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EFFECTIVENESS OF USING YOUNG COCONUT WATER AS A NATURAL STIMULANT ON THE FECUNDITY AND HATCHING RATE OF MANDALIKA CATFISH EGGS

Efektivitas Penggunaan Air Kelapa Muda Sebagai Stimulan Alami Terhadap Fekunditas dan Derajat Penetasan Telur Ikan Lele Mandalika

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ABSTRACT

The high cost of synthetic hormones and the difficulty of standardizing pituitary methods are obstacles in the cultivation of Mandalika catfish. Young coconut water (*Cocos nucifera*) contains phytohormones, amino acids, and minerals that have the potential to act as natural stimulants to stimulate the endocrine system and improve fish reproductive performance. This study aims to evaluate the effectiveness of using various stimulants on fecundity, hatching rate, and hatching time of catfish eggs, as well as to monitor the stability of water quality during the incubation process. This experimental study used a Completely Randomized Design (CRD) with three treatments: commercial hormones (P1), young coconut water (P2), and pituitary gland (P3). The doses used were 0.5 ml/kg for female broodstock and 0.3 ml/kg for male broodstock intramuscularly. The results showed that young coconut water (P2) gave the best results with an average fecundity of 20,125 eggs, significantly higher than P3 (10,250 eggs) and P1 (10,000 eggs). The highest hatching rate was also achieved by treatment P2 at 83.00%, followed by P3 (71.75%) and P1 (71.00%). Egg hatching time ranged from 31 to 34.25 hours, with P1 recording the fastest time but the lowest hatching rate. Water quality parameters were optimally maintained throughout the study at a temperature of 26–27°C, pH 6.5, and DO 3 mg/L. Young coconut water has proven to be the most effective natural stimulant in increasing the quantity and quality of Mandalika catfish reproduction, while also offering a cost-effective and environmentally friendly solution for farmers.

Keywords: Artificial Spawning, Catfish, Fecundity, Hatching Rate, Young Coconut Water

ABSTRAK

Tingginya biaya hormon sintetis dan sulitnya standarisasi metode hipofisasi menjadi kendala dalam pembenihan ikan lele mandalika. Air kelapa muda (*Cocos nucifera*) mengandung fitohormon, asam amino, dan mineral yang berpotensi sebagai stimulan alami untuk merangsang sistem endokrin dan meningkatkan performa reproduksi ikan. Penelitian ini bertujuan untuk mengevaluasi efektivitas penggunaan berbagai jenis stimulan terhadap fekunditas, derajat penetasan (*hatching rate*), dan waktu penetasan telur ikan lele, serta memantau stabilitas kualitas air selama proses inkubasi. Penelitian eksperimental ini menggunakan Rancangan Acak Lengkap (RAL) dengan tiga perlakuan: hormon komersial (P1), air kelapa muda (P2), dan kelenjar hipofisa (P3). Dosis yang digunakan adalah 0,5 ml/kg untuk induk betina dan 0,3 ml/kg untuk induk jantan secara intramuskular. Hasil penelitian menunjukkan bahwa air kelapa muda (P2) memberikan hasil terbaik dengan rata-rata fekunditas mencapai 20.125 butir, secara signifikan lebih tinggi dibandingkan P3 (10.250 butir) dan P1 (10.000 butir). Derajat penetasan tertinggi juga dicapai oleh perlakuan P2 sebesar 83,00%, diikuti P3 (71,75%) dan P1 (71,00%). Waktu penetasan telur berkisar antara 31 hingga 34,25 jam, di mana P1 mencatatkan waktu tercepat namun dengan daya tetas terendah. Parameter kualitas air selama penelitian terjaga optimal dengan suhu 26–27 °C, pH 6,5, dan DO 3 mg/L. Air kelapa muda terbukti menjadi stimulan alami yang paling efektif dalam meningkatkan kuantitas dan kualitas reproduksi ikan lele mandalika, sekaligus menawarkan solusi efisiensi biaya yang ramah lingkungan bagi pembudidaya.

