zooplankton were identified of which Chlorophyceae (20 genera) in phytoplankton population and Crustacea (9 genera) in zooplankton population were dominant. The mean value of total plankton population ($\times 10^3$ cells $L^{-1}$) were 158.42±53.33, 191.17±62.24 and 240.17±93.37 in $T_1$, $T_2$ and $T_3$ treatments, respectively and contributing to the fish production according to their availability and abundance within the treatment. The study reveals that the rural based farmers can develop an actual mechanism of plankton production in aquatic environment which could be essential necessary for the maintenance of water quality and sustainable development of small scale indigenous fish culture in Bangladesh and other developing countries.*

***Key Words:*** *Amblypharyngodon mola, phytoplankton, zooplankton, Small Indigenous Species (SIS), Vitamin-A*

## INTRODUCTION

Bangladesh is very rich in fish biodiversity. There are more than 260 fresh water fishes available and among these only a few of the larger indigenous varieties mainly carps are under culture (1). More than 50 small fish species play an important role in the national diet of Bangladesh. Sixteen small Indigenous Species (SIS) of fish are given priority for culture (2). Vitamin A deficiency is a declared public health problem in most developing countries and many countries, including Bangladesh have national programs for distribution of vitamin A capsules to children. Among those SIS species *A. mola*, is important to the fish culturists because of high nutritional value and it is most demandable and delicious SIS fish to the people of Bangladesh. The species is the richest source of vitamin A and 90% of the vitamin is present in the eye and viscera (3,4). A medium size *A. mola* has about 2 g of edible protein in its body, which contain 520 IU vitamin-A. This means that *A. mola* together would contribute more than 1500 IU of vitamin-A which is sufficient to save a child from blindness, caused by vitamin-A deficiency (5). Fish perform all their bodily functions in water. Because fish are totally dependent upon water to breathe, feed and grow, excrete wastes, maintain a salt balance, and reproduce, understanding the physical and chemical qualities of water is critical to successful aquaculture. To a great extent water determines the success or failure of an aquaculture operation. Due to their omnivorous and surface feeders characteristic they are able to feed themselves by grazing on phytoplankton blooms. Suitable water quality parameters are the prerequisite for aquaculture. Culture of fish and other commercially important aquatic organisms are completely dependent on the different water quality parameters. Proper fisheries management and scientific fish culture are basically dependent on the various information about the water quality parameter of the water bodies. The knowledge of water quality parameters of the water bodies provides an important tool for successful fish production and fisheries management.

In Bangladesh fish culture mainly depends on natural food especially phytoplankton and zooplankton which is produced through fertilization, feeding and fish species management practice in the fish pond. Fertilization and feeding practice enrich the nutrient supply in the aquaculture pond which boost up the plankton community. The actual mechanism of plankton production in aquatic environment is very much necessary for the maintenance of water quality and sustainable SIS culture in Bangladesh. Most of the published references in Bangladesh are based on general limnological survey (6,7). However references on the water quality parameter and plankton community structure in SIS culture ponds are very few. The present study was undertaken the investigation of water quality parameter and plankton community structure of SIS culture ponds in Bangladesh.

## MATERIALS AND METHODS

### A. Experimental sites and nature of trial

The experiment was conducted in nine earthen ponds for a period of 4 months from July to October, 2011 at the Fisheries Field Laboratory, Agricultural University, Bangladesh (Fig. 1). The ponds were rectangular in shape, well exposed to sunlight and completely free from aquatic vegetation. The pond dikes were well protected and covered with grass. All ponds under three treatments were subjected to the same regime of feeding and fertilization. Urea, TSP and cow dung were used at 10 days interval at the rate of 300 g, 300 g and 5000 g per decimal, respectively after stocking.

