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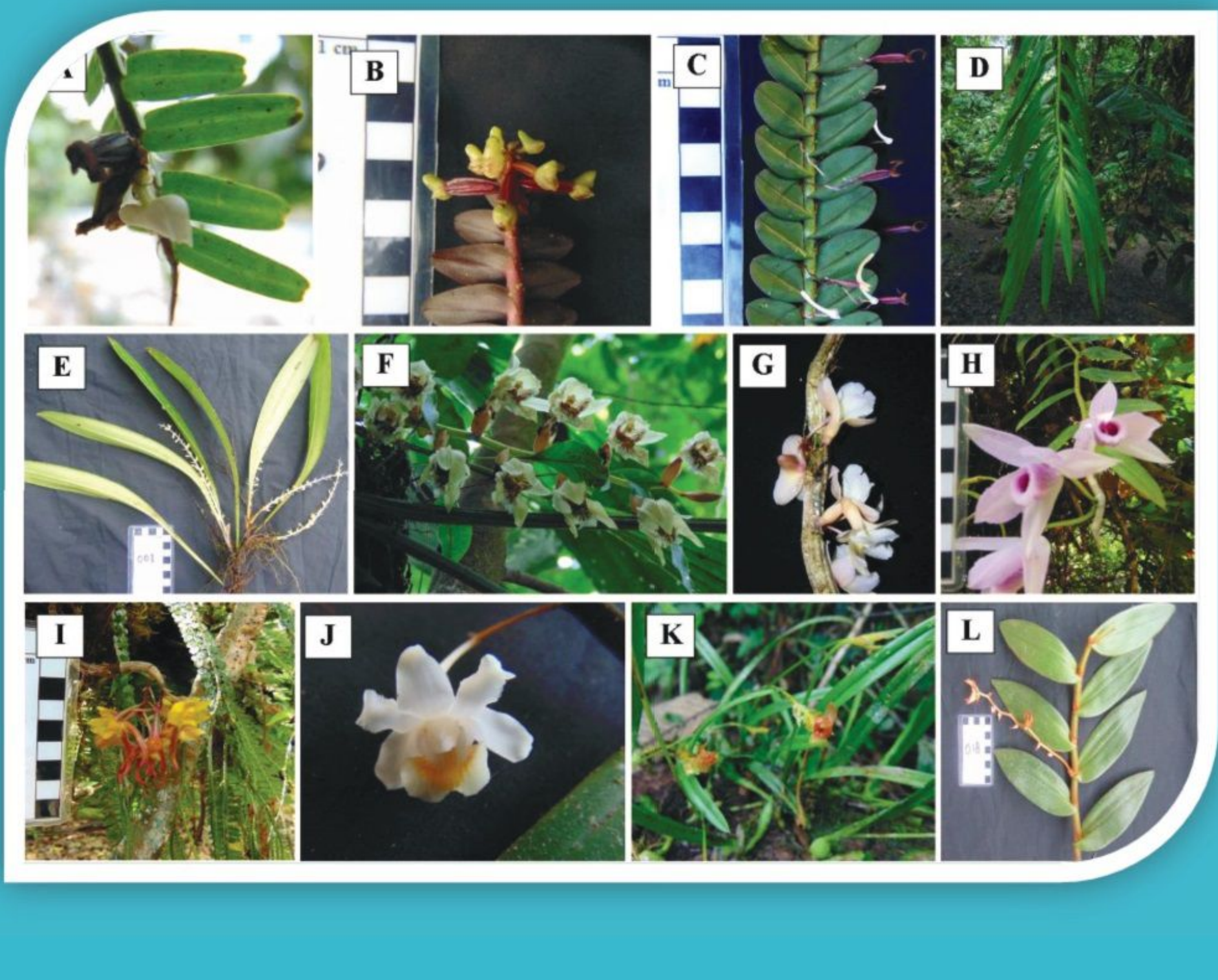

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Keterangan foto cover depan: Jenis anggrek epifit di kaki gunung Liangpran.
(*Notes of cover picture*): (*The epiphytic orchids in the foothill of Mount Liangpran)* sesuai dengan halaman 312 (*as in page 312*).

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PLANKTON DISTRIBUTION IN CONTROLLED WATER OF MILKFISH LARVA CULTURE SYSTEM

[Distribusi Plankton di Sistem Air Terkontrol pada Pemeliharaan Larva Ikan Bandeng]

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ABSTRAK

Pemilihan plankton sebagai pakan untuk larva ikan bandeng sangat penting disebabkan oleh karakter alami larva yang merupakan spesies herbivora dan kebutuhan dasar larva akan pakan dengan kualitas nutrisi yang tinggi demi menunjang pertumbuhan dan kelulushidupannya. Fitoplankton jenis *Nannochloropsis* sp. dan zooplankton rotifer (*Brachionus* sp.) dipilih sebagai pakan alami utama untuk larva ikan bandeng. Penelitian ini dilakukan sebanyak dua kali siklus pembenihan dengan menggunakan empat bak sebagai ulangan per siklus. Hasil penelitian menunjukkan bahwa kedua plankton secara efektif memberikan nutrisi yang sangat baik, dibuktikan dengan kenaikan nilai pertumbuhan (panjang larva 12±1,37 mm dan bobot larva 7±4.89 mg) dan tingginya nilai kelulushidupan selama waktu pembenihan (65.93–77.70 %). Keragaman plankton menunjukkan bahwa Klas dari rotifer (Monogononta) dan klas dari *Nannochloropsis* sp. (Eustigmatophyceae) merupakan plankton yang paling dominan di media pemeliharaan larva, yang mengindikasikan bahwa kelimpahan pakan di dalam system cukup besar dan kebutuhan pakan larva tercukupi. Jumlah total plankton selama penelitian cukup tinggi sebanding dengan konsentrasi jumlah plankton yang diberikan, menyatakan bahwa kondisi media pemeliharaan larva masih terkontrol selama penelitian berlangsung.