Kata Kunci: Air Kelapa Muda, Fekunditas, Daya Tetas, Ikan Lele, Pemijahan Buatan

INTRODUCTION

The Mandalika catfish is one of the most important freshwater fisheries commodities globally due to its rapid growth and resilience to extreme environmental conditions. In Indonesia, this fish farming has developed into a significant commercial sector. However, as cultivation intensity increases, the demand for high-quality fry has become a major challenge (Astuti et al., 2019). Artificial spawning using hormone induction has become a crucial technology to ensure year-round seed availability without relying on seasonal fluctuations (Mechaly et al., 2024).

In the artificial spawning process, successful ovulation is highly dependent on the quality of the hormonal stimulation provided. The use of synthetic hormones such as Ovaprim (a mixture of GnRH analogs and antidopamine) has become the industry standard due to its consistent effectiveness in triggering gonadal maturation in various teleost fish species (Sang et al., 2009). However, reliance on commercial hormones poses a cost barrier for small- and medium-scale farmers, given the relatively high price of synthetic products on the international market.

Alternatively, utilizing the pituitary gland through hypophysization techniques is a classic method that is still used. However, this method has significant drawbacks, including difficult dosage standardization and the need for donor fish, often at the expense of other individuals (Yaron, 1995). This has prompted research into natural ingredients containing bioactive compounds to stimulate the endocrine system in fish.

Young coconut water (*Cocos nucifera*) contains various organic compounds, including phytohormones such as cytokinins, amino acids, minerals, and vitamins that play a role in cellular metabolism. Several studies have shown that the complex nutrients in coconut water can act as cytoprotective agents and biological stimulants (Yong et al., 2009). The use of natural ingredients in aquaculture is gaining interest due to their environmentally friendly and economical properties, in line with the principles of sustainable aquaculture that minimize the input of synthetic chemicals (Dawood et al., 2018).

Based on this potential, this study aims to evaluate the effectiveness of young coconut water as a natural stimulant compared to commercial hormones and pituitary gland hormones. Through an experimental approach, the results of this study are expected to demonstrate that young coconut water can provide optimal reproductive performance, particularly in terms of fecundity and hatching rate in catfish eggs, while also providing a cost-effective solution for the hatchery sector.

The objective of this study was to evaluate the effectiveness of using various stimulants—namely young coconut water, commercial hormones, and pituitary gland stimulants—on catfish reproductive performance, including fecundity and hatching rate. Furthermore, this study aimed to analyze the duration of egg hatching in each treatment and monitor the stability of water quality parameters such as temperature, pH, and dissolved oxygen to ensure optimal environmental conditions throughout the hatchery process.

RESEARCH METHODS

This research was conducted for one month in April 2025 at the Wet Laboratory of Universitas 45 Mataram.

This study employed an experimental method using a Completely Randomized Design (CRD) consisting of three stimulant treatments for catfish broodstock: commercial hormones (P1), young coconut water (P2), and pituitary gland (P3). The procedure began with the selection of mature male and female broodstock, followed by intramuscular injection of the stimulant at the appropriate dosage (0.5 ml/kg for female broodstock and 0.3 ml/kg for male broodstock). Following the injection, the broodstock were artificially spawned, and the resulting eggs were immediately transferred to a prepared incubator for reproductive parameter monitoring.

Parameters observed in this study included egg fecundity, hatching rate, and hatching time. Water quality measurements, including temperature, pH, and dissolved oxygen (DO), were conducted periodically to ensure stable environmental conditions throughout the incubation period. The data obtained were then tabulated and analyzed descriptively and comparatively to determine the effectiveness of each stimulant. All technical procedures in this study adhered to standard operating procedures for catfish hatchery production to ensure the validity and reliability of the data generated.

RESULT

Egg Fecundity

Based on observations, the type of stimulant administered significantly affected the number of eggs produced (fecundity) by the broodstock catfish. The fecundity data for each treatment are presented in the following table:

Table 1. Average Fecundity of Catfish Eggs by Treatment

Treatment	Male Broodstock (gr)	Male Broodstock (gr)	Type of Stimulation	Average Number of Eggs (Grains)
P1	500	500	Commercial Hormones	10,000
P2	500	500	Young Coconut Water	20,125
P3	500	500	Pituitary Gland	10,250

Based on the research results, the use of various types of stimulants on broodstock fish with uniform male and female weights (500 grams) showed differences in the number of eggs produced. Stimulation using young coconut water (P2) produced the highest average egg production of 20,125 eggs, followed by stimulation with the pituitary gland (P3) with 10,250 eggs, and commercial hormones (P1) with 10,000 eggs. Treatment P2 (young coconut water) proved to be the most effective in increasing fecundity, producing almost twice as many eggs as treatments P1 and P3. The results between the use of Commercial Hormones (P1) and Pituitary Gland Hormones (P3) showed relatively similar numbers, namely 10,000 and 10,250 eggs, respectively.