**FIGURE CAPTIONS**

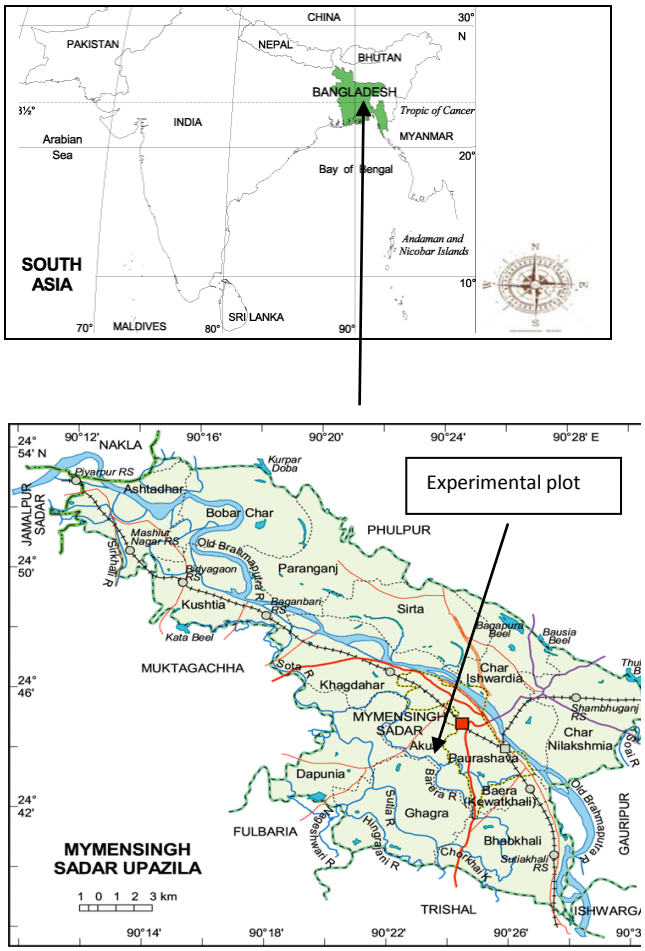


**Figure 1.** Map showing the sampling area at Bangladesh Agricultural University in Bangladesh.

### B. Fish stocking and management

Nine earthen pond each with three treatments, viz. $T_1$, $T_2$ and $T_3$ were stocked with *A. mola* of 1.80±0.24 cm average size at the density of 145,000; 73,000 and 36,500 individual $ha^{-1}$, respectively. At first feeds were supplied twice daily at the rate of 10% body weight (up to 15 days), and reduced to 8% throughout the experiment. Supplementary feeds (nursery feed-1, Aftab feed) were used and purchased from the local market. Half portion of the required food was applied in the morning at 7 AM in feed plate evenly over the surface of the ponds, and the rest half in the evening at 5 PM.

### C. Water quality determination

Physicochemical water quality parameters such as temperature ($^oC$), transparency (cm), dissolved oxygen (mg $l^{-1}$) were measured. Water temperature was recorded with a Celsius thermometer. Dissolved oxygen and pH were measured directly by using a digital oxygen meter (YSI, Model 58) and pH meter (Jenway, Model 3020), respectively. Total alkalinity was determined by methyl orange indicator and standard EDTA solution by titrimetric method (8).

The concentrations of nitrate-nitrogen (mg $l^{-1}$) and phosphate-phosphorus (mg $l^{-1}$) of water samples were determined in the laboratory after filtering the water sample taken from each treatment by using a HACH DR 2000 and reagent pillows of nitrover-5 and phosver-3. Chlorophyll-a (µg $l^{-1}$) was measured from the filter paper (Whatman GF/C) used for filtering the water samples. The filter papers were dissolved in 10 ml acetone and kept overnight, then centrifuged and made ready for the analysis of chlorophyll-a. Later, chlorophyll-a was determined by using a spectrometer (Milton Roy Spectronic, Model 1001) at 664 and 750 nm wavelengths.