Kata kunci: Larva Bandeng, *Nannochloropsis* sp., Plankton, Pembenihan, Rotifer

ABSTRACT

The selection of planktons as live feed for milkfish larvae is a vital tool to meet the natural character as herbivorous species and to fulfill the needs for nutritious food for fish larval growth and survival. Phytoplankton *Nannochloropsis* sp. and zooplankton rotifer (*Brachionus* sp.) were two-selected plankton used as the main food source for the milkfish larvae. We performed this study in two times larval culture batch with four observations of tanks as replication. The results showed that we nourished both targeted planktons as larval food, regarding the positive impacts on larval growth (12±1,37 mm of total length, 7±4.89 mg of body weight) and a high survival rate (65.93–77.70%) achieved at the end of the culture period. Plankton diversity analysis presented that Class of rotifer (Monogononta) and *Nannochloropsis* sp. (Eustigmatophyceae) were both counted as the most dominant plankton group found in the rearing media, showing a decent sign of food supply for fish in rearing water column. The total number of planktons was high and had the tendency to follow the concentration of selected planktons over the culture period in the controlled water.

Key words: Larval rearing, *Nannochloropsis* sp., Milkfish larvae, Plankton, Rotifer

INTRODUCTION

Plankton inhabits and grows in marine and freshwater as primary food source in water food chain for many fish and aquatic larvae. In aquaculture, plankton is utterly important for the functioning of early feeding and succession of larval stages many farmed species (Dhert *et al.*, 2001). Therefore, effects of food for larval development and survival are extensively investigated (Holt, 2011; St. John *et al.*, 2001; Malzahn *et al.*, 2007).

Milkfish (*Chanos chanos* Forsskal) is renowned as herbivorous species, so that they have high dependency on plankton as the main food, especially in the larval stage (Yap *et al.*, 2007). Hence, the availability of plankton in the larviculture water becomes a bottleneck to fulfill the needs of milkfish larvae in the quantity and quality of nutrition in order to undergo any morphological changes, growth and survival of milkfish larva.

Several studies had investigated in selecting of plankton as live feed, observing in enrichment of food, and also the optimum feeding regime in order to enhance the growth and survival of milkfish larvae (Afifah and Aslianti, 2010; Priyono *et al.,* 2011; Sumiarsa *et al.,* 1996). It was reported that *Nannochloropsis* sp. and rotifer (*Brachionus* sp.) are the most suitable plankton consumed by most of marine larvae due to its easiness to be cultured, high-content nutritional values and its fitness with to the larval mouth size (Dehasque *et al.*, 1998; Patadjai, 2001).

However, the information about the distribution of selected plankton itself in the rearing media and the effect of those given plankton in the plankton community system of rearing media has never to be discussed. The aims of this study were to investigate the consumption pattern of milkfish larvae to its selected plankton food (*Nannochloropsis* sp. and

Kontributor Utama
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Brachionus sp.), to understand the effectiveness of selected plankton feedings on larval daily needs, and finally to identify if there are any changes or effect in plankton communities structure in the rearing controlled condition.

MATERIALS AND METHODS

Milkfish larval rearing

Milkfish larval rearing was conducted in Milkfish Hatchery of Institute for Mariculture Research and Fisheries Extension (IMRAFE) at Gondol, Bali Indonesia. This study was carried out in two cycles of larval rearing at June and September, using four tanks as replications for each period.

Concrete tanks volume 8 m^3 were employed as rearing container, filled with sterilized seawater 32–34 ppt and equipped with 6 points of aeration stone as oxygen supply. The average of 100 milkfish eggs/L was put in each tank as the initial density of larvae stock. The eggs were stocked at first day post hatching (dph) then sampled for counting as number of Hatching Rate (HR). Milkfish larval rearing was conducted based on Standard Operating Procedures for Milkfish Larval Rearing released by Institute for Mariculture Research and Development (IMRAD) (Priyono *et al*., 2011).

Live feed was obtained from the outdoor mass culture production system in Live Feed Installation of IMRAD Gondol Bali. *Nannochloropsis* sp. was used as the main phytoplankton to nourish rotifer (*Brachionus* sp.) that simultaneously will be given as the main food to the milkfish larvae. Feeding regime and water exchange management employed in this study can be seen as in Table 1. Three hundreds cells/ml of *Nannochloropsis* sp. were added to tanks throughout rearing period. Five individual of rotifer/ml were put into the rearing media since first until seven dph and then continuously increased by 5 individual/ml up to harvest time. The number of remaining given planktons in the rearing media was counted daily and adjusted based on their needs. Rearing water were changed every day began from 10 dph by 50% from the total water volume, and raise for 10% and up to 100% at 16 dph.

Larvae were reared until become seed for 16 dph. At the end of the study, the final number of seeds were counted as Survival Rate (SR), which twenty seeds were then randomly selected to measured growth (total length and body weight).

Sample collection and analysis

Plankton profiles pattern was observed by taking 1 L of larviculture water sample and placed it into plastic sample bottle. Samples were taken from each replication tank every 5 days, started from 2 dph. Samplings were conducted on the next morning days to indicate the number of *Nannochloropsis* sp. and rotifer consumed in the previous day. All collected samples were put into a cold and insulated container then transported to the laboratory for analysis.

Phytoplankton and zooplankton were measured for their quantity in Laboratory of Biology IMRAD Gondol Bali. The number of *Nannochloropsis* sp. was counted manually using Haemocytometer (Taylor *et al*., 1997). Rotifer was enumerated utilizing Sedgewick Rafter Counting Chamber (APHA, 2005). Both *Nannochloropsis* and rotifer samples were placed under a compound light Microscope (Olympus CH-2 eyepiece magnification 10x, 40x

Table 1. Milkfish larval rearing feeding and water changing management (*Manajemen pemberian pakan dan pergantian air pada pembenihan larva ikan bandeng*)

	Days Post Hatch (*Hari setelah menetas*)					
	0-1	2	4	8	12	16
Nannochloropsis sp. Rotifer (ind/ml)		**5----------**	**5----------**	**10----------**	**15----------**	**20----------**
Water exchange (% water/ tanks)					**50----------**	**100--------**

and 100x). Chlorophyll *a* analysis was also performed with employing Standard Methods for Chlorophyll *a* Concentrations, in order to estimate total biomass in the rearing system (APHA, 2011).

Water samples (200 ml) were also transported to Marine Quality Assessment Laboratory of Institute of Marine Research Observation in Perancak, Jembrana Bali to identify any presence of other plankton in the rearing water column. All distinct plankton founded in this experiment were recorded and identified to the lowest possible taxa level.