Egg Hatchling Rate

The percentage of eggs that successfully hatched into larvae was observed to determine the spawning quality of each stimulant. Egg hatching rate data is presented in the figure below:

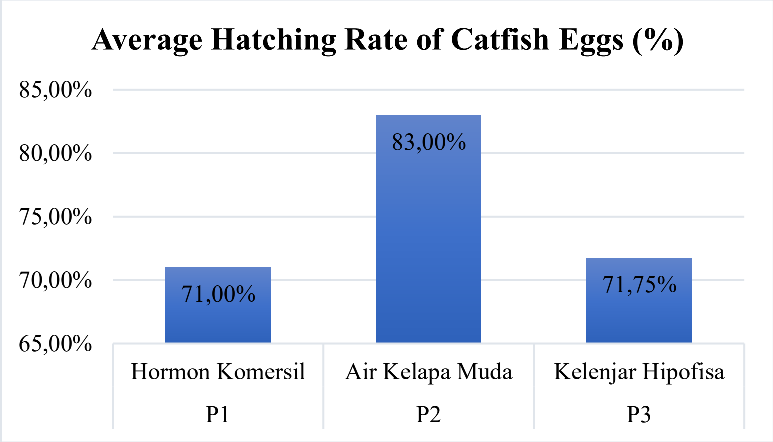

Figure 1. Average Percentage of Catfish Egg Hatch

Based on the observations presented in the Figure 1, it is clear that the type of stimulation given to the broodstock catfish significantly affected the quality of the hatched eggs. Treatment P2 (Young Coconut Water) showed significant superiority, with an average hatching rate of 83.00%. This figure far surpassed the other two treatments, where treatment P3 (Pituitary Gland) produced a hatching rate of 71.75%, and treatment P1 (Commercial Hormone) recorded the lowest value at 71.00%.

When correlated with egg count data, the effectiveness of young coconut water is seen not only in the quantity of eggs produced (20,125), but also in their quality, as evidenced by the high percentage of eggs that successfully hatched into larvae. This indicates that the nutritional or mineral content in young coconut water can stimulate gonad maturity and gamete quality more optimally than the use of manufactured hormones or conventional pituitary methods. Overall, the data trend indicates that the use of natural ingredients such as young coconut water has significant potential to increase catfish hatchery productivity, both in terms of egg count and hatching success. The following image shows the difference between fertilized and unfertilized eggs and hatched eggs.

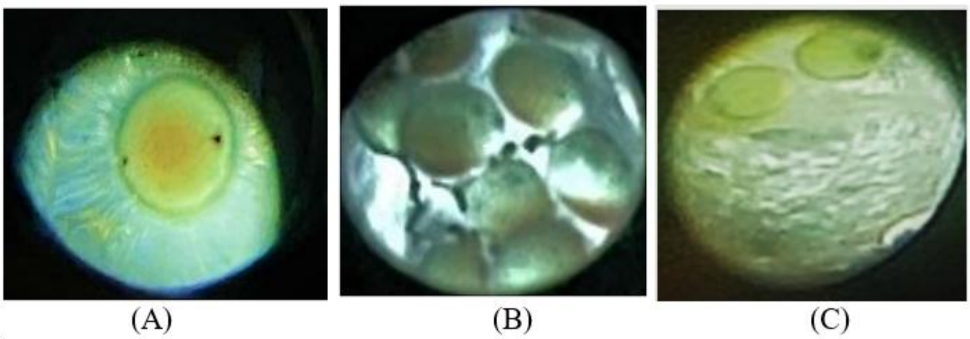

Figure 2. Differences in Catfish Egg Condition (A) Unfertilized Eggs, (B) Fertilized Eggs, (C) Hatched Eggs (Personal Documentation, 2026)

