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Impact of Sewage Discharge on The Community Structure and Gonad Maturity of Fish in The Way Awi River Bandar Lampung

(Dampak dari Pembuangan Limbah Terhadap Struktur Komunitas dan Tingkat Kematangan Gonad Ikan di Sungai Way Awi Bandar Lampung)

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Abstrak

Pencemaran air merupakan masuk atau dimasukannya makhluk hidup, zat atau komponen lain oleh manusia yang dapat menyebabkan menurunnya kualitas atau bahkan merusak perairan. Tingkat kematangan gonad merupakan tahapan persiapan calon induk untuk proses pemijahan tingkat kematangan gonad dan dapat diukur melalui pengamatan visual maupun histologi.. Tujuan dari penelitian ini adalah untuk mengetahui kualitas air di Sungai Way Awi berdasarkan struktur komunitas ikan dan juga untuk mengetahui dampak yang ditimbulkan dari pembuangan limbah terhadap tingkat kematangan gonad ikan di sungai Way Awi Bandar Lampung. Penelitian ini dilakukan pada bulan November – Desember 2023 di Sungai Way Awi Bandar Lampung Titik pengambilan sampel yaitu pada lima titik Sungai Way Awi. Sampel air dianalisis dengan analisis kimia yaitu pH, BOD, COD dan DO. Analisis fisikanya dengan suhu dan TSS (Total solid suspended). Berdasarkan hasil analisis Sungai Way Awi statusnya tercemar sedang dengan struktur komunitas yang tidak berpengaruh signifikan, namun jumlah ikan dari hulu menuju ke hilir semakin sedikit. Penelitian ini diharapkan memberikan informasi bahaya limbah apabila dibuang secara terus menerus kedalam sungai.

Kata kunci: *Pencemaran, Limbah domestik, Gonad Somatic Index, Struktur Komunitas .*

Abstract

Water pollution refers to the introduction of living organisms, substances, or other components by human activities that can degrade water quality or cause environmental harm. Gonad maturity level indicates the stage of readiness of prospective broodstock for the spawning process, assessed through visual and histological methods. This study aimed to assess water quality in the Way Awi River based on fish community structure and to evaluate the impact of sewage discharge on fish gonad maturity levels in Bandar Lampung's Way Awi River. Conducted between November and December 2023, this research sampled five points along the Way Awi River. Chemical analysis included pH, BOD, COD, and DO, while physical parameters such as temperature and TSS (Total Suspended Solids) were also analyzed. The findings indicate that the Way Awi River is moderately polluted, with no significant impact on the community structure, although there is a noticeable decrease in fish numbers from upstream to downstream. This study underscores the importance of understanding the risks associated with continuous disposal of waste into rivers.

Keywords: Pollution, Domestic waste, Gonad Somatic Index, Community Structure.

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INTRODUCTION

Water pollution is a significant environmental issue because it has profound impacts that can be very hazardous if not properly addressed. According to Pratama (2020), waste pollution can originate from domestic and non-domestic sources. Domestic waste typically contains five main characteristics: bacteria, parasites, and possibly viruses, in significant quantities that often contaminate shellfish and bathing areas along the coast [1]. The discharge of waste fluids into rivers can change the river's color and cause a foul, pungent odor. This odor can lead to respiratory problems and disrupt the survival of animals living in the river [2].

Domestic waste can arise from household activities. Difficult-to-decompose household domestic waste includes detergents, shampoos, bleaches, fragrances, and other chemicals. The increasing population growth rate is causing an increase in the pollution rate of this waste [3].