Water quality analysis was conducted daily for temperature, pH, dissolved oxygen (DO) by using water thermometer, pH, and DO meter, respectively. While, analysis of ammonium and nitrite were carried out every 4 days by employing Standards Methods for The Examination of Water and Waste Water (APHA, 2005).

Data analysis

All the collected data were tabulated and analysed in Microsoft Excel for Mac 2012. Diversity index was also employed to give a mathematical measure of species diversity in the tested water. The Simpson Index (D) was used to investigate the proportion of one particular individual to the total number individuals in community. While Evenness (E) was calculated according to Pielou (1967) to emphasize how even the individual taxa is distributed to the other taxa group (Kelly *et al.*, 1998).

RESULTS

Feeding pattern of milkfish larvae

The data showed that milkfish larval consumption on selected plankton (rotifer) in the rearing system was increased by the culture periods (Figure 1). The mean number of rotifer occurrence in the rearing water was depleted in nearly 24 hours after feeding, representing a relatively high number of rotifer consumed by milkfish larvae for a single day. Comparably, both rearing cycle displayed similar patterns of milkfish larval consumption. The consumed rotifer pattern presented a very close quantity to its starting stock number indicating that rotifer was efficiently consumed and preferable as food for milkfish larvae.

In order to provide high nutritional contents in rotifer, *Nannocholopsis* sp. was also continuously supplemented daily in rearing media in constant amount of 300.000 cells/ ml as described in Figure 2. The number of *Nannocholopsis* sp. in the water was showing downward trends for both culture cycles over culture periods. On the other hand, data also showed the increase in Nannochloropsis cell number consumed by larvae. Following the same trends in both culture cycles, *Nannochoropsis* sp. were

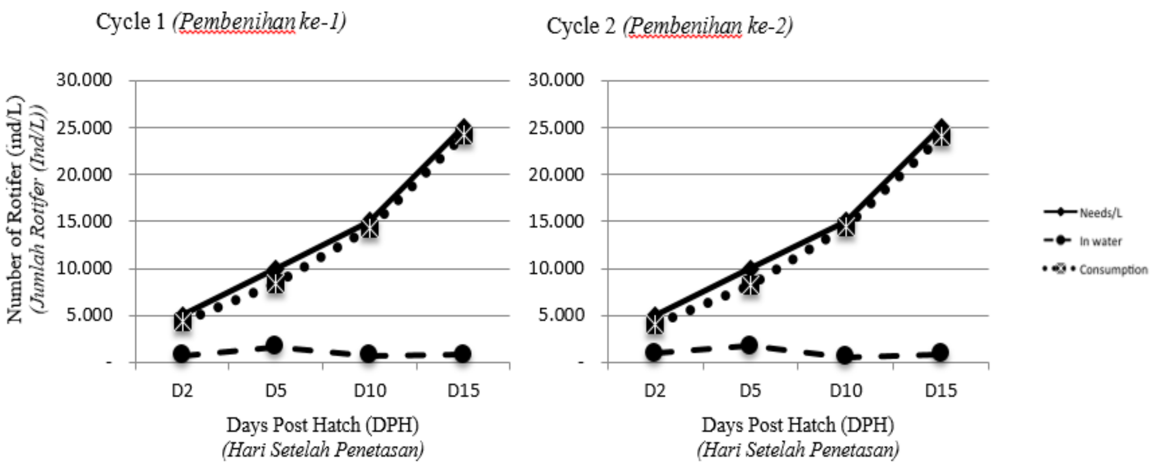

Figure 1. The mean of Rotifer occurrence sampled from water column throughout rearing period from two culture cycles. (*Rata-rata jumlah Rotifer ± SD selama pemeliharaan larva bandeng dari dua siklus pembenihan.*)

consumed in the number of 220.000 at 2 dph to 297.000 cells/ ml at 15 dph in first culture cycle, and accounted from 134,000 to 12.100 ml/cells, in the second culture batch respectively. Figure 1 indicates that algae were fully used by rotifer in 15 dph of rearing system.

Chlorophyll a

Total plankton biomass in the larvae tanks, as estimated by the chlorophyll a concentrations is presented in Figure 3. Concentration of chlorophyll a tend to be stable in the range between 3 to 3.50 µg/mm then fell in to approximately 2.40 µg/mm. Data obtained from both culture cycles were presenting consistent trends, indicating that the values of this chlorophyll a may have relation in the feeding pattern of milkfish larvae. It is assumed that when larvae are getting older, the amount of given plankton stock as food will increase, means that the plankton biomass is higher. After stocked plankton fully consumed by larvae, the biomass values will follow down.

Growth and survival of larvae

In this study, milkfish larvae presented a good proportional growth and high survival rates after 16 days of rearing time. The mean values of total length of larvae recorded in the end of this study were 11.78±1.72 mm and 12.46±2.04 mm for cycle 1 and 2, respectively (Figure 4). While the average body weight were gained for nearly 7±59 mm and 7±1.8 in the final culture day for both culture cycles. Survival Rates showed average values of 77.7% and 65.93% noted from both culture cycles (Figure 5).

Other plankton in culture water system

There were three major groups founded in this study consisting of plankton, zooplankton and other microorganism species, which comprises in several classes, families and genera as described in (Table 2).

This study identified that class of rotifer (Monogononta) and *Nannochloropsis* sp. (Eustigmatophyceae) were both the most dominant plankton group found in milkfish larval rearing media of both experiment cycles. This condition suggest that selected planktons (rotifer and *Nannochloropsis* sp) still the most available plankton in the system and also gives the biggest contribution in supplying suitable amount of food for milkfish larvae.

