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Performance of Eunicid Polychaetes Commonly Exploited by Artisanal Fishers Under Different Culture and Diet Regimes Between 2015 and 2017 (Marphysa Mossambica)

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Abstract

Eunicid polychaetes are harvested and exploited as fishing bait in various regions around the world [1]. Unregulated harvesting into the intertidal flats of Southeast Queensland, Australia has destroyed the habitat for many biodiversity and loss of the polychaete [2]. Culture of the worm could provide an alternative supply of polychaetes as baits for fishing and also as feeds in mariculture. Thus reduce time spent during digging for the bait worms, and pressure on use of Rastronobela argentia and sardine which are used as human food. Therefore, this study aimed at investigating the performance of cultured Eunicid polychaete under different regimes. Several species of Eunicid worms have been successfully cultured in laboratory settings for research, aquaculture and bait recreational fishing. This study cultured polychaetes in 2 culture set up regimes (semi intensive cages in situ, and aerated and recirculation lab intensive cage) on known stocking densities. The diet regime comprised of spinach, manure and a mixture of both manure and spinach diets on known quantities. The performance was monitored on growth rate, survival rate, reproduction, and burrowing behavior. The results obtained indicated mean survival rates were highest in the semi intensive cage at 75.31% compared to the aerated and recirculation system at 45.11%. Similarly the highest mean growth rates recorded was in the semi intensive cage in situ at 0.057- 0.102 mm/day against the aerated and recirculation lab intensive cages at 0.015 – 0.021 mm/day. On the other hand in the diet regime where spinach was used as a control. The survival and growth rate was highest on the cow dung manure diet followed by spinach diet and lowest in the 1:1 mixture of manure and spinach. It can be concluded that, the semi intensive cage in situ and cow dung manure diet could offer the best culture technique that can be adopted for the artificial rearing of the Eunicid polychaete. This can be compared to the survival rate obtained for the Marphysa sanguinea spp recorded of up to 90% (e.g., Xu et al., 2015) and a mean growth rate of 0.19-0.25 mm/day Xu et al. (2015) grown under laboratory conditions. Another study by Naylor et al. (2011) reported growth rates of 0.16-0.44 mm/day for Marphysa sanguinea collected from estuarine mudflats in the UK.

Keywords: Polychaetes, Stocking Density, Marphysa Mossambica

Introduction

Bait fishing of polychaete worm is an important economic activity along the Kenyan coast, contributing substantially to fish landing and livelihoods of artisanal fishers at the Kenyan coast. However, this has led to the overexploitation of the polychaetes from their wild leading to reduction of their numbers and loss of biodiversity. Their unsustainable exploitation threatens integrity of the muddy and sandy mudflats and adjacent ecosystems. This study aimed at evaluating the performance of Marphysa mossambica in terms of survival, recruitment and growth under different feeding and culture regimes, with the vital aim of developing artificial culture protocols to provide an alternative supply of polychaetes as baits for fishing and also as feeds in mariculture sector which immensely face high costs of feeds as a major challenge, among other challenges of regulatory concerns, susceptibility to diseases and parasites. In addition supply of readily available baits to the fishers will reduce time spent during digging for the bait worms, as well as reduce the damage to the mangrove ecosystem. Overexploitation as well of small fish such as sardine and Rastronobela argentia which are used as human food, fish feed and animal feed in the face of huge human food needs especially in developing countries with high population growth rate, low income and malnutrition. Exploring a non-human food alternative to these animal protein sources is a better solution. While mass polychaete culture techniques have been developed for some temperate polychaete taxa, none is available for Kenyan and African taxa and hence this study.

Literature Review

Eunicid Polychaete worms are marine, dioecious and multi segmented annelids with parapodia. They dominate marine benthic substrate in both temperate and tropical shorelines. Polychaetes possess a variety of morphological and physiological adaptations that enable them occupy different planktonic and benthic habitats [3]. Benthic forms are found from the intertidal zone to the deepest depths of the ocean in sandy and muddy sediments, digging or in temporary or permanent mucous tubes that are part of the in-faunal community, or crawling on the surface of the substrate and termed sedentary. The planktonic forms have adapted structures to swim, and spend part or all their lives in the water column, hence termed errant. Polychaetes burrowing activity is important in maintaining aeration and nutrient cycling, animportant role in the marine benthic food chain, in organic matter recycling within the sediment, and break down of dissolved organic matter [4].