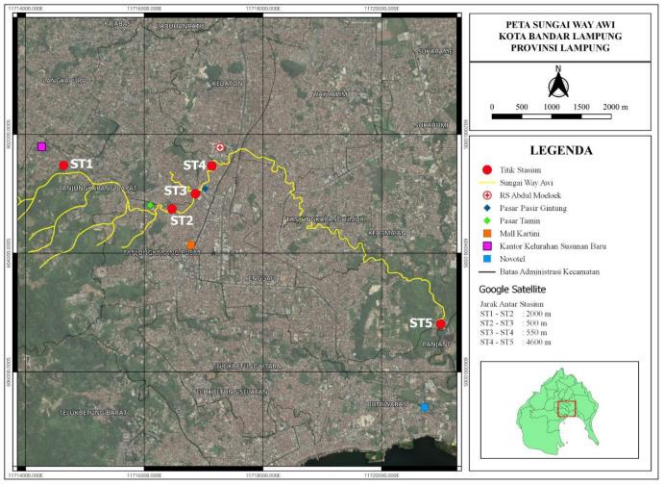
Fish are aquatic vertebrates that breathe through gills. Fish, as aquatic animals, have several physiological mechanisms not found in terrestrial animals. Fish play a crucial role in ecosystems and the environment, where they can serve as bioindicators of water quality. Common fish used as water quality indicators include tilapia, catfish, and gourami [4].

Gonad maturity level (GML) is an important biological parameter to understand. Gonad maturity level is a specific stage of gonad development before and after fish spawning, during which most metabolic processes are directed towards gonad development [5].

METHODS

Sampling

The research was conducted in the Way Awi River, Lampung Province, Indonesia. Fish sampling was carried out in November 2023 using a seine net with a size of 40 cm. Samples were taken at Stations I to V. Station I is located in Susunan Baru Village, Station II is at Tamin Market, Station III is at Gintung Market, Station IV is near Abdul Moeloek Hospital, and Station V is downstream at Way Garuntang



Picture 1. Fish Sampling Location.

Observation and Identification

The observation and identification of fish samples were conducted from November to

December 2023 at the Zoology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Lampung. The identification was performed by identifying the types of fish caught using Hasanudin Saanin's Taxonomy book. Fish dissection was carried out to determine the gonad maturity level.

Data Analysis

Data analysis focused on the fish community structure, including:

Diversity Index

The Shannon-Wiener equation was used to calculate the diversity index [6]

$$H' = \sum_{t=1}^{a} Pi.In\ Pi$$

where :

H' = Shannon-Wiener diversity index
S = Number of species
Pi = ni/N (Proportion of individuals of species i to the total number of individuals)
ni = Number of individuals of species i
N = Total number of individuals

Uniformity Index

The Shannon-Wiener equation was also used to determine the uniformity index:

$$E = \frac{H'}{Hmaks}$$

where:

E = Uniformity index
H' = Shannon-Wiener diversity index
Hmaks = In S (Maximum diversity)

Dominance Index

The dominance index, which determines the dominant group within a community, was calculated using the Simpson formula :

$$C = \sum_{i=1}^{a} (\frac{ni}{N})2$$

where:

C = Simpson's dominance index
ni = Number of individuals of species i
N = Total number of individuals

Gonad Maturity Index

The gonad maturity index was calculated using the formula by Gabche and Hockey (1995):

$$IKG\frac{Bg}{Bt}X100\%$$

where:

IKG = Gonad maturity index (%)
Bg = Gonad weight (gram)
Bt = Body weight (gram).

Measurement of Physicochemical Parameters In situ and Ex situ

Water samples for physicochemical parameters were directly collected from the Way Awi River in Bandar Lampung. Water samples were taken from the riverbank using a 10 L bucket. The physical parameters measured were temperature and Total Suspended Solids (TSS), while the chemical parameters observed were pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Phosphate, and Nitrate. Instruments used included a pH meter, DO meter, and thermometer.

RESULTS AND DISCUSSION

Sample Identification Results

Based on the research conducted in the Way Awi River, Bandar Lampung, a total of 71 fish individuals belonging to 3 different species were identified. These species are *Rasbora argyrotaenia, Barbodes binotatus,* and *Poecilia reticulata.*

At Station I, 35 fish individuals belonging to 2 different species were found: *Rasbora argyrotaenia* with 21 individuals and *Poecilia reticulata* with 14 individuals. At Station II, 23 fish individuals belonging to 2 different species were found: *Rasbora argyrotaenia* with 10 individuals and *Barbodes binotatus*

with 13 individuals. At Station III, 4 fish individuals belonging to 2 different species were found: *Rasbora argyrotaenia* with 2 individuals and *Poecilia reticulata* with 2 individuals. At Station IV, 7 fish individuals belonging to 2 different species were found: *Rasbora argyrotaenia* with 4 individuals and *Barbodes binotatus* with 3 individuals. At Station V, 2 fish individuals belonging to 2 different species were found: *Rasbora argyrotaenia* with 1 individual and *Barbodes binotatus* with 1 individual.