Analysis data showed that plankton diversity for milkfish larvae indexed from 0,37 to 0,69 at first cycle and between 0,63 and 0,91 at second culture

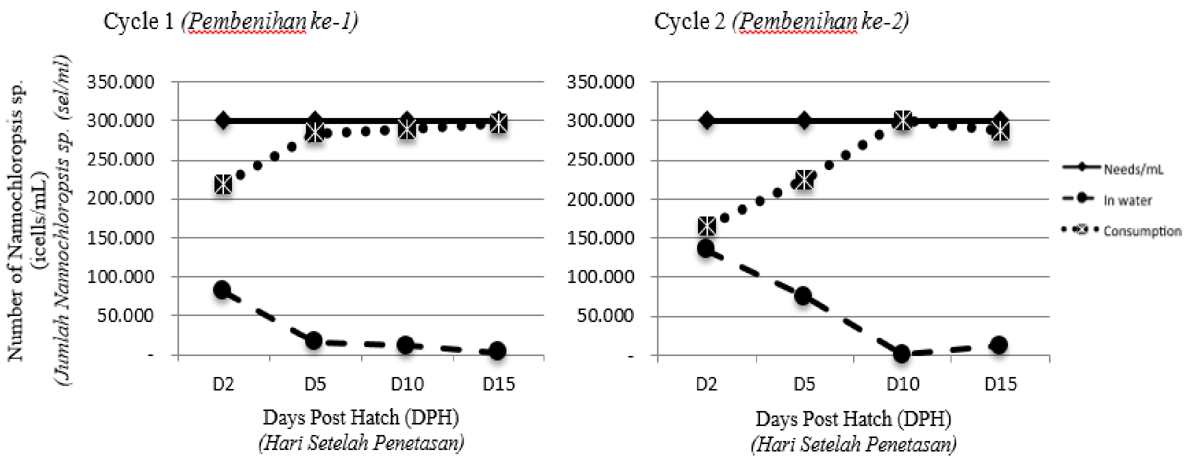

Figure 2. The average number of *Nannochloropsis* sp. sampled from water column throughout rearing period for both culture cycles. (*Rata-rata jumlah Nannochloropsis* sp. ± *SD selama pemeliharaan larva bandeng dari dua siklus pembenihan*.)

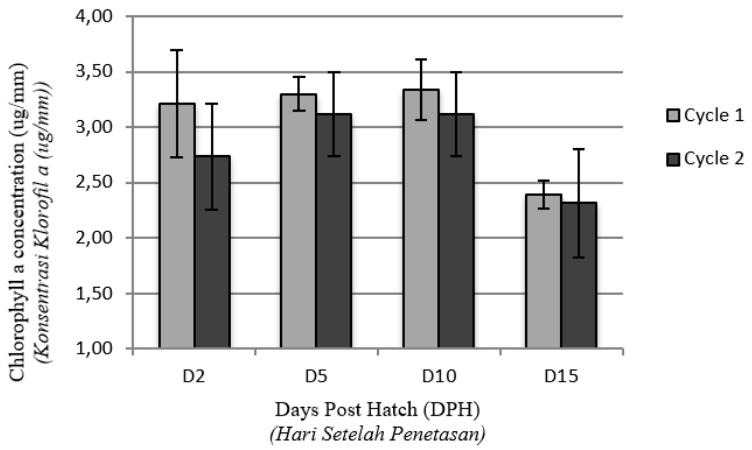

Figure 3. The average concentrator of chlorophyll a measured from milkfish larvae rearing water for both culture cycles. (*Rata-rata nilai klorofil a ± SD yang diukur dari air pemeliharaan larva bandeng dari dua siklus pembenihan*)

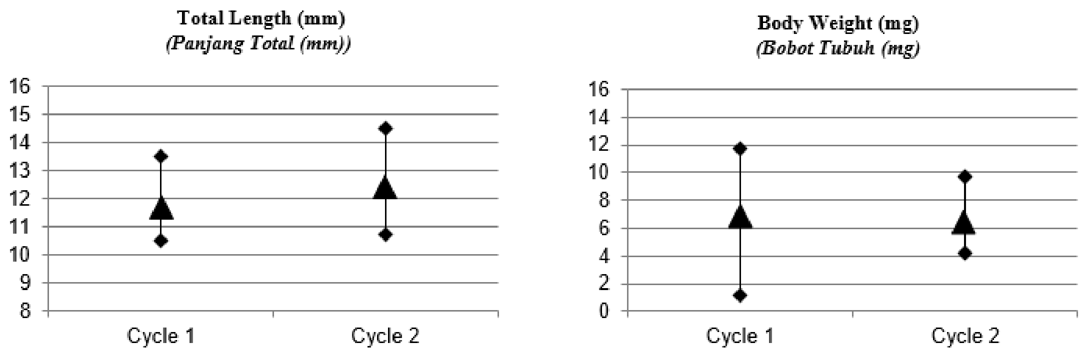

Figure 4. The average length (left) and body weight (right) of milkfish larvae at the termination of this study (15 dph) measured for both culture cycles. (*Rata-rata nilai panjang total (kiri) dan bobot tubuh (kanan) ± SE yang dihitung dari dua siklus pembenihan*)

cycle, respectively. The highest plankton diversity is 10 dph of rearing (Figure 6), suggesting that species found were more varied after the rearing system received water exchange treatment. Consistently, the lowest diversity index showed in 2 and 5 dph sampling water, illustrated only few species variation detected in the water column with stable water or without additional water intake. Moreover, evenness values demonstrated low values ranging from 0,25 to 0,60 in first culture batch and between 0,43 and 0,50 in second larval rearing (Figure 6).

Water quality

Environmental factors such as water temperature, salinity, light intensity, and colour, day/night periodicity and water quality have an effect on both plankton and larvae in the rearing conditions. All parameter of water quality recorded during this study were preferable and in range for common milkfish larval culture conditions (Figure 7). Live feed plankton in the intensive finfish larviculture system is cultured the rearing media in the range of temperature 22–28 °C, pH 7–8.5, dissolved oxygen > 4 ppm and total

Table 2. List of plankton and microorganism found during milkfish larval rearing periods (*Daftar plankton dan mikroorganisme yang di temukan selama pemeliharaan larva ikan bandeng*)

