Study on Possibility of Raising Peanut Worm at Truong Giang's River Mount at Nui Thanh District, Quang Nam Province, Vietnam

Nam Ngo Xuan[1], Suphawadee Yaemkong[2], Jemjila Boonrod[2], Mai Trong Hoang[1], Anh Minh Do[3], Nguyen Ngoc Tuan[2,4*]

ABSTRACT: This study was carried out to find out the possibility of raising peanut worm at Truong Giang's river mount at Nui Thanh district, Quang Nam province, Vietnam. The study collected all related information such as meteorology and natural distribution as well as biology of peanut worm from local authorities. Besides, Participatory Rapid Assessment method was used in interviewing farmers in order to understand about local ecosystem before sampling water and ground soil for analysis of nitrogen, phosphorus, potassium, organic matter, soil proportion and plankton. A growing trial was set up in cage in the bottom with 5 cm above ground. Totally, 9 cages were divided into 3 groups with different depth: above tidal zone (D1), intertidal zone (D2) and under tidal zone (D3) and 5 worms (~3g) were stocked in each cage. The results showed that all parameter including water, ground soil and plankton were suitable for growing peanut worm. The preliminary trial also confirmed this conclusion when peanut worm grew well with average weight gain ranged from 4.95 to 5.14 g, high survival rate (from 69.74 to 88.89%). The depth of bottom did not affect to the growth of peanut worms. However, harvesting technique should be improved to prevent negative impact to ecosystem.

Keywords: Peanut worm, Truong Giang, River mount, Quang Nam

Introduction

Peanut worm is the common name for *Sipuncula* which includes 150 species in 17 genera (Cutler et al., 1992). Most of them play important roles in ecosystem as environmental cleaners, bio-indicators. Peanut worm - *Sipunculus nudus* is a specie belonging to this group and being considering as an important economic animal for their high edible and medicinal value. They burrowed to live in the ground that they were capable adapting to anaerobic, tolerant to high sulphide concentrations in environment and flexible in osmosis of changing salinity (Völkel and Grieshaber, 1992; Pörtner et al., 1998; Lan and Yan, 2001). Due to high demand, natural resource of *S. nudus* was rapidly decreased because of overexploitation (Li et al., 2015). The price of fresh peanut worm was comparable to that that of beef. Currently, price of dried peanut worm in Vietnam is about 200-250 USD.kg^{-1} when they sell to traders from China where demand is higher (Nguyen, 2011). In another study, Li et al (2017) estimated the production of peanut worm in China was

[1] Institute of Ecology and Works Protection, Chua Boc, Ha Noi, 10000, Viet Nam
[2] Pibulsongkram Rajabhat University, Phitsanulok 65000, Thailand
[3] University of Science and Technology of Hanoi, Hoang Quoc Viet, Ha Noi, 10000, Viet Nam
[4] Vietnam National University of Agriculture, Gia Lam, Ha Noi, 10000, Viet Nam
* Corresponding author: nntuan245@gmail.com

Figure1 Study area

around 20.000 tons which could not meet the demand locally. In order to support for local market and to reduce pressure on exploitation, peanut worm was reproduced artificially in China and neighbor countries such as Vietnam (Lan and Yan, 2001; Lan et al., 2004; Ha et al., 2007). A number of studies was conducted in China to find out suitable density, food as well as sediment for raising peanut worm. Li et al (2017) had raised peanut worm integrate with fish (Li et al., 2015). In another study, Zhang et al. (2011) pointed out that scientist found out the optimum level of lipid for peanut worm was 8.70%. One year later, the same authors recommended the protein level for nursing *S. nundus* was 46.79% (Zhang et al., 2012).

In Vietnam, there was diversity of peanut worm with 21 species have been recognized (Nguyen, 2011). However, it was reported that population of *S. nundus* decreased up to 55% in some regions (Phan et al., 2013), mainly cause of over-exploitation. The artificial reproduction of *S. nudus* was successfully in Khanh Hoa province (Vo et al., 2013) and in Quang Ninh province (Nguyen, 2016), made them immediately become an economic species for aquaculture. Quang Nam province located in the central part of Vietnam where Truong Giang river flow along coastal line, starts from Cua Dai (Da Nang province) to bring marine water flow through province and ends at the other mount at Nui Thanh district (Figure 1). This characteristic brings a lot of potential for aquaculture such as large area of water surface, diversity of habitants and fauna.