Table 1. Fish Species Found in Way Awi River

Station	Local Name	Scientific Name	Total
I	Barb	*R.argyrotaenia*	21
	Guppy	*P.reticulata*	14
II	Barb	*R.argyrotaenia*	10
	Spotted barb	*B.binotatus*	13
III	Barb	*R.argyrotaenia*	2
	Guppy	*P.rericulata*	2
IV	Barb	*R.argyrotaenia*	4
	Spotted barb	*B.binotatus*	3
V	Barb	*R.argyrotaenia*	1
	Spotted barb	*B.binotatus*	1

Table 2. Results of Community Structure Analysis: Diversity Index

Community Structure Calculation	Station				
	I	**II**	**III**	**IV**	**V**
Diversity Index	0,683	0,673	0,693	0,683	0,693
Evenness Index	0,9854	0,9709	0,9998	0,9998	0,9998
Dominance Index	0,51	0,52	0,5	0,51	0,5

Community Structure

Diversity Index

The diversity index heavily depends on the number of species in each community; the more species present, the higher the diversity index. However, this value also depends on the number of individuals observed [7]. Based on the index values in Table 2, the Way Awi river is moderately polluted, with a low fish community diversity, as indicated by an H' value of less than 1. When the H' value is between 1 and 3, the ecosystem exhibits high biodiversity, supporting the aquatic life within it [8].

Evenness Index

According to Inasafitri (2009), the more evenly distributed the number of individuals among species, the higher the evenness index. Based on calculations, the evenness index of the fish community in the Way Awi river is moderate, as shown in Table 2. If the evenness index (E) is less than 0.4, the species evenness is low. If the index is between 0.4 and 0.6, the

evenness is moderate, and if E is greater than 0.6, the species evenness is high (Sari et al., 2021). Therefore, the Way Awi river in Bandar Lampung has a high evenness index, with an average value exceeding 0.6.

Dominance Index

The dominance index indicates the degree to which a species dominates within a community [9]. According to the calculations, no single species dominates in the Way Awi river. Using Simpson's dominance index, if the dominance value (C) is between 0 and 0.5, no genus dominates. If the dominance index value is between 0.5 and 1, then a genus dominates.

Gonad Maturity Level/GSI Value

Pada pengambilan sampel yang dilakukan tiap Fish samples taken at each station showed varying stages of gonad maturity. At station I, out of 35 individuals, only 15 fish had reached gonad maturity stage V (spent stage) with 10 individuals, and 5 were maturing. At station II, out of 23 fish, only 11 had matured gonads, with 10 at the spent stage and 1 maturing. At station III, of the 4 fish, 2 were at the spent stage, and the other 2 had not reached gonad maturity. At station IV, out of 7 fish, 4 were at the spent stage, and 4 had not reached gonad maturity. At station V, only two species were found: Rasbora argyrotaenia and *Barbodes bonotatus.* The fish were too small to identify their gonad maturity stage.

Table 3. Results of Physical Parameter Analysis

Indicator	UoM	Station					Quality Standard
		I	II	III	IV	V	
Temperature	^{0}C	27,8	29,1	30	29,8	28,6	Dev 3
TSS	mg/L	27	14	51	79	16	50

*PP No. 22 Year 2021 Class II

Physical Parameters

Physical parameters are essential for determining the observed water quality [10]. In this study, temperature and Total Suspended Solids (TSS) were the parameters measured. The results showed variations in temperature and TSS across different stations. The water temperature ranged from 27°C to 30°C, which is within the optimal range for fish growth. Boyd and Litchkoppler (1982) stated that the optimal temperature for freshwater fish is between 25°C and 32°C. The temperature variations are due to the different locations of the river flow, leading to different measurement results [11].