### D. Plankton study

For plankton study ten liters of pond water were taken each time from different locations and depths from each pond and were filtered through fine mash plankton net. Filtered sample was taken into a measuring cylinder and a standard volume of 50 ml was made carefully. Then the collected sample were preserved in 10% buffered formalin in a small plastic vials for subsequent studies. For identification, samples were gently shaken to resuspend all materials and allowed to settle for one minute. Then 2-3 drops were removed from the middle of the sample and placed on a glass slide. Taxonomic determination of phytoplankton and zooplankton were performed with a phase contrast microscrope (Olympus, Japan) at X 100 to 400 with bright field and phase contrast illumination on living materials. Quantitative estimation of phytoplankton and zooplankton

were done on a Sedgewick-Rafter counting chamber (S-R cell) following the method described by Stirling (1985) (9). Counting results were expressed as cells per mililitre.

### E. Fish Harvesting

All the ponds were completely harvested after three months of rearing, first by seine netting and then by de-watering the ponds with a drainage submersible pump (Pedrollo 2 HP). The harvested fish were counted and their lengths and weights were measured.

### F. Data analysis

The experiment was set up following the principles of Completely Randomized Design (CRD) and the data were analyzed using the Statistical Package for Social Science (SPSS) version -11.

## RESULTS AND DISCUSSION

The culture of fish and other commercially important aquatic organisms are completely depending on the water quality parameters. The mean values with standard deviation of different water quality parameters as recorded from the experimental ponds fewer than three treatments are presented in Table 1. ANOVA was performed to observe the degree of difference among the treatments.

The water temperature of experimental ponds ranged from 25.75 to 29.25ºC during the experiment in different treatments, which was more or less similar to (10-13) who recorded temperature ranges from 22 to $35^0$C. The mean (±SD) values of transparency were 48.76±2.98 cm, 46.67±3.44 cm and 40.64±4.71 cm in the $T_1$, $T_2$ and $T_3$ treatments respectively, which was more or less similar with the findings of (14) as recorded values ranging from 15 to 58 cm. Uddin (2002) recorded ranging from 11-63.5 cm from the ponds in BAU campus (15). The mean values of pH were 7.53±0.25, 7.54±0.23 and 7.62±0.21 in $T_1$, $T_2$ and $T_3$ treatments, respectively. The pH value recorded from the experiment agreed with the findings of (16,17) who found the ranges of pH from 6.3 to 8.9, 7.55 to 7.84, 7.05 to 7.72 and 7.51 to 7.91, respectively. Result shows that values of temperature, pH and transparency were favorable in the experiment

The mean values of oxygen concentration were from 4.3 to 8.9 mg $l^{-1}$, 4.3 to 8.7 mg $l^{-1}$ and 4.7 to 8.5 mg $l^{-1}$ in $T_1$, $T_2$ and $T_3$ treatments, respectively. DoF (1996) reported that the range of dissolved oxygen suitable for fish culture would be 5.0 to 8.0 mg $l^{-1}$ (18). The concentration of dissolved oxygen in the present study was also similar to the findings of (10,14,16) who recorded dissolved oxygen ranged from 4.0 to 7.0, 2 to 7.04, 3.4 to 8.1 and 1.2 to 7.2 mg $L^{-1}$, respectively. The mean (± SD) values of total alkalinity 74.27± 13.26 mg $l^{-1}$, 80.00± 14.36 mg $l^{-1}$ and 74.36± 13.35 mg $l^{-1}$ in $T_1$, $T_2$ and $T_3$ treatments, respectively indicating that total alkalinity in the present experiment might be considered as a suitable range for fish culture. Total alkalinity value 48-70 mg $l^{-1}$ recorded by (7) is lie within the values of present study. In the present study the mean values of $NH_3$-N were 0.23±0.25, 0.27±0.21 and 0.18±0.16 mg $l^{-1}$ in $T_1$ ,$T_2$ and $T_3$ treatments, respectively which were more or less similar to (19) who recorded ammonia-nitrogen value ranged from 0.01 to 0.569 mg $l^{-1}$, respectively. So, in the present study ammonia-nitrogen value was within the suitable range for *A. mola* culture. The mean (±SD) values of $NO_3$-N were 0.04±0.04, 0.02±0.02 and 0.02±0.02 mg $l^{-1}$ in $T_1$, $T_2$ and $T_3$ treatments respectively. Which were more or less similar to the finding of (12). The range of $NO_3$-N from 0.20 - 3.0 mg $l^{-1}$ were found in pond waters by (6,14). In the present study, values of phosphate-phosphorous ($mgl^{-1}$) were found to vary from 0.1 to 0.60 $mgl^{-1}$ in $T_1$, $T_2$ and $T_3$ treatments. The mean (±SD) values of $PO_4$-P were 0.33±0.32, 0.20±0.17 and 0.31±0.29 $mgl^{-1}$ in $T_1$, $T_2$ and $T_3$ treatments respectively, which were more or less similar with the findings of (6) who found phosphate-phosphorus range from 0.09 mg $l^{-1}$ to 5.2 mg $l^{-1}$. The mean (± SD) values of chlorophyll-*a* were 102.10±50.10 µg $l^{-}$