Groups	Class *(Kelas)*	Family *(Famili)*	Genus *(Genus)*
1. Plankton	1. Eustigmatophyceae	1. Eustigmataceae	1. *Nannochloropsis*
		2. Eucampiaceae	2. *Streptotheca*
	2. Diatoms	3. Coscinodiscaceae	1. *Concinodiscus*
		4. Biddulphiaceae	1. *Isthmia*
			2. *Biddulphia*
		5. Thalassiosiraceae	1.*Thalassiosira*
		6. Melosiraceae	2. *Meosira*
		7. Fragilariaceae	1. *Thalassiothrix*
		8. Nitzschiaceae	1. *Amphipora*
			2. *Donkinia*
		9. Rhizosoleniaceae	1. *Rhizosolenia*
		10. Naviculaceae	1. *Pleurosigma*
			2. *Mestogloia*
			3. *Diploneis*
		11. Eucampiaceae	1. *Streptotheca*
	3. Dinophyceae	12. Glenodiaceae	1. *Glenodinium*
		13. Ceratiaceae	1. *Ceratium*
		14. Peridiniaceae	1. *Peridinium*
			2. *Prorocentrum*
	4. Cyanophyceae	15. Oscilatoriaceae	1. *Pelagothrix*
			2. *Anabaena*
2. Zooplankton	1. Monogononta	1. Brachionidae	1. *Brachionus*
			2. *Notholca*
3. Microorganism	1. Ciliata	1. Cyttarocilidae	1. *Favella*
	2. Crustacea	2. Cypridinidae	1. *Cypridina*
		3. Clytemnestridae	1. *Clytemnestera*
		4. Tachidiidae	1. *Microstella*
		5. Macrosetellidae	1. *Macrosetella*
		6. Sarcodina	1. *Sphaerozoum*
		7. Acartiidae	1. *Acartia*
	3. Holothuroidea	8. Holothuriidae	1. *Holothuria*
	4. Larva planktonic		Larva planktonic

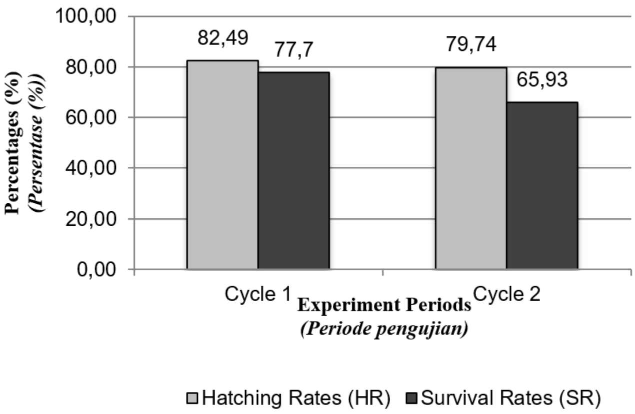

Figure 5. The average Hatching Rate (HR) and Survival Rate (SR) of milkfish larvae accounted for both culture cycles. (*Rata-rata nilai daya tetas (HR) dan kelulushidupan (SR) yang dihitung dari dua siklus pembenihan.*)

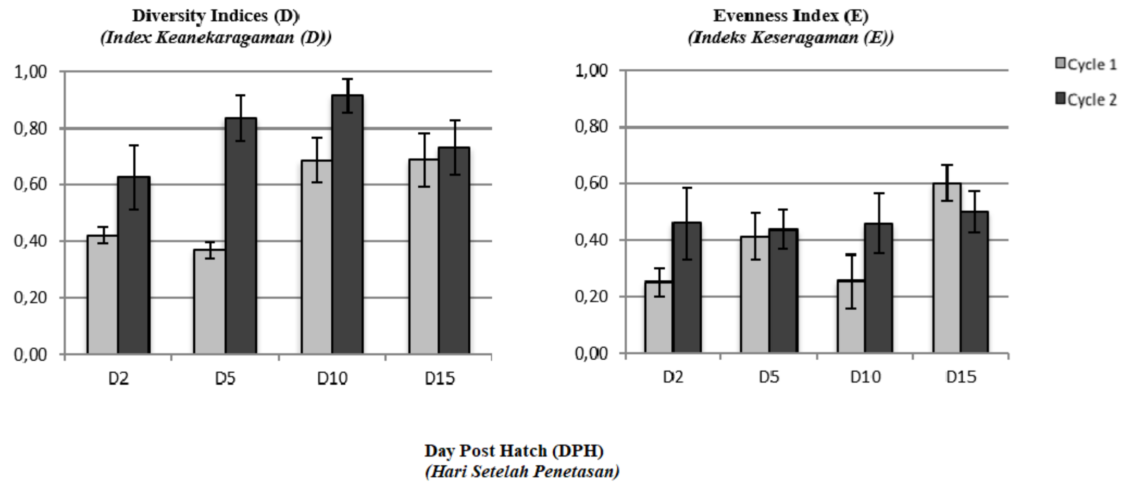

Figure 6. The diversity indices (Shannon diversity; Evenness) of plankton collected from milkfish larvae rearing water for both culture cycles. (*Rata-rata nilai analisa keragaman plankton (Shannon diversity; Evenness) ± SE yang diukur dari air pemeliharaan larva bandeng dari dua siklus pembenihan.*)

ammonia nitrogen ≤5 ppm (Delbos, 2009). It seems that regular water exchange on daily basis in this system can maintain the water quality within desired parameters and preferable for plankton cells proliferations and for milkfish larvae growth.

DISCUSSION

This study showed there is a reliable increasing pattern in the number of consumed rotifer over larval stage, that in milkfish larviculture system, indicating the effectiveness in feeding regime. This finding was consistent with previous studies that documented the suitability of using rotifer for basic food and nutrition's source some other marine fish larvae because of its high nutritional quality contents, availability at any natural marine water and its proper size to be digested for targeted cultured species (Agh and Sorgeloos, 2005;. Arimoro, 2006; Izquierdo, 1996; Wilkersons, 2001).