TSS measurements showed significant differences, with the highest TSS values recorded at stations III and IV. According to Government Regulation No. 22 of 2021 on Environmental Protection and Management, the quality standard for TSS in Class II water is 40 mg/L. Stations III and IV had TSS values of 51 mg/L and 79 mg/L, respectively. TSS originates from waste settling at the riverbed, forming sediments that can obstruct river flow and cause riverbed siltation. Station III is near Pasar Gintung, where the water is slimy, muddy, and has an unpleasant odor, making sample collection difficult. Station IV, located near Abdul Moeloek Hospital, is also close to residential areas, where residents discharge wastewater directly into the river, leading to high TSS levels.

Table 3. Results of Chemical Parameter Analysis

Indicator	UoM	Station					Quality Standard
		I	II	III	IV	V	
pH	-	8,17	6,10	8,10	7,14	8,03	6-9
BOD	mg/L	11	10	11	12	11	3
DO	mg/L	6,5	6,6	6,6	6,6	6,5	4
COD	mg/L	38,6	31,6	35,3	39,7	39,6	25
Phosphate	mg/L	0,20	9,12	9,37	8,81	1,62	0,2
Nitrate	mg/L	1,049	0,053	0,061	0,058	3,695	10
PP No. 22 Year 2021 Class II							

Chemical Parameter

The water quality of the Way Awi river in Bandar Lampung was assessed using chemical parameters, including pH, BOD, DO, COD, phosphate, and nitrate.

Acidity level (pH) is a crucial parameter in determining water quality, indicating how acidic or basic the water is. The pH values varied across different stations: 8.17 at station I, 6.10 at station II, 8.10 at station III, 7.14 at station IV, and 8.03 at station V. According to Government Regulation No. 22 of 2021, the acceptable pH range is 6 to 9, which is suitable for aquatic life.

Biological Oxygen Demand (BOD) measures water quality by indicating the amount of pollution from organic waste. The BOD values at all stations exceeded the standard limit set by Government Regulation No. 22 of 2021 for Class II water, which is 3 mg/L. The BOD values ranged from 10 to 12 mg/L in the water samples. High BOD levels are caused by pollutants such as waste entering the water, increasing the organic load.

Dissolved Oxygen (DO) is another important water quality parameter, indicating the amount of oxygen dissolved in the water. The average DO value in the Way Awi river was 6.5 mg/L, which is considered good for fish life. BOD and DO are inversely related; higher BOD levels lead to lower DO levels, indicating pollution [13].

Chemical Oxygen Demand (COD) measures the amount of oxygen required to decompose all organic matter in the water. The COD values in the Way Awi river were 38.6 mg/L at station I, 31.6 mg/L at station II, 35.6 mg/L at station III, 39.7 mg/L at station IV, and 39.7 mg/L at station V. The standard COD limit, according to Government Regulation No. 22 of 2021, is 25 mg/L. The difference between COD and BOD values indicates the presence of organic matter that is difficult to decompose.

Phosphate levels in the Way Awi river varied significantly: 0.20 mg/L at station I, 9.12 mg/L at station II, 9.37 mg/L at station III, 8.81 mg/L at station IV, and 1.62 mg/L at station V. Four out of the five stations did not meet the standard limits. High phosphate levels are often due to domestic waste containing detergents [14], as detergents have phosphate ions as a component.

Nitrate is a vital element in water bodies. The nitrate levels in the Way Awi river were 1.049 mg/L at the upstream, 0.053 mg/L at station II, 0.061 mg/L at station III, 0.058 mg/L at station IV, and 3.695 mg/L at station V. These values are within the acceptable limit of 10 mg/L set by Government Regulation No. 22 of 2021.

Table 4. Pearson Correlation of Fish Community Structure with Water Quality Parameters

		Temperature	TSS	pH	BOD	DO	COD	Phosphate	Nitrate
H'	Pearson Correlation	-.145	**-.915***	-.845	-.423	-.327	-.543	-.261	.516
	Sig. (2-tailed)	.816	.029	.071	.478	.591	.344	.671	.374
	N	5	5	5	5	5	5	5	5
E	Pearson Correlation	-.856	**-.915***	-.105	-.639	-.675	-.131	-.668	.546
	Sig. (2-tailed)	.064	.029	.867	.246	.211	.834	.218	.341
	N	5	5	5	5	5	5	5	5
D	Pearson Correlation	-.848	**-.916***	-.134	-.658	-.650	-.162	-.645	.514
	Sig. (2-tailed)	.070	.029	.830	.227	.235	.795	.240	.375
	N	5	5	5	5	5	5	5	5