[1],118.60±40.15 µg $l^{-1}$and 143.51±45.58 µg $l^{-1}$ in $T_1$, $T_2$ and $T_3$ treatments, respectively. A good concentration of chlorophyll-*a* was observed throughout the experimental period. Stocking density of *A. mola* was lowest in $T_3$ so *A. mola* could not consume much phytoplankton as a result transparency was lowest in $T_3$. As Ahmed (2004) found a negative relationship between chlorophyll-*a* and water transparency. So the mean value of chlorophyll-*a* was highest in $T_3$ then second highest value was in $T_2$ where *A. mola* was stocked at higher density than $T_3$ that means phytoplankton was consumed here at a higher rate by *A. mola* as a result chlorophyll-*a* value was lower than $T_1$. Finally the lowest chlorophyll-*a* was found in $T_1$ where *A. mola* was stocked at highest density. So in the treatment the phytoplankton consumption was higher and as a result, chlorophyll-*a* value was lowest. The values of chlorophyll-*a* concentration showed remarkable fluctuations during the study period which might be associated with fertilization and grazing by fish *A. mola*.

A total number of 38 genera of phytoplankton were found (Table 2)` belonging to Bacillariophyceae (9 genera), Cyanophyceae (7 genera), Euglenophyceae (2 genera) and Chlorophyceae (20 genera) during the study period, which agrees with the findings of Hossain (2000) who recorded 38 genera of microalgae when studied biological production of ponds (20). The mean abundance of phytoplankton and zooplanktons with their different groups were presented in the Table 4. The monthly abundance (×$10^3$ cells $L^{-1}$) of phytoplankton was found to range from 73 to 263, 95 to 223 and 107 to 360 with mean values 132.83±67.71, 157.83±62.75 and 200.58±86.71 in $T_1$, $T_2$ and $T_3$ treatments, respectively. A total number of 13 genera of zooplanktons were found (Table 3) in the experimental d. period. The mean values of zooplankton (×$10^3$ cells $L^{-1}$) were 25.58±2.47, 33.33±3.60 and 39.58±19.94 in $T_1$, $T_2$ and $T_3$ treatments, respectively. Wahab and Ahmed (1991) reported mean phytoplankton population $17.72\times10^4$, $9.26\times10^4$, and $13.87\times10^4$, and zooplankton population to be $1.19\times10^4$, $1.90\times10^4$ and $1.07\times10^4$/L from three sets of ponds, respectively. However, (6) recorded 5.20-$6.34\times10^4$/L zooplankton from polyculture ponds.