Peanut worm is considered as a potential species for aquaculture in Quang Nam, especially when shrimp farming is facing many problems with diseases and unstable prices. In the past, peanut worm was found in many regions in Quang Nam. However, appearance of this species in nature is deceased due to a lot of changes in construction for shrimp farming and other sectors. Furthermore, the overexploitation also makes its population dramatically deceased. Thus, this study aimed to find out the possibility of raising peanut worm in the region throughout evaluation of water

quality, sediment quality as well as biology and distribution of this animal. The successful of this study could also contribute to development of diversification of aquaculture in Quang Nam, especially could bring certain economic profit in order to enhance the livelihood of local people.

Materials and methods

The study was carried out with 3 steps: 1) Data collection from local government; 2) Sampling water and sediment quality; 3) Preliminary test on growth of peanut worm on the sea.

Data collection

Information about resource of peanut worm will be firstly collected from previous study, database from local department, and interviewing farmers and traders. Participatory Rapid Appraisal method (Theis and Grady, 1991) with prepared questionnaire were used for interview to collect information about this species including information about the population and production of peanut worm as well as currently uses of this animal.

Water and sediment quality

Data of temperature and precipitation was collected from local center for hydro – meteorology. Totally, 60 water samples and 60 sediment samples (represented for both dry and rainy season) were collected at 5 different sampling locations (Table 1). The sampling methods followed instruction of ISO 5667-6:2005 and Vietnamese standard 6663 – 3:2000.

Table 1 Sampling locations

Code	Location	Latitude	Longitude
SS01	Cross between Truong Giang river and Tam Ky river, Tam Tien commune, Nui Thanh district	0590624	1716468
SS02	Tam Hoa, Tam Hoa commune, Nui Thanh district	0592464	1714850
SS03	Mollusc farming ground, Tam Hai commune, Nui Thanh district	0595366	1712596
SS04	Alluvial ground, Tam Hai commune, Nui Thanh	0595285	1712348
SS05	Mollusc farming ground, Tam Giang commune, Nui Thanh	0596523	1711967

Preliminary test on growth of peanut worm

Peanut worm juvenile was collected from the ground locally and then stocked in 9 plastic cages with density of 5 worms/cage. The cage dimensions were 40x60x30 cm and was covered by a plastic net to ensure peanut worm could not go away. The cages were filled with sand before being set into the ground near mangrove forest with 3 different depths: D1) dry in low tidal and integrated to mangrove forest, D2) dry when low tidal and not integrated to mangrove forest, D3) never be dried under tidal zone (Figure 2). Top 5 cm of cage was set above the ground surface. The growth of peanut worm was measured every three months and the trial lasted for 9 months.

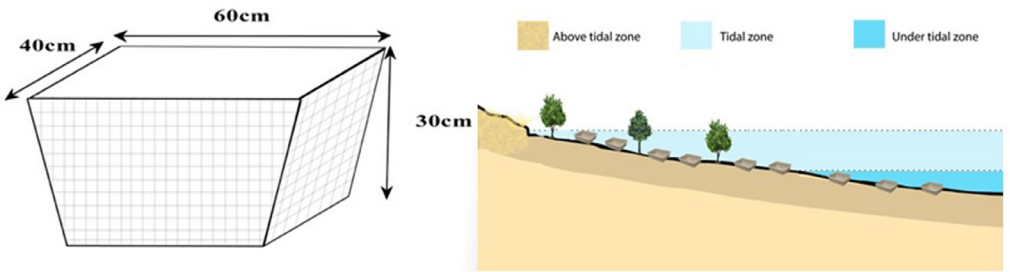

Figure 2 Cage dimension and setting depth in the study

All the data was calculated for mean and standard deviation and referred to Vietnam Aquaculture standards as well as the requirement of peanut worm. Comparison of the effects among depths of sea ground and growth of peanut worm were subjected to ANOVA analysis and turkey test ($p<0.05$) in SAS 9.0.

Results and Discussion

Climate and water quality

The study area located in the tropical zone with two seasons (dry and rainy season). The average temperature in 2016 was 25.6°C the lowest was recorded for January (21.3°C) and the highest was in June (29.6°C). According to the local center for hydro – meteorology, the average temperature for last 15 years was 25.9°C. The precipitation ranged from 2000-3500mm.year^{-1}. The rainy season starts from September to December and dry season mainly from February to July.

The pH in the study seemed to be stable, ranged from 6.8 – 7.5 and salinity altered from 5.7 to 10.2 ppt (Table 2). However, the salinity was influence by season and the flow of Truong Giang river. The highest salinity was recorded for 26-28 ppt at Cua Dai's river mount.