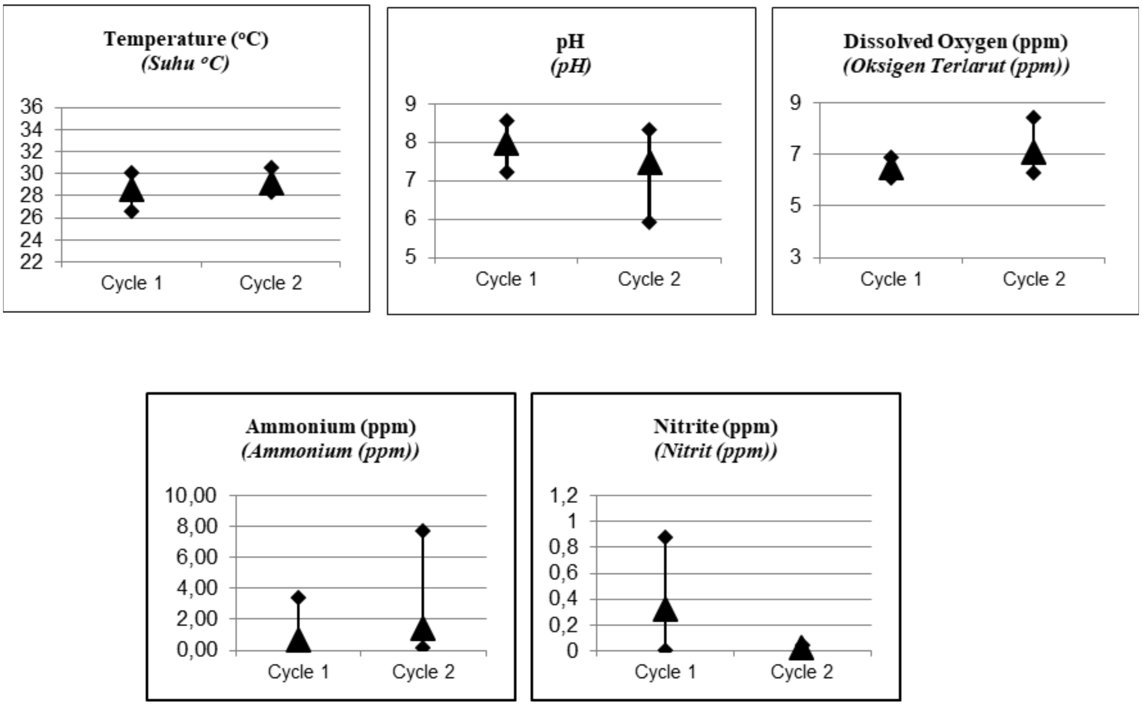

Figure 7. The average number of water quality measured from milkfish larvae rearing water throughout rearing period for both culture cycles. (*Rata-rata nilai kualitas air ± SD yang diukur dari air pemeliharaan larva bandeng dari dua siklus pembenihan*)

In the practice of marine aquaculture, rotifer *Brachionus* sp. is one of the most important exogenous live feeds needed for larvae (Lubzens, 1989). Rotifer is nourished by *Nannochloropsis* sp. by the act as zooplanktons' natural food and nanno will also performs as green water treatment in the system (Hulatt, 2017; Juario and Duray, 1983). In fact, the total number of algae consumed by rotifer seems to be related to each indidual rotifer body size. In terms of nutritional value, *Nannochloropsis* sp. has high quantity of omega-3 and n-3-highly unsaturated essential fatty acid (n-3 HUFA), which marine fish are unable to synthesize in large amount but important ingredients for growth and survival of marine fish larvae (Park *et al.*, 2006; Sulehria *et al.*, 2015).

The best-selected plankton kinds and their availability in the larviculture media are the key elements on growth and survival of milkfish in underdoing larval stage. Previous study showed that milkfish larvae will reach approximately 11 mm of length, about 8 mg of weight (Aslianti *et al*, 2012), and also recorded to have survival rate ranged from 27,10 to 63,57 % after 16 days of culture (Nasukha & Aslianti, 2012). It means that the growth and survival values gained in this study are considerably higher compared with several previous studies. Indeed, monitoring the number selected plankton and maintaining its feeding patterns are needed throughout rearing periods. In the case of milkfish larvae as herbivorous species, the amount and nutrition contents of plankton as food become the ultimate factor that cannot be averted.

In the larviculture system, the distribution and number of other plankton needs to be controlled. Even if the use of clean and sterile seawater has integrated in the protocol in the milkfish larval rearing husbandry, the incidence of various types of other planktons and or microorganism than given ones in the water still seems unavoidable. Low evenness in this study represents the domination of few species in the rearing water area. It was noted that class of rotifer (Monogononta) and

Nannochloropsis sp. (Eustigmatophyceae) were still the most dominant plankton founded in the rearing media. Outnumbering of other micro-organism than selected plankton is likely to be occurred especially when the supplies of targeted ones is getting lower whilst feeding frequency of larvae going higher in the rearing media. In the nature, marine larvae may prefer to a particular food, but their selectivity appears to be flexible depend on the readability and availability of food, in a way of that larvae may substitute their food (Robert *et al*., 2014).

Thus, it may raise a concern that other non-selected organism in the water may become competitors for food and water space also become vector to any bacterial or parasitic disease to the larvae (Dhert *et al*., 2001; Skjermo and Vadstein, 1999). Even though some studies mention that mixed algae may become good option for marine larvae, but at the same time giving more chance on plankton contamination in the culture water (Sulehria *et al*., 2015).

CONCLUSION

This result of this study indicates the distributions of planktons and its consumptions patterns in rearing media are important to be monitored. The selected planktons for feeding, rotifers nourished with *Nannochloropsis* sp. is suitable and essential for main food for milkfish larvae, verified with the consumption pattern of larvae and its relation with better growth and higher survival rates of larvae. The incidence and outnumber of other plankton may occur if the main selected plankton as a food in water is considerably low, hence it may trigger to contamination or disturbance in rearing system.

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Pedoman Penulisan Naskah Berita Biologi

Berita Biologi adalah jurnal yang menerbitkan artikel kemajuan penelitian di bidang biologi dan ilmu-ilmu terkait di Indonesia. Berita Biologi memuat karya tulis ilmiah asli berupa makalah hasil penelitian, komunikasi pendek dan tinjauan kembali yang belum pernah diterbitkan atau tidak sedang dikirim ke media lain. Masalah yang diliput harus menampilkan aspek atau informasi baru.

Tipe naskah

1. **Makalah lengkap hasil penelitian (*original paper*)**
   Naskah merupakan hasil penelitian sendiri yang mengangkat topik yang *up to date*. Tidak lebih dari 15 halaman termasuk tabel dan gambar. Pencantuman lampiran seperlunya, namun redaksi berhak mengurangi atau meniadakan lampiran.
2. **Komunikasi pendek (*short communication*)**
   Komuniasi pendek merupakan makalah hasil penelitian yang ingin dipublikasikan secara cepat karena hasil termuan yang menarik, spesifik dan atau baru, agar dapat segera diketahui oleh umum. Hasil dan pembahasan dapat digabung.
3. **Tinjauan kembali (*review*)**
   Tinjauan kembali merupakan rangkuman tinjauan ilmiah yang sistematis-kritis secara ringkas namun mendalam terhadap topik penelitian tertentu. Hal yang ditinjau meliputi segala sesuatu yang relevan terhadap topik tinjauan yang memberikan gambaran '*state of the art*', meliputi temuan awal, kemajuan hingga issue terkini, termasuk perdebatan dan kesenjangan yang ada dalam topik yang dibahas. Tinjauan ulang ini harus merangkum minimal 30 artikel.