Production and growth performance of *A. mola* were presented in the Table 5. Productions of *A. mola* vary between three treatments, which indicated that there were a effects of stocking density on the growth performance of *A. mola*. In three treatments initial weight of *A. mola* 150.0 ± 0.00 g was stocked. The mean net production of *A. mola* was 32.74±6.53, 34.82±6.53, and 43.22±8.66 kg $ha^{-1}$ in $T_1$, $T_2$ and $T_3$, respectively. Yield of *A. mola* recorded by (7) was 7.92-12.5 kg $ha^{-1}$ in polyculture with carp, which was lower than the yield obtained in the present study. In present study the highest production of *A. mola* was 43.22±8.66 kg $ha^{-1}$ observed in the treatment $T_3$, where *A. mola* was stocked at a low density of 7.1 ind. /$m^2$. The stocking of *A. mola* associated with improvement of environmental conditions through a range of ecological and biological processes. Kohinoor (2000) reported that average production of carp in polyculture without *A. mola* was 1,479±79.13 kg/ha, whereas the average production of carp with *A. mola* was 1,274±73.70 kg/ha (7). The total production was 16.06% lower in where *A. mola* was introduced. In present study, the mean net production of *A. mola* was 32.74±6.53, 34.82±6.53, and 43.22±8.66 kg $ha^{-1}$ in $T_1$, $T_2$ and $T_3$, respectively. The net production *A. mola* was significantly higher in the treatment $T_3$ rest of two ($T_1$, $T_2$) where stocking density was very low. But the stocking number of *A. mola* was higher in $T_1$ where production was low from other treatments. Nutrient rich small fish *A. mola* mainly fed upon plankton and protect the water body from formation of plankton bloom. It might be concluded that 36500 *A. mola* $hac^{-1}$ was a better stocking density for *A. mola* monoculture.

**Table 1**. Mean values of water quality parameters (mean ± SD) recorded from different treatments

| Parameters | Treatments | | | Level of significance |
|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | |
| Temperature ($^oC$) | 27.65± 0.85 | 27.65± 0.90 | 27.46± 0.91 | NS |
| Transparency (cm) | 48.76± 2.98$^a$ | 46.67± 3.44$^b$ | 40.64± 4.71$^c$ | * |
| $p^H$ range | 7.53± 0.25 | 7.54 ± 0.23 | 7.62± 0.21 | NS |
| DO (mg $l^{-1}$) | 7.46± 1.49 | 5.75± 1.40 | 6.29± 1.21 | NS |
| Total alkalinity | 74.27±13.26 | 81.00±14.36 | 74.36± 13.35 | NS |
| $NH_3$-N ($mgl^{-1}$) | 0.23 ± 0.25 | 0.27 ± 0.21 | 0.18 ± 0.16 | NS |
| $NO_3$-N ($mgl^{-1}$) | 0.04 ± 0.04 | 0.02 ± 0.02 | 0.02 ± 0.02 | NS |
| $PO_4$-P ($mgl^{-1}$) | 0.33 ± 0.32 | 0.20± 0.17 | 0.31 ± 0.29 | NS |
| Chlorophyll *a* ($\mu gL^{-1}$) | 102.10±50.10$^b$ | 118.60±40.15$^{ab}$ | 143.51±45.58$^a$ | * |

NS= Means are not significantly different (P>0.05)

* Mean values with different superscript letters in the same row indicate a significant difference at 5% significance level.

**Table 2.** List of Phytoplankton genera identified in the studied ponds during the study

| ***Group*** | ***Phytoplankton genera*** |
|---|---|
| ***Bacillariophyceae*** | *Cyclotella* |
| | *Coscinodiscus* |
| | *Diatoma* |
| | *Fragillaria* |
| | *Navicula* |
| | *Nitzschia* |
| | *Surirella* |
| | *Synedra* |
| | *Tabellaria* |
| ***Cyanophyceae*** | *Anabaena* |
| | *Anacystis* |
| | *Aphanizomenon* |
| | *Aphanocapsa* |
| | *Gomphosphaeria* |
| | *Microcystis* |
| | *Oscillatoria* |

| | |
|---|---|
| ***Euglenophyceae*** | *Euglena* |
| | *Phacus* |
| ***Chlorophyceae*** | *Actinastrum* |
| | *Ankistrodesmus* |
| | *Botryococcus* |
| | *Chaetophora* |
| | *Chlorella* |
| | *Closterium* |
| | *Coelastrum* |
| | *Gonatozygon* |
| | *Microspora* |
| | *Oedogonium* |
| | *Oocystis* |
| | *Palmella* |
| | *Pediastrum* |
| | *Scenedesmus* |
| | *Sphaerocystis* |
| | *Stigeoclonium* |
| | *Tetraedon* |
| | *Ulothrix* |
| | *Volvox* |
| | *Zygnema* |