Nguyen (2016) reported that peanut worm lived in the salinity of 15-20 ppt and temperature from 24 – 28°C. The both temperature and salinity shocks could make them releasing gametes and optimun salinity

Table 2 Results of water quality in the rainy season

Parameters	Values	Parameters	Values
pH	7.1 ± 0.3	TSS (mg/l)	35.0 ± 17.2
Salinity (ppt)	8.0 ± 1.8	$N\text{-}NH_4^+$ (mg/l)	1.0 ± 0.5
BOD_5 (mg/l)	4.2 ± 1.6	$N\text{-}NO_3^-$ (mg/l)	3.9 ± 2.6
COD (mg/l)	8.8 ± 2.9	SO_4^{2-} (mg/l)	590.9 ± 131.6

BOD: Biochemical Oxygen Demand; COD: Chemical Oxygen Demand; TSS: Total Solid Sediment

for fertilization was 20 ppt. The salinity in this study was 8.0 ± 1.8 ppt, lower than optimum range because of effects from rainy season. At this range of salinity, peanut worm can tolerant to this range of salinity. In fact, this season was reproductive season of peanut worm in Quang Nam province (statement from local farmers during interview).

Sediment and soil bottom quality

Results of mornitoration showed that the study area was -2 to 0m as compare to standard sea level. The ground has a slope from 2 to 3°. The average organic matter of the bottom (up to 40cm) was 0.49 ± 0.26%, ranged from 0.16 to 0.71%. The size of top 30cm soil were classified into 3 groups (Table 3), in which big size (>0.02mm) was majority with 86%, followed by medium size (8.2%) and the smallest size accounted for 5.7%. In deeper bottom, the medium size seemed to be lower (4.5%) whereas the clay was higher (11.3%).

According to the ranking of Ti-Urin, the soil in this study was clean or poor in term of organic matter and nutrition. The results of nitrogen, potassium and kali analysis were low. Total nitrogen in the bottom soil was 0.04 ± 0.02%, phosphorus was 0.09 ± 0.01% whereas potassium kali was 1.54 ± 0.41%.

Table 3 Ground soil proportion (%)

Size	Depth 0-30cm	Depth 30-60cm
> 0.02mm (sand)	86.1	84.2
0.02-0.002mm (organic matter)	8.2	4.5
<0.002mm (clay)	5.7	11.3

Table 4 Results of nitrogen, phosphorus, potassium and heavy metals in the soil samples (%)

Parameters	Values	Parameters	Values
Organic matters	0.49 ± 0.26	Arsenic	0.60 ± 0.05
Nitrogen	0.04 ± 0.02	Cadimium	0.26 ± 0.04
Phosphorus	0.09 ± 0.01	Copper	3.93 ± 0.77
Potassium	1.54 ± 0.41	Lead	2.09 ± 0.71
Ca^{2+} (lđl/100g)	6.34 ± 3.00	Zinc	27.47 ± 3.88
Mg^{2+} (lđl/100g)	6.05 ± 1.08	Mercury	0.009 ± 0.001

The soil quality played an important role for living habit of peanut worm. When analysis the content of peanut worm's intestine, Nguyen (2016) found that organic materials (0.02-0.002 mm) accounted from 1.66 to 1.88% whereas the remain was sand. The authors also reported that peanut worm will not settle in the ground where contain too much fine clay (<0.002mm). Thus, the ground in the study could be suitable for this animal.

The result of plankton analysis showed that Bacillariophyta was the most dominant with density ranged from 14.200 cells.L-1 at SS02 to 45.000 cells.L-1 at SS03. Dinophyta was found

near the river mount, but low density (from 2.500 to 11.700 cells.L-1). Cyanobacteiophyta was not found at the location SS03 but often higher than Dinophyta in other places (6.700 - 18.300 cells.L-1).

The result of growth and survival of peanut worm after 6 months of stocking

An alluvial ground near a newly mangrove forest was selected for peanut worm. The results showed that worms grew well and depth of bottom did not affect to their growth (Figure 3). The highest weight gain archived in the group D2 (tidal zone) with weight gain of 5.14 ± 1.42g, whereas the lowest was 4.95 ± 0.84g (170.65%) recorded for the group D3. However, no difference was found among treatments. The results also showed that survival was relatively high. The average survival rate ranged from 69.74 ± 3.72% (in group D1) to 88.89 ± 5.65 (in group D2). However, the survival was not significant different from each other ($P<0.05$). The observation pointed out that peanut worm died mainly in the first measurement and mortality was rarely found afterwards. The high mortality at the first month could be the cause of juvenile quality. The collecting method or transportation could injure animal. Since they adapted to the new environment, mortality was not observed.