Struktur naskah

1. **Bahasa**
   Bahasa yang digunakan adalah Bahasa Indonesia atau Inggris yang baik dan benar.
2. **Judul**
   Judul diberikan dalam bahasa Indonesia dan inggris. Judul ditulis dalam huruf tegak kecuali untuk nama ilmiah yang menggunakan bahasa latin, Judul harus singkat, jelas dan mencerminkan isi naskah dengan diikuti oleh nama serta alamat surat menyurat penulis dan alamat email. Nama penulis untuk korespondensi diberi tanda amplop cetak atas (*superscript*). Jika penulis lebih dari satu orang bagi pejabat fungsional penelitian, pengembangan agar menentukan status sebagai kontributor utama melalui penandaan simbol dan keterangan sebagai kontributor utama dicatatan kaki di halaman pertama artikel.
3. **Abstrak**
   Abstrak dibuat dalam dua bahasa, bahasa Indonesia dan Inggris. Abstrak memuat secara singkat tentang latar belakang, tujuan, metode, hasil yang signifikan, kesimpulan dan implikasi hasil penelitian. Abstrak berisi maksimum 200 kata, spasi tunggal. Di bawah abstrak dicantumkan kata kunci yang terdiri atas maksimum enam kata, dimana kata pertama adalah yang terpenting. Abstrak dalam Bahasa Inggris merupakan terjemahan dari Bahasa Indonesia. Editor berhak untuk mengedit abstrak demi alasan kejelasan isi abstrak.
4. **Pendahuluan**
   Pendahuluan berisi latar belakang, permasalahan dan tujuan penelitian. Perlu disebutkan juga studi terdahulu yang pernah dilakukan terkait dengan penelitian yang dilakukan.
5. **Bahan dan cara kerja**
   Bahan dan cara kerja berisi informasi mengenai metode yang digunakan dalam penelitian. Pada bagian ini boleh dibuat sub-judul yang sesuai dengan tahapan penelitian. Metoda harus dipaparkan dengan jelas sesuai dengan standar topik penelitian dan dapat diulang oleh peneliti lain. Apabila metoda yang digunakan adalah metoda yang sudah baku cukup ditulis sitasinya dan apabila ada modifikasi maka harus dituliskan dengan jelas bagian mana dan hal apa yang dimodifikasi.
6. **Hasil**
   Hasil memuat data ataupun informasi utama yang diperoleh berdasarkan metoda yang digunakan. Apabila ingin mengacu pada suatu tabel/ grafik/diagram atau gambar, maka hasil yang terdapat pada bagian tersebut dapat diuraikan dengan jelas dengan tidak menggunakan kalimat 'Lihat Tabel 1'. Apabila menggunakan nilai rata- rata maka harus menyertakan pula standar deviasinya.
7. **Pembahasan**
   Pembahasan bukan merupakan pengulangan dari hasil. Pembahasan mengungkap alasan didapatkannya hasil dan arti atau makna dari hasil yang didapat tersebut. Bila memungkinkan, hasil penelitian ini dapat dibandingkan dengan studi terdahulu.
8. **Kesimpulan**
   Kesimpulan berisi infomasi yang menyimpulkan hasil penelitian, sesuai dengan tujuan penelitian, implikasi dari hasil penelitian dan penelitian berikutnya yang bisa dilakukan.
9. **Ucapan terima kasih**
   Bagian ini berisi ucapan terima kasih kepada suatu instansi jika penelitian ini didanai atau didukungan oleh instansi tersebut, ataupun kepada pihak yang membantu langsung penelitian atau penulisan artikel ini.
10. **Daftar pustaka**
    Tidak diperkenankan untuk mensitasi artikel yang tidak melalui proses *peer review*. Apabila harus menyitir dari "laporan" atau "komunikasi personal" dituliskan '*unpublished*' dan tidak perlu ditampilkan di daftar pustaka. Daftar pustaka harus berisi informasi yang *up to date* yang sebagian besar berasal dari *original papers* dan penulisan terbitan berkala ilmiah (nama jurnal) tidak disingkat.

Format naskah

1. Naskah diketik dengan menggunakan program Microsoft Word, huruf New Times Roman ukuran 12, spasi ganda kecuali Abstrak spasi tunggal. Batas kiri-kanan atas-bawah masing-masing 2,5 cm. Maksimum isi naskah 15 halaman termasuk ilustrasi dan tabel.
2. Penulisan bilangan pecahan dengan koma mengikuti bahasa yang ditulis menggunakan dua angka desimal di belakang koma. Apabila menggunakan Bahasa Indonesia, angka desimal ditulis dengan menggunakan koma (,) dan ditulis dengan menggunakan titik (.) bila menggunakan bahasa Inggris. Contoh: Panjang buku adalah 2,5 cm. Lenght of the book is 2.5 cm. Penulisan angka 1-9 ditulis dalam kata kecuali bila bilangan satuan ukur, sedangkan angka 10 dan seterusnya ditulis dengan angka. Contoh lima orang siswa, panjang buku 5 cm.
3. Penulisan satuan mengikuti aturan *international system of units*.
4. Nama takson dan kategori taksonomi ditulis dengan merujuk kepada aturan standar yang diakui. Untuk tumbuhan menggunakan *International Code of Botanical Nomenclature* (ICBN), untuk hewan menggunakan International *Code of Zoological Nomenclature* (ICZN), untuk jamur *International Code of Nomenclature for Algae*, *Fungi and Plant* (ICFAFP), *International Code of Nomenclature of Bacteria* (ICNB), dan untuk organisme yang lain merujuk pada kesepakatan Internasional. Penulisan nama takson lengkap dengan nama author hanya dilakukan pada bagian deskripsi takson, misalnya pada naskah taksonomi. Penulisan nama takson untuk bidang lainnya tidak perlu menggunakan nama author.
5. Tata nama di bidang genetika dan kimia merujuk kepada aturan baku terbaru yang berlaku.
6. Untuk range angka menggunakan en dash (–), contohnya pp.1565–1569, jumlah anakan berkisar 7–8 ekor. Untuk penggabungan kata menggunakan hyphen (-), contohnya: masing-masing.
7. Ilustrasi dapat berupa foto (hitam putih atau berwarna) atau gambar tangan (*line drawing*).
8. Tabel
   Tabel diberi judul yang singkat dan jelas, spasi tunggal dalam bahasa Indonesia dan Inggris, sehingga Tabel dapat berdiri sendiri. Tabel diberi nomor urut sesuai dengan keterangan dalam teks. Keterangan Tabel diletakkan di bawah Tabel. Tabel tidak dibuat tertutup dengan garis vertikal, hanya menggunakan garis horisontal yang memisahkan judul dan batas bawah.