They are harvested and exploited as fishing bait in various regions around the world [1]. A bait is any object used for catching fish attached to a fishing hook, or inserted into trap. Common natural baits include worms, leeches, minnows, frogs, salamanders and insects. Angler fishers along the Kenyan coastline excavate for Maryphsa sp as fishing bait [5]. Its unique traits such as soft body, high poly unsaturated fatty acids content makes them ideal as bait species for capturing of high value marine top predator organisms [3]. However, this exploitation by fishers has resulted in immense impacts on targeted, non-targeted biota and the environment. Unregulated harvesting through perturbations into the mangrove intertidal flats (East china, United Kingdom, Gulf of Mexico and Australia) where polychaetes occur has destroyed the habitat for many biodiversity and loss of the polychaete [16]. Bait gathering, and digging, cause direct mortalities, degrade ecosystems' health and reduce biodiversity in estuaries and intertidal mudflats around the world [6-8].

Interventions have been put in place to curb the menace of wild harvesting of polychaetes as bait in the temperate regions, such intervention are lacking for the local polychaete (Marphysa mossambica). These interventions include culturing of the polychaetes. Several species of Eunicid worms have been successfully cultured in laboratory settings. These include, Eunice pennata, and Eunice norvegica, Marphysa sanguinea and Marphysa kinbergii, Palola siciliensis and Palola viridis. These worms are cultured for research purposes, as well as for use as live bait in recreational fishing. They are also used as a food source for marine aquaculture. Fidalgo et al (2003) describes the artificial culture of the polychaetes in Europe (Arenicola sp), and Australia [9]. The best-known fishery of marine worms is found on the eastern seaboard of the USA on the coast of Maine, where Nereis sp reared on spinach diet is the fourth most valuable fishery, accounting 90% of the baitworm fisheries in the United States. Polychaetes being omnivorous have been reported to thrive best on protein or nitrogen rich diet (high in spinach diet) and from decomposition of organic matter [10].

Culture of marine worms in Kenya has not been attempted and therefore, alternatives sources to wild caught worms are lacking. Understanding the survival, reproduction, recruitment and growth of local polychaete taxa is critical to management of polychaete bait in order to provide alternate sources of this exploited resource. Artificial propagation protocols when developed may be useful in implementing mass rearing of polychaetes targeted by artisanal bait fishers and consequently reducing both costs and time incurred during excavation as well as the human footprints of these activities.

This study is designed to contribute to identification of a suitable mass rearing protocol for the mass culture of Marphysa mossambica under locally available diets. Preliminary results presented here aim to determine the survival and growth patterns of the wild Marphya mossambica under captivity.

Materials and Methods

Collection of Wild Parent Polychaete Stock

Polychaete parent stock were collected at Mtwapa Creek (3^o 57.295'S 39^o 42.943'E), along the Kenyan Coast. The targeted Eunicid species was identified as Marphysa mossambica Richmond (2011). Mtwapa Creek is located 16km North East of Mombasa. The creek is reknown for both deep-sea and artisanal fishing. A mangrove forest dominated by Rhizophora mucronata,Ceriops tagal and Sonneratia alba lines the shoreline of the creek. The creek and mangrove channels waters are important breeding grounds for many fish species [11]. The shoreline soil is rich in clay and inundated by semidiurnal tides. Experimental setups were established at Kwetu Training Centre in the period December 2015 to December 2017 [12-14].

Initial Marphysa sp stock was obtained by excavation from the muddy intertidal flats at customs beach (3^o 57.220'S 39^o 45.500'E), at Mtwapa Creek. The excavation was done by use of a 1 m mangrove excavation rod locally known as Chulo. Adult polychaete specimen with lengths >50mm were collected and transported to the laboratory using 20 litre plastic containers half filled with sand and seawater to just cover the sand. The containers were suitably labelled indicating the sampling site, date and time of collection. Polychaete rearing sand from the creek was also obtained from the same site and carried separately. The sand was exposed by spreading in an open area and sun dried over a period of 5 to 10 days. The dried sand was subsequently introduced into the polychaete culture units and flushed with sea water obtained from the creek to attain an optimum salinity condition [15].