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Pearson Correlation of Fish Community Structure with Water Quality Parameters

Based on the data, there is a very significant relationship between TSS and the diversity index, with a correlation coefficient (r) of -0.915 and p-value of 0.029. TSS also shows a significant relationship with the evenness index, with a correlation coefficient (r) of -0.915 and p= 0.029. Similarly, TSS correlates with the dominance index, with a correlation coefficient (r) of -0.916 and p= 0.029, indicating a highly significant relationship.

High TSS values affect the fish community structure; high TSS values influence fish diversity indices. Polluted rivers lead to a lack of diverse fish. High TSS values reduce the oxygen released by organisms in the water, affecting the fish in the river [15].

High TSS values also affect the dominance index of fish. In the Way Awi River, no genus dominates. The dominance of a genus is affected by pollutants or environmental changes. TSS values that do not meet quality standards lead to no dominant fish in the Way Awi River [16].

TSS values in the Way Awi River vary according to river conditions, with the highest values at stations III and IV, which do not meet the 2021 PP No. 22 quality standard of 50 mg/L. Water conditions are turbid and foul-smelling at these stations, resulting in TSS values exceeding the standard. TSS consists of suspended solids, including soil particles (clay, mud, and sand), algae, plankton, and other substances.

TSS originates from household waste, industrial activities, and agriculture from various rivers flowing into river waters. Increased TSS levels increase turbidity, which in turn inhibits sunlight penetration into the water, hindering fish development. Suspended solids can also have negative impacts on aquatic ecosystems. If a water body has high concentrations of total suspended solids, its water productivity will decrease [17].

The high TSS levels in the Way Awi River are caused by continuous activities of the surrounding community [18]. At station III, high TSS values are due to the river's

proximity to the market, causing the water to be nearly black and very slippery. At station IV, in the Abdul Muluk area, high TSS levels are due to the community around Abdul Moeloek Hospital directly disposing waste into the river through drainage channels, causing high TSS levels.

CONCLUSION

The research shows that the Way Awi River is moderately polluted with a fish community structure that does not significantly affect fish population, but the number of fish from upstream to downstream is decreasing. The polluted Way Awi River also affects the gonad maturity level of fish, with the maturity of gonads not being even across each station.

REFERENCES

[1] G. Pratama, I. D. Kurniawan, dan A. F. Ilhamdy, "Pengendalian Pencemaran Limbah Domestik sebagai Upaya Rehabilitasi Pesisir di Desa Malangrapat, Kabupaten Bintan", *Journal of Community Empowering and Services*, vol. 4, no. 1, 2020, pp. 45 - 52. https://doi.org/10.20961/prima.v4i1.41228

[2] Dahruji, P.F. Wilianarti dan T. Hendarto, "Studi Pengolahan Limbah Usaha Mandiri Rumah Tanggadan Dampak Bagi Kesehatan di Wilayah Kenjeran", Aksiologiya *Jurnal Pengabdian Kepada Masyarakat*, vol. 1, no. 1, Feb. 2017. https://doi.org/10.30651/aks.v1i1.304

[3] G. M Saragih, Hadrah dan E. Prayoga, "Analisis Pengaruh Limbah Domestik terhadap Kualitas Air Anak Sungai Asam", *Jurnal Daur Lingkungan*, vol. 5, no.2, pp. 33-37. Agustus 2022. 10.33087/daurling.v5i2.115.

[4] D. Y. Pratiwi, A. P. Nugroho, dan A. Yustiati, "Dampak kualitas air pada kawasan keramba budidaya ikan air tawar di Waduk Cengklik, Boyolali", *Jurnal Akuatika Indonesia*, vol. 2, no. 2, 2019, pp. 84 – 91. https://dx.doi.org/10.24198/jaki.v4i2.25260

[5] N. K. M. Setiawati dan R. Melianawati, "Pertumbuhan dan Tingkat Kematangan Gonad Ikan Kerapu Batik (*Epinephelus polyphekadion*) Hasil Budidaya", *Journal of Fisheries and Marine Research*, vol. 4, no. 1, pp. 125 –131. 2020. https://doi.org/10.21776/ub.jfmr.2020.004.01.18.