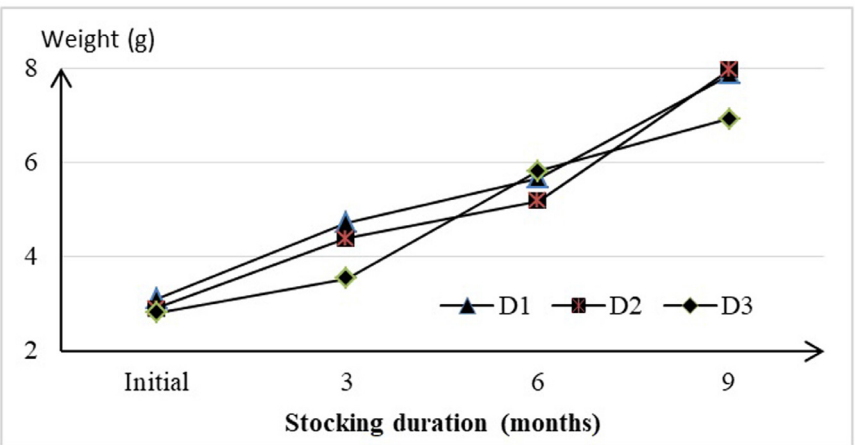

Figure 3 Growth of peanut worm in the trial at different depths

The growth of peanut worm in the trial was not too high. An (2014) reported that it could be raise peanut worm to the size of 50g after 6 months of stocking in Nha Trang province, central part of Vietnam. However, the author did not clarify the species of peanut worm used in that study. While Hoang (2010) stated that there were two species of peanut worm living in Nha Trang, one was *S. nundus* and the other was *S. robustus* which has much higher growth rate. Secondly, the temperature in Nha Trang was much warmer than Quang Nam. However, growth of peanut worm in the current study was still higher than that reported by Vo et al. (2015) who raised peanut worm from 0.29g to 2.93g after 80 days in concrete tanks with supplemental feed. Nguyen (2016) also reported for lower growth rate of peanut worm *S. nundus* when raising them in the North of Vietnam where average temperature was lower.

Table 5 Weight gain and survival rate of peanut worm in the preliminary trial

	D1	D2	D3
Weight Gain (g)	4.97 ± 0.94	5.14 ± 1.42	4.95 ± 0.84
Relative Weight Gain (%)	145.81 ± 56.2	183.64 ± 50.74	170.65 ± 28.67
Survival Rate (%)	69.74 ± 3.72	88.89 ± 5.65	72.22 ± 4.51

Besides, the high stocking density in current trial might affect to the growth. Furthermore, cage was coverred by net could also affect to the water exchange and transportation of food into the cage, resulted in low growth rate of peanut worm. The purpose of keeping peanut worm in the net was to evaluate their growth and survival more accurately. In fact, farmers could stock peanut worm directly to the bottom without net. Thus, growth rate of peanut worm can be improved.

Culturing peanut worm near or integrated to mangrove forest showed many advantages. Peanut worm can ingest organic materials to convert them to higher nutritional products. Furthermore, it can clean environment and participate into many complex processes of ecosystem. However, harvesting peanut worm is still the biggest constrain in production of this animal. Digging the ground to harvest peanut worm either destroy the worm tunnels or leading to a rapid loss of organic material, nitrogen and phosphorus, result in environmental pollution. Li et al. (2017) recommended to improve the harvesting method using adequate electrical currents would be more effective and eco-friendly for the collection of these worms.

Conclusion

Truong Giang's river mount showed many suitable factors to raise peanut worm. Both water quality and ground were clean, unpolluted with diversity of natural food for aquatic animals in general and for peanut worm particularly. The existent of peanut worm in nature consolidated the suitability of environment to grow this animal.

The resulted of preliminary trial confirmed that peanut worm grew well with high ratio of survival after 9 months of stocking. The results showed that peanut worm could be a potential species for aquaculture and demonstrated the possibility to grow peanut worm on the sea ground as well as integrated with mangrove forest in future.

Acknowledgements

The author would like to give appreciation thanks for financial supports from Institute of Ecology and Works Protection (Vietnam) and Pibulsongkram Rajabhat University (Thailand). Authors would like to thank all the participants, farmers and local officers for providing the data in this research.