Polychaete Culture Units

The culture units consisted of aerated recirculation lab intensive cages with approximate area and volume of 0.0491m2 and

0.0196m3; and semi intensive cages in situ with approximate area and volume of 0.25m2 and0.125m3. The units were filled with sundried sand obtained from the creek to a depth of 0.3m in the both systems. A drainage of each culture unit was fitted with a fine mesh net to avoid loss of the specimen and substrate during draining. Seawater was introduced into the unit after every twelve hours, to cover the sand by a minimum height of 5cm. The seawater was allowed to slowly drain out until the next flooding to simulate semidiurnal tidal regime. Aeration of the seawater was done using a dc mini water pump small aquarium fitted inside the cages in the aerated recirculation lab intensive cages [16].

Polychaete Diet Regimes

The diet regime comprised of spinach, manure and a mixture of both manure and spinach diets. The Polychaetes were fed on known quantity of the following diets twice per week; spinach, cow dung manure and 1:1 mixture of manure and spinach.

The three types of polychaete feeds; spinach, cow dung manure and mixture of both manure and spinach at ratio of 1:1 were obtained from farms adjacent to Kwetu training center and environs. The cow dung and spinach used were dried using solar dryers at Kwetu training center and ground by use of motor and pestle to fine particle and stored for later use.

Polychaetes in each culture unit were fed 1g of the respective diet, twice a week prior to flooding with seawater. These set ups were in triplicate for the spinach, manure and the mixture of both manure and spinach. Each culture setup was monitored daily and observed burrows recorded. The units were sampled after every two weeks to obtain weight and lengths as well as observe for new recruits.

Growth Rate Under Culture and Diet Regime

Data on initial and final polychaete sizes obtained was used in calculating growth rate for each regime using the following formulae;

$$growth\ rate = \frac{final\ length(cm) - inital\ length(cm)}{number\ of\ days}$$

Survival of the Polychaetes Under Culture and Diet Regime

Data on number of surviving polychaete obtained was used in calculating survival rate for each regime using the formula below;

$$survival\ rate = \frac{number\ of\ polychaetes\ remaining}{initial\ polychaete\ introduced} * 100$$

Result and Discussion

From the experimental designs conducted in the period December 2015 to December 2017.

Mean Growth Rate Under Culture Regimes

The study was conducted on two culture regimes where polychaetes were cultured in aerated recirculation lab intensive cages, and in the semi-intensive cages in situ. The length of polychaetes was measured fortnightly, and the mean growth rate was calculated for each group. The mean growth rates recorded in the aerated recirculation lab intensive cages and semi-intensive cages in situ were 0.015- 0.021 mm/day and 0.057-0.102 mm/day, respectively. An ANOVA revealed a significant difference between the two groups ($F = 35.12$, $p < 0.001$). Post-hoc Tukey tests indicated that the growth rate in the semi-intensive cages was significantly higher than in the aerated recirculation lab intensive cages ($p < 0.001$). The results of this study indicate that the growth rate of polychaetes in semi-intensive in situ cages is significantly higher than that in aerated recirculation lab intensive cages. This finding may be attributed to several factors. Firstly, semi-intensive cages in situ offer more natural and varied environments, which may result in higher feeding rates and more active growth for polychaetes.

Mean Growth Rate Under Diet Regimes

The objective of this study was to compare the growth rates of polychaete worms fed with different diet regimes. The study was conducted on three groups of polychaete worms, each fed with a different diet regime: spinach, manure, and a mixture of organic manure and spinach. The length of each worm was measured fortnightly, and the mean growth rate was calculated for each diet regime. The mean growth rates of the polychaete worms recorded on the spinach, manure, and mixture of organic manure and spinach diets were 0.03 mm/day, 0.15 mm/day, and 0.017 mm/day, respectively. An ANOVA revealed a significant difference between the mean growth rates of the three groups ($F = 8.96$, $p < 0.05$). Post-hoc Tukey tests indicated that the growth rate in the manure group was significantly higher than in the spinach group ($p < 0.05$), and the mixture group had a significantly lower growth rate compared to the manure group ($p < 0.05$). The results of this study indicate that the growth rates of polychaete worms vary significantly with different diet regimes. The highest mean growth rate was observed in the manure, while the lowest mean growth rate was observed in the mixture of organic manure and spinach. The ANOVA and Tukey tests confirmed the significant difference between the growth rates of the three groups, with the manure diet regime providing the most favorable conditions for growth and development. These findings have important implications for the development of effective diet regime for polychaete worms. The use of manure as a food source may offer a more efficient and sustainable way to promote the growth and health of the polychaete. Future studies could explore the optimal nutrient balance and feeding frequency required to promote the growth of the polychaete. The figure 1 below illustrates the growth rates against dietary regimes.