[6] P. E. Odum, *Dasar-Dasar Ekologi*. Diterjemahkan oleh Tjahjono, Edisi Ketiga. Yogyakarta: Gadjah Mada University Press, 1996.

[7] Inasafitri, "Keanekaragaman, Keseragaman dan Dominasi Bivalvia di Muara Sungai Porong sebagai Area Buangan Lumpur Lapindo" *REKAYASA*, vol. 2, no. 1, pp. 8 – 13, 2009.

[8] I. Prasiwi dan E. Wardhani, "Analisis Hubugan Kualitas Perairan Terhadap Indeks Keanekaragaman Plankton dan Benthos di Waduk Cirata", *Jurnal Teknologi Ramah Lingkungan*, vol. 2, no. 3, 2018, pp. 1-13. https://doi.org/10.26760/jrh.v2i3.2510

[9] Sayan, K. dan Melawi, K. 2007. Natural histories: *stories from the Tennessee Valley*. Choice Reviews Online. 45(02).

[10] I. Emilia dan D. Mutiara, ". Parameter Fisika, Kimia dan Bakteriologi Air Minum Alkali Terionisasi yang Diproduksi Mesin Kangen Water Levluk SD 501", *Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam,* vol. 6, no. 1. 2019. pp. 67 – 70. https://doi.org/10.31851/sainmatika.v16i1.2845.

[11] Boyd, C.E., Wood, C.W. and Thunjai T. 2002. Aquaculture Pond Bottom Soil Quality Management. *Pond Dynamic*

Aquaculture Collaborative Research Support Program, Oregon State University, Corvallis, Oregon.

[12] H. R. Pour, N. Mirghafari dan A. Marzban, "Determination of biochemical oxygen demand (BOD) without nitrification and mineral oxidant bacteria interferences by carbonate turbidimetry" *Research Journal of Pharmaceutical, Biological and Chemical Sciences,* vol. 5, no. 5, Sept 2014, pp. 90- 95.

[13] N. Fadzry, H. Hidayat dan E. Eniati, "Analisis COD, BOD dan DO pada Instalasi Pengolahan Air Limbah (IPAL) Balai Pengelolaan Infrastruktur Air Limbah dan Minum Perkotaan Dinas PUP-ESDM Yogyakarta", *ICJR Indonesian Journal of Chemical Research*, vol. 5, no. 2. pp. 80-89, Des 2020. https://doi.org/10.20885/ijcer.vol5.iss2.art5.

[14] C. Patricia, W. Astono dan D. I. Hendrawan, "Kandungan Nitrat dan Fosfat Di Sungai Ciliwung", *Seminar Nasional Cendekiawan Ke 4*, no. 6, pp. 179-185, 2018.

[15] A. T. Salsabila, S. Rudiyanti dan O. E. Jati, "Status Pencemaran Sungai Elo Kabupaten Magelang Berdasarkan Variabel Tss, Bod, dan Amonia" *JFMR-Journal of Fisheries and Marine Research*. 7, no. 2, 2023. pp. 31- 39. https://doi.org/10.21776/ub.jfmr.2023.007.02.4

[16] A. Wirasatriya. "Pola Distribusi Klorofil-a dan Total Suspended Solid (TSS) di Teluk Toli Toli, Sulawesi", *Buletin Oseanografi Marina*, vol. 1, no. 1, pp. 10-12, 2011. https://doi.org/10.14710/buloma.v1i1.2990

[17] G. Y. Kamajaya, I. D. N. N. Putra dan I. N. G. Putra, "Analisis Sebaran Total Suspended Solid (TSS) Berdasarkan Citra Landsat 8 Menggunakan Tiga Algoritma Berbeda Di Perairan Teluk Benoa, Bali", *Journal of Marine and Aquatic Sciences*, vol. 7, no. 1, pp. 18-24, 2021.

[18] T.R Parsons, M. Takashi and B.T Hargave, *"Biological Oceanography Process*", hird Edition. Pergamon Press. New York. 1984.

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