References

An, H. 2014. Reproduction and culture peanut worm http://thuysanvietnam.com.vn/san-xuat-giong-va-nuoi-thuong-pham-sa-sung-article-7250.tsvn (Accessed 14th November 2018).

Cutler, N. J., E. B. Cutler, and J. Vargas. 1992. Peanut worms (phylum Sipuncula) from Costa Rica. Gusanos maní (phylum Sipuncula) de Costa Rica. Rev Biol Trop 40:153-158.

Ha, N., M. Nhuan, N. Ngoc, and H. Dung. 2007. The distribution of peanut-worm (*Sipunculus nudus*) in relation with geo-environmental characteristics. VNU Journal of Science, Earth Sciences 23:110-115.

Hoang, X. D. 2010. Peanut worm - sexual potency. http://suckhoedoisong.vn/sa-sung-thuoc-trang-duong-n37002.html (Accessed 14th November 2018).

Lan, G., S. Miao, B. Yan, and B. Wu. 2004. Natural food in larval peanut worm (*Sipunculus nudus*). Fisheries Science 24(2):1-4.

Lan, G., and B. Yan. 2001. The reproductive biology of peanut worm, *Sipunculus nudus*. Shuichan xuebao 26(6):503-509.

Li, J., X. Xie, C. Zhu, Y. Guo, and S. Chen. 2017. Edible peanut worm (*Sipunculus nudus*) in the Beibu Gulf: Resource, aquaculture, ecological impact and counterplan. Journal of Ocean University of China 16(5):823-830.

Li, J., C. Zhu, Y. Guo, X. Xie, G. Huang, and S. Chen. 2015. Experimental study of bioturbation by *Sipunculus nudus* in a polyculture system. Aquaculture 437:175-181.

Nguyen, D. H. 2011. Peanut worm - not unlimited resources. http://www.vacne.org.vn/sa-sung-nguon-loi-troi-cho-khong-phai-la-vo-tan/25094.html (Accessed 14th November 2018).

Nguyen, H. 2016. Artificial reproduction of peanut worm. http://baoquangninh.com.vn/khoa-hoc-cong-nghe/201608/sinh-san-nhan-tao-sa-sung-2314784/ (Accessed 14th November 2018).

Phan, D. N., V. S. Tuan, H. T. Tuyen, and N. A. Khang. 2013. The change of exploited fishery resources in Thi Nai lagoon. In: J. P. North, editor, Collection of Marine Research Works. Viet Nam Institute of Oceanography. p. 521.

Pörtner, H.-O., A. Reipschläger, and N. Heisler. 1998. Acid-base regulation, metabolism and energetics in Sipunculus nudus as a function of ambient carbon dioxide level. Journal of Experimental Biology 201(1):43-55.

Theis, J., and H. M. Grady. 1991. Participatory rapid appraisal for community development. A training manual based on experiences in the Middle East and North Africa.

Vo, T. D., N. V. Canh, L. T. Nhan, V. T. Dung, H. V. Chung, and N. P. B. Ngoc. 2013. Preliminary results on culturing peanut worm (*Sipunculus nudus* Linnaeus, 1767) in Khanh Hoa Journal of Agriculture and Development 19:92-96.

Vo, T. D., V. T. Dung, and N. T. N. Trang. 2015. Research results of peanut worm (*Sipunculus nudus* Linnaeus, 1767) culture trial in Ximen tanks using artificial breeding seeds of different sizes Fisheries Science and Technology 1:12-16.

Völkel, S., and M. K. Grieshaber. 1992. Mechanisms of sulphide tolerance in the peanut worm, *Sipunculus nudus* (*Sipunculidae*) and in the lugworm, Arenicola marina (*Polychaeta*). Journal of Comparative Physiology B: Biochemical, Systemic, and Environmental Physiology 162(5):469-477.

Zhang, Q., W. Tong, L. Dong, Y. Jiang, and T. Tong. 2011. Effects of dietary lipid levels on growth performance, body composition and digestive enzyme activities of juvenile peanut worm *Sipunculus nudus* Linnaeus. Prog Fish Sci 32(6):99-106.

Zhang, Q., W. Tong, L. Dong, Y. Jiang, and T. Tong. 2012. Effects of dietary protein level on growth performance and body composition of juvenile peanut worm *Sipunculus nudus* Linnaeus. Prog Fish Sci 33(1):86-92.