Based on visual observations of the development of catfish eggs, as shown in Figure 2, three distinct morphological conditions were identified. In Figure 2(A), the eggs appear cloudy yellow to whitish and appear opaque; this condition indicates unfertilized or failed fertilization and will soon rot. Conversely, in Figure 2(B), the visualization shows a clearer, slightly brownish cluster of eggs, with visible spots or lumps within them, indicating successful fertilization and the ongoing process of cell division (embryonic). Finally, in Figure 2(C), observations capture the moment the eggs hatch, marked by morphological changes into small, transparent, greenish fish larvae, the final stage of the incubation period before they become actively swimming. The hatching time for each treatment varied depending on the spawning time. For more details, see Figure 3 below:

Figure 3. Graph of Differences in Hatching Time for Catfish Eggs

Based on the graph of observations of the hatching time for catfish eggs, differences in the duration of each treatment were observed. Treatment P1 recorded the fastest hatching time, at 31 hours. The hatching time increased in treatment P2, which required 32.35 hours. Meanwhile, the longest hatching time was found in treatment P3, where the eggs required 34.25 hours to hatch. Overall, the data shows an increasing trend in hatching time from treatment P1 to P3, indicating that different types of stimuli influence the speed of embryo development until hatching.

Water Quality

Water quality monitoring is conducted regularly to ensure the rearing environment remains in optimal conditions for the development of catfish embryos. Measurements indicate that the water temperature is around 26–27°C, the acidity (pH) is 6.5, and the dissolved oxygen (DO) level is 3 mg/L.

DISCUSSION

The high fecundity of 20,125 young coconut water larvae in the P2 (young coconut water) treatment indicates that young coconut water has significant potential as a natural stimulant for triggering ovulation in catfish. This is thought to be due to its complex nutrient content, including potassium, magnesium, and calcium, as well as organic compounds that support physiological reproductive processes. According to Prades et al. (2012), in their composition review, coconut water contains the phytohormone cytokinin (zeatin), which biologically plays a role in stimulating cell division and energy metabolism, thus helping optimize egg production in female broodstock.

The superiority of young coconut water over commercially available hormones (P1) and pituitary gland hormones (P3) is also related to its role in maintaining osmotic balance during egg production. The natural electrolyte content in coconut water helps minimize stress on oocytes during spawning. Consistent with findings by Torsabo et al. (2024), ionic balance and macronutrient availability are crucial for maintaining gamete viability in freshwater fish. The significant increase in fecundity in P2 indicates that the chemical environment created by young coconut water favors synchronized final oocyte maturation.

On the other hand, the low egg count in the P1 (Commercial Hormone) treatment was likely caused by excessive hormonal pressure or an inappropriate dosage relative to the broodstock's physiological condition. Excessive or inappropriate use of synthetic hormones often triggers oxidative stress in the gonads, which actually inhibits optimal egg production. According to research Rohayati et al. (2021), although synthetic hormones are designed for rapid results, their effectiveness is highly dependent on the individual fish's tolerance threshold. Therefore, natural ingredients such as coconut water often provide more stable results due to their gentler action on the endocrine system.

In addition to internal factors, the successful fecundity in this study was also supported by stable environmental conditions, where the water temperature was maintained at 26–27°C. Temperature is a biological catalyst that determines the speed of the broodstock's response to administered stimulants. According to Zahangir et al. (2022), stable environmental temperature is crucial for the success of hormone induction. Optimal temperatures support the function of the pituitary gland and hypothalamus in distributing spawning signals throughout the fish's body, allowing for maximum egg release.

Overall, these findings reinforce the urgency of utilizing local natural materials as alternative inputs in sustainable aquaculture. The use of young coconut water not only provides technically higher fecundity results but also offers a cost-effective solution for catfish farmers. This aligns with the direction of modern aquaculture innovation as outlined by Hasan et al. (2021), who argue that the integration of environmentally friendly organic materials can increase the productivity of the hatchery sector without relying on expensive synthetic chemicals that pose risks to the sustainability of the aquatic environment.

The increase in egg number in the P2 (young coconut water) treatment was accompanied by superior biological quality, as evidenced by the high hatching rate, reaching 83.00%. This demonstrates that stimulation with young coconut water not only increases quantity (fecundity) but also ensures oocyte quality by enriching the yolk with nutrients. The amino acid and vitamin content in young coconut water is thought to act as a protective agent for embryos during incubation. This is in line with research Budani & Tiboni (2020), which indicates that the availability of natural micronutrients and antioxidants in organic matter can reduce embryo mortality due to pathogen attack or early metabolic failure, resulting in a higher hatchability compared to the use of synthetic hormones, which tend to neglect the micronutrient aspect of oocytes.