**Table 3.** List of Zooplankton genera identified in the studied ponds during the study

| ***Group*** | ***Zooplankton*** |
|---|---|
| ***Rotifer*** | *Asplanchna* |
| | *Brachionus* |
| | *Filinia* |
| | *Lecane* |
| | *Trichocerca* |
| ***Crustacean*** | Nauplius |
| ***Copepoda*** | *Cyclops* |
| | *Diatoms* |
| ***Cladocera*** | *Daphnia* |
| | *Diaphanosoma* |
| | *Sida* |
| | *Moina* |

**Table 4.** Mean (Mean ± SD) abundance ($\times 10^3$, cells $L^{-1}$) of phytoplankton and zooplankton with their different groups under three treatments each having three replicates. (N=15)

| Plankton groups | Treatments | | | Level of significance |
|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | |
| Bacillariophyceae | 41.42±21.81 | 38.33±13.74 | 50.92±23.62 | NS |
| Chlorophyceae | 64.83±36.20 | 71.75±30.24 | 96.25±47.76 | NS |
| Cyanophyceae | 20.58±17.43 | 44.25±23.43 | 49.42±38.87 | * |
| Euglenophyceae | 6.00±3.10 | 3.67±2.15 | 4.00±2.00 | NS |
| **Total Phytoplankton** | 132.83±67.71 | 157.83±62.75 | 200.58±86.71 | NS |
| Rotifera | 8.42±6.40 | 8.45±3.82 | 14.67±10.53 | NS |
| Crustacea(Nauplius) | 17.17±5.75 | 23.08±4.98 | 24.92±11.05 | * |
| Cladocera | 6.75±3.051 | 12.50±7.53 | 0.33±6.01 | NS |
| Copepoda | 4.58±2.15 | 5.08±.1.88 | 5.00±3.00 | NS |
| **Total Zooplankton** | 25.58±10.47 | 33.33±3.60 | 39.58±19.94 | * |
| **Total plankton** | 158.42±53.33 | 191.17±62.24 | 240.17±93.37 | * |

NS = Means are not significantly different ($P > 0.05$)

* Mean values with different superscript letters in the same row indicate a significant difference at 5% significance level .

**Table 5** Growth performance (Mean ± SD) of *A. mola* in three treatments

| | Treatments | $T_1$ | $T_2$ | $T_3$ | ANOVA Sig. |
|---|---|---|---|---|---|
| ***A. mola*** | Stocking no. (indiv. $h^{-1}$) | 145000 | 73000 | 36500 | |
| | Average harvest no. (indiv. $h^{-1}$) | 155633.31±11.5 | 84200±4 | 45600±7.21 | NS |
| | Survival (%) | $107.33\pm0.79^{c}$ | $115.34\pm0.55^{b}$ | $124.93\pm1.98^{a}$ | * |
| | Average weight gain (%) | $14.89\pm4.02^{b}$ | $26.00\pm5.29^{b}$ | $63.33\pm13.68^{a}$ | * |
| | SGR (% body wt/day) | $0.154\pm0.039^{b}$ | $0.256\pm0.0462^{b}$ | $0.543\pm.093^{a}$ | * |
| | Gross production (kg $ha^{-1}$) | $268.19\pm8.77^{a}$ | $159.11\pm5.96^{b}$ | $111.62\pm7.61^{c}$ | * |
| | Net Production (kg $ha^{-1}$) | 32.74±6.53 | 34.82±6.53 | 43.22±8.66 | NS |

NS = Values are not significantly different ($P > 0.05$)
* = Values with different superscripts in the same row indicate a significance

## CONCLUSION

The findings of the production of *A. mola* in mono culture system was not encouraging. But this short-term survey on physicochemical parameters and plankton in the *A. mola* culture pond provide a future guideline for the culture. Small indigenous fish species (SIS) culture would be added social benefit to the fish farmer and enhance our nutritional status specially the mitigation measure of vitamin-A deficiency. Farmers can develop an appropriate culture technique of *A. mola* with a modest supplementary feed over short period of time.

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