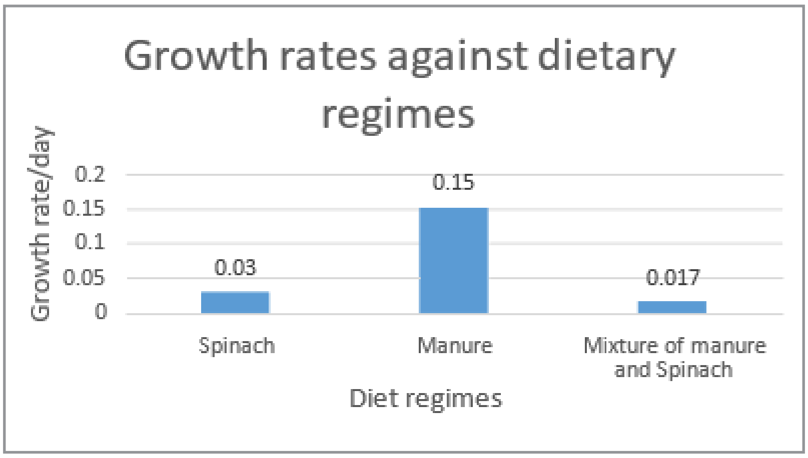

Figure 1: Growth Rates of Polychaetes Under Three Diet Regimes

Mean Survival Rate Of The Polychaetes Under Culture Regimes
To investigate the effect of different culture setups on the mean survival rate of polychaete worms. Two culture setups were used (aerated recirculation lab intensive cages and semi intensive cages in situ). The survival rate of the worms was recorded after every fortnight during sampling. The data were analyzed using a one-way ANOVA followed by post-hoc Tukey tests. The mean survival rate of the polychaete worms varied significantly across the two culture regime ($F = 84.2$, $p < 0.001$). The mean survival rate in the semi intensive cage in situ was 75.31% compared to the aerated and recirculation lab intensive cages which recorded a mean survival rate of 45.11%. The post-hoc Tukey tests revealed significant differences in the mean survival rates between all temperature treatments ($p < 0.05$). The results of this study demonstrate that culture regime had a significant effect on the survival rate of polychaete worms.

Mean Survival Rate of the Polychaetes Under Diet Regimes
The mean survival rate of polychaetes under different diet regimes was determined using spinach (Control), manure, and a mixture of manure and spinach. The results of the study showed that the mean survival rate of polychaetes was significantly different ($F=10.2$, $p<0.05$) among the three diet regimes. The mean survival rate of polychaetes under the control diet (spinach) was 55%, under the manure diet was 68%, and under the mixture of manure and spinach diet was 37%. The study aimed to determine the mean survival rate of polychaetes under different diet regimes. The results of the study showed that the mean survival rate of polychaetes was significantly different among the three diet regimes. The highest mean survival rate was observed under the manure diet, followed by the control diet (spinach), and the lowest mean survival rate was observed under the mixture of manure and spinach diet. The higher mean survival rate observed under the manure diet could be attributed to the higher nutrient content of manure compared to spinach. Manure is rich in nutrients such as nitrogen, phosphorus, and potassium, which are essential for the growth and survival of polychaetes. The lower mean survival rate observed under the mixture of manure and spinach diet could be due to the negative interaction between manure and spinach. The study highlights the importance of considering the nutrient content and interaction between different food sources when designing diets for polychaetes in aquaculture systems. The results of the study could be useful in optimizing diet regimes for polychaetes in aquaculture systems and improving their survival rates

Conclusion
The results obtained indicated mean survival rates were highest in the semi intensive care at 75.31% compared to the aerated and recirculation system at 45.11%. Similarly the highest mean growth rates recorded was in the semi intensive cage in situ at 0.057- 0.102 mm/day against the aerated and recirculation lab intensive cages at 0.015 – 0.021 mm/day. On the other hand in the diet regime where spinach was used as a control. The survival and growth rate was highest on the cow dung manure diet followed by spinach diet and lowest in the 1:1 mixture of manure and spinach. It can be concluded that, the semi intensive cage in situ and cow dung manure diet could offer the best culture technique that can be adopted for the artificial rearing of the Eunicid polychaete.

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