8. Gambar
   Gambar bisa berupa foto, grafik, diagram dan peta. Judul gambar ditulis secara singkat dan jelas, spasi tunggal. Keterangan yang menyertai gambar harus dapat berdiri sendiri, ditulis dalam bahasa Indonesia dan Inggris. Gambar dikirim dalam bentuk .jpeg dengan resolusi minimal 300 dpi, untuk *line drawing* minimal 600dpi.
9. Daftar Pustaka
   Sitasi dalam naskah adalah nama penulis dan tahun. Bila penulis lebih dari satu menggunakan kata 'dan' atau *et al*. Contoh: (Kramer, 1983), (Hamzah dan Yusuf, 1995), (Premachandra *et al*., 1992). Bila naskah ditulis dalam bahasa Inggris yang menggunakan sitasi 2 orang penulis maka digunakan kata 'and'. Contoh: (Hamzah and Yusuf, 1995). Jika sitasi beruntun maka dimulai dari tahun yang paling tua, jika tahun sama maka dari nama penulis sesuai urutan abjad. Contoh: (Anderson, 2000; Agusta *et al*., 2005; Danar, 2005). Penulisan daftar pustaka, sebagai berikut:

   a. **Jurnal**
   Nama jurnal ditulis lengkap.
   Agusta, A., Maehara, S., Ohashi, K., Simanjuntak, P. and Shibuya, H., 2005. Stereoselective oxidation at C-4 of flavans by the endophytic fungus *Diaporthe* sp. isolated from a tea plant. *Chemical and Pharmaceutical Bulletin*, *53*(12), pp.1565–1569.
   b. **Buku**
   Anderson, R.C. 2000. *Nematode Parasites of Vertebrates, Their Development and Tramsmission*. 2nd ed. CABI Publishing. New York. pp. 650.
   c. **Prosiding atau hasil Simposium/Seminar/Lokakarya.**
   Kurata, H., El-Samad, H., Yi, T.M., Khammash, M. and Doyle, J., 2001. Feedback Regulation of the Heat Shock Response in *Eschericia coli*. *Proceedings of the 40th IEEE Conference on Decision and Control*. Orlando, USA. pp. 837–842.
   d. **Makalah sebagai bagian dari buku**
   Sausan, D., 2014. Keanekaragaman Jamur di Hutan Kabungolor, Tau Lumbis Kabupaten Nunukan, Kalimanan Utara. Dalam: Irham, M. & Dewi, K. eds. *Keanekaraman Hayati di Beranda Negeri*. pp. 47–58. PT. Eaststar Adhi Citra. Jakarta.
   e. **Thesis, skripsi dan disertasi**
   Sundari, S., 2012. Soil Respiration and Dissolved Organic Carbon Efflux in Tropical Peatlands. *Dissertation*. Graduate School of Agriculture. Hokkaido University. Sapporo. Japan.
   f. **Artikel online.**
   Artikel yang diunduh secara online ditulis dengan mengikuti format yang berlaku untuk jurnal, buku ataupun thesis dengan dilengkapi alamat situs dan waktu mengunduh. Tidak diperkenankan untuk mensitasi artikel yang tidak melalui proses peer review misalnya laporan perjalanan maupun artikel dari laman web yang tidak bisa dipertangung jawabkan kebenarannya seperti wikipedia.
   Himman, L.M., 2002. A Moral Change: Business Ethics After Enron. San Diego University Publication. *http:ethics.sandiego.edu/LMH/oped/Enron/index.asp*. (accessed 27 Januari 2008) bila naskah ditulis dalam bahasa inggris atau (diakses 27 Januari 2008) bila naskah ditulis dalam bahasa indonesia

Formulir persetujuan hak alih terbit dan keaslian naskah
Setiap penulis yang mengajukan naskahnya ke redaksi Berita Biologi akan diminta untuk menandatangani lembar persetujuan yang berisi hak alih terbit naskah termasuk hak untuk memperbanyak artikel dalam berbagai bentuk kepada penerbit Berita Biologi. Sedangkan penulis tetap berhak untuk menyebarkan edisi cetak dan elektronik untuk kepentingan penelitian dan pendidikan. Formulir itu juga berisi pernyataan keaslian naskah yang menyebutkan bahwa naskah adalah hasil penelitian asli, belum pernah dan tidak sedang diterbitkan di tempat lain serta bebas dari konflik kepentingan.

Penelitian yang melibatkan hewan
Setiap naskah yang penelitiannya melibatkan hewan (terutama mamalia) sebagai obyek percobaan/penelitian, wajib menyertakan *'ethical clearance approval*' terkait animal *welfare* yang dikeluarkan oleh badan atau pihak berwenang.

Lembar ilustrasi sampul
Gambar ilustrasi yang terdapat di sampul jurnal Berita Biologi berasal dari salah satu naskah yang dipublikasi pada edisi tersebut. Oleh karena itu, setiap naskah yang ada ilustrasinya diharapkan dapat mengirimkan ilustrasi atau foto dengan kualitas gambar yang baik dengan disertai keterangan singkat ilustrasi atau foto dan nama pembuat ilustrasi atau pembuat foto.

Proofs
Naskah *proofs* akan dikirim ke penulis dan penulis diwajibkan untuk membaca dan memeriksa kembali isi naskah dengan teliti. Naskah proofs harus dikirim kembali ke redaksi dalam waktu tiga hari kerja.

Naskah cetak
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