In addition to hatching quality, the hatching time in the P2 treatment, which was around 32.35 hours, indicates stable embryo development efficiency. Although the P1 treatment had the fastest hatching time (31 hours), the low hatching rate in this treatment indicates accelerated embryo development (premature hatching) due to synthetic hormonal pressure. In contrast, young coconut water provides a more natural physiological environment for embryos to develop synchronously. According to Thomas et al. (2022), an optimal and stable hatching time is an indicator of successful hatchery management, as the resulting larvae have efficiently absorbed yolk reserves and a more complete morphological structure than larvae forced to hatch too quickly by aggressive exogenous hormones.

The high hatch rate of 83.00% in the P2 (Young Coconut Water) treatment indicates that this natural stimulant not only effectively stimulates ovulation but also supports optimal embryogenesis quality. Young coconut water contains essential minerals and vitamins that play a role in maintaining egg membrane integrity during incubation. According to Yong et al. (2009) and supported by a recent nutritional review by Prades et al. (2012), coconut water is rich in amino acids and natural growth regulators that can increase cellular resistance to environmental stress, allowing more embryos to develop to hatching stage than other treatments.

The superiority of young coconut water in increasing hatchability is also closely related to its ability as a natural isotonic medium that aids the fertilization process. Electrolytes such as potassium and magnesium in coconut water play a crucial role in activating sperm motility and preventing premature hardening of the chorion (egg shell). Consistent with research Dzyuba et al. (2017), the cation balance in the fertilization medium is crucial for successful hatching in freshwater fish. The stable ionic conditions in treatment P2 provide a more supportive microenvironment for sperm penetration and early embryo development.

Conversely, hatch rates in treatments P1 (71.00%) and P3 (71.75%) tended to be lower, possibly due to the less stable egg quality produced due to the intensity of synthetic hormone stimulation or pituitary extraction. The use of overly potent commercial hormones sometimes triggers forced ovulation before the oocytes reach full cytoplasmic maturity. According to a study Nagahama & Yamashita (2008), the hormonal profile during induction can reduce egg viability and increase embryo susceptibility to developmental failure. In this case, young coconut water offers a more biocompatible stimulus to the physiological system of the catfish broodstock.

Environmental factors, particularly temperature stability at 26–27°C throughout the study, also contributed to the 83.00% hatchability achieved in the P2 treatment. Controlled temperatures minimize the risk of fungal infections and support efficient embryo metabolism. According to Kupren et al. (2011), media temperature is a key determinant of incubation duration and hatching success in teleost fish eggs. The combination of nutrient-rich natural stimulants and ideal environmental conditions has been shown to maximize catfish hatchery productivity and offer a low-cost, sustainable technology alternative for the fisheries sector (Hasan et al., 2021).

Visual identification of catfish egg condition is crucial in determining hatchery success. In Figure 2(A), unfertilized eggs are characterized by a deep yellow to chalky white color and are opaque (impermeable to light). This phenomenon occurs due to coagulation of egg proteins due to water entry through the micropyle without sperm penetration, resulting in the failure of the egg's osmotic defense system to develop. According to Silvia E Plaul & Di Cesare L (2023), unfertilized eggs will lyse quickly and become a primary substrate for the growth of the fungus *Saprolegnia* sp., which can threaten the health of surrounding healthy eggs through the transmission of hyphal filaments.

The fertilized egg in Figure 2(B) exhibits distinct morphological characteristics, ranging from transparent to light brown. This transparency indicates that the egg's chorion has hardened (water hardening) and the perivitelline space has fully formed to protect the developing embryo. Consistent with findings from Mahfudhah et al. (2020), transparency in freshwater fish eggs is an indicator of high embryo viability. The dark spot within the egg reflects the accumulation of cells at the animal pole (blastodis), signaling the onset of post-fertilization cell division.

The embryonic development process culminates in the hatching phase, illustrated in Figure 2(C), when the chorion ruptures and the larvae emerge into the external environment. This hatching is triggered by the activity of the chorionase enzyme, which softens the egg wall, as well as active muscle movements of the embryo itself. Viader-Guerrero et al. (2021) stated that the synchronization between enzymatic maturation and mechanical activity of larvae is strongly influenced by the temperature of the incubation medium, where normally hatched larvae have a large yolk sac reserve as their primary energy source before they are able to feed independently (exogenously).

Overall, the difference in egg condition from unfertilized to hatched reflects the effectiveness of the hormone induction process and the applied incubation management. The high percentage of fertilized eggs and successful hatching indicates that the stimulation provided is capable of triggering synchronous oocyte maturation and optimal gamete quality.

This aligns with a review by Martínez-Brown et al. (2023), which states that microscopic monitoring of egg morphology is not merely routine documentation but a critical evaluation method for predicting larval survival rates and production efficiency in intensive-scale fish hatcheries.

The hatching time of catfish eggs in this study occurred within 24–36 hours after fertilization, significantly influenced by the stability of the rearing medium temperature at 26–27°C. This process begins with the development of the embryo within the chorion until the larvae are ready to emerge due to the activity of the hatching enzyme (chorionase) and the mechanical movement of the larvae. According to Yalcin et al. (2022), environmental temperature is the main biochemical factor determining the rate of embryo metabolism; optimal temperature accelerates cell division and enzymatic activity, thereby shortening the incubation duration without sacrificing the quality of the resulting larvae.

Successful hatching within this timeframe was also supported by adequate environmental conditions, such as a dissolved oxygen (DO) level of 3 mg/L and an acidity level (pH) of 6.5. Stable water quality ensures smooth embryonic respiration within the egg, which is crucial as the hatching phase approaches. This aligns with the statement Hasan et al. (2021) that synchronization between internal embryonic factors and external environmental factors determines the efficiency of hatching time. The uniform hatching duration in this study demonstrates that the stimulants administered, both natural and artificial, did not negatively inhibit the physiological development of catfish embryos.

In addition to temperature, dissolved oxygen (DO) concentration plays a vital role in triggering the hatching mechanism through the activity of the hatching gland. In the final phase of incubation, the embryo's oxygen demand increases sharply as movement activity increases within the chorion. A decrease in DO levels below the optimal threshold can cause embryonic hypoxia, resulting in failure of chorionase enzyme secretion or larval muscle fatigue before successfully rupturing the chorion wall. Adequate oxygen not only supports the embryo's aerobic metabolism but also ensures the larvae's mechanical efficiency during the rotational movements necessary to synchronously tear the egg's protective covering.

The pH value of 6.5 in this study also contributes to the effectiveness of enzymatic activity. The chorionase enzyme is highly sensitive to pH fluctuations; excessively acidic or alkaline conditions can denature the enzyme's protein, thus inhibiting the chorion softening process. A stable pH within the neutral range tends to support optimal enzyme kinetics, accelerating egg membrane degradation without compromising the integrity of the larval integument. This is in line with research Silvia E Plaul & Di Cesare L (2023), which states that the acid-base balance of the incubation medium is crucial for maintaining egg membrane permeability, allowing the unimpeded process of ion exchange and the release of embryo metabolic waste into the water medium.

The interaction between temperature, pH, and dissolved oxygen creates a microenvironment that determines the osmotic integrity of the egg until hatching. Maintaining water quality minimizes the risk of environmental stress that can trigger premature hatching, which often results in deformed or weak larvae. Stable water physicochemical parameters ensure that the energy derived from the yolk sac is fully allocated to organogenesis and somatic growth, rather than to compensate for environmental stress. Based on a review by Desrial & Yahya Abdul Kodir (2024), optimal water quality synchronization during the incubation phase is a key determining factor in producing catfish fry with high growth performance and strong immune systems in the subsequent nursery phase.

CONCLUSION

The use of young coconut water (P2) was the most effective method for increasing catfish reproductive productivity, resulting in the highest fecundity of 2,125 eggs and an optimal hatching rate of 83.00%.

The hatching process consistently occurred within 31 to 34.25 hours, supported by stable water quality parameters (temperature 26–27°C, pH 6.5, and DO 3 mg/L), demonstrating that young coconut water is a safe, low-cost alternative for embryo development.

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