# ความอุดมสมบูรณ์และความหลากหลายของไส้เดือนน้ำจืดในจังหวัดเชียงใหม่

# Abundance and Diversity of Aquatic Worms in Chiang Mai Province, THAILAND

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## บทคัดย่อ

การศึกษาความอุดมสมบูรณ์และความหลากหลายของไส้เดือนน้ำจืดจากลำเหมืองสาธารณะในเขตตำบลแม่แฝก อำเภอสันทราย ในจังหวัดเชียงใหม่ 3 จุดสำรวจๆ ละ 3 ซ้ำใน 3 ฤดูกาล (ฤดูร้อน, ฤดูฝน และฤดูหนาว เก็บตัวอย่างเดือนมีนาคม, กรกฎาคม และพฤศจิกายน ตามลำดับ) พบว่าฤดูหนาวมีไส้เดือนน้ำจืดรวมมากที่สุด คือ 20,241 ตัวต่อตารางเมตร *Aeolosoma* sp. พบมากที่สุด มีดัชนีความมากชนิด ดัชนีความเท่าเทียม และดัชนีความหลากหลายต่ำที่สุดคือ 0.20, 0.11 และ 0.12 ตามลำดับ ฤดูร้อนมีไส้เดือนน้ำจืดรวมน้อยที่สุด คือ 7,410 ตัวต่อตารางเมตร มีดัชนีความมากชนิด ดัชนีความเท่าเทียม และดัชนีความหลากหลายมากที่สุดคือ 0.22, 0.58 และ 0.64 ตามลำดับ ทุกฤดูกาลที่สำรวจพบ *Aeolosoma* sp. มากที่สุด ตามฤดูกาลและจุดสำรวจพบว่า ฤดูหนาวจุดสำรวจที่ 3 พบ *Aeolosoma* sp. มากที่สุด มีดัชนีความมากชนิด ดัชนีความเท่าเทียม และดัชนีความหลากหลายต่ำที่สุด คือ 0.11, 0.01 และ 0.01 ตามลำดับ มีความคล้ายคลึงกันตามฤดูกาลและจุดสำรวจแบ่งได้เป็น 2 กลุ่มอย่างชัดเจน และมีความแตกต่างอย่างมีนัยสำคัญทางสถิติที่ระดับความเชื่อมั่น 95% กลุ่มที่ 1 ประกอบด้วยไส้เดือนน้ำจืดที่สำรวจพบทั้ง 3 ฤดูกาลในจุดที่ 1 และ 2 และเฉพาะฤดูร้อนจุดสำรวจที่ 3 กลุ่มที่ 2 ประกอบด้วยไส้เดือนน้ำจืดที่สำรวจพบในจุดสำรวจที่ 3 เฉพาะในฤดูฝนและฤดูหนาว

**คำสำคัญ** : ความอุดมสมบูรณ์ ความหลากหลาย ไส้เดือนน้ำจืด

## Abstract

Study on abundance and diversity of aquatic worms from natural ditch in Sansai, Chiang Mai Province using 3 sampling stations 3 times in 3 seasons (summer, rainy and winter) and harvested in March, July and November respectively found *Aeolosoma* sp. to be the most abundant in winter. Lowest richness index, diversity index and evenness index were 0.20, 0.11 and 0.12 respectively. Summer found aquatic worm to be the lowest in population but with the highest richness index, diversity index and evenness index which were 0.22, 0.54 and 0.64 respectively. Every season found *Aeolosoma* sp. to be the main species. When comparing between seasons and stations *Aeolosoma* sp. was found to be the most abundant in winter station

3rd with the lowest richness index, diversity index and evenness index which were 0.11, 0.01 and 0.01 respectively. There were similarity between seasons and sampling stations which were clearly divided into 2 groups ($p>0.05$). Group 1 was composed of aquatic worms in every season at stations 1st and 2nd and summer station 3rd. Group 2 was composed of aquatic worm from rainy and winter season at station 3rd.

**Keywords**: abundance, diversity, aquatic worms, Oligochaeta

## Introduction

Aquatic worms are segmented worms ranging in size from a few millimeters to fifteen centimeters. They resemble earthworms but more slender segmented; color is reddish, brown or grey. Currently, there are approximately 80 species of freshwater Oligochaetes. They are benthic dweller and found anywhere in freshwater, including lakes, ponds, marshes and streams in shallow sediment layers where they live off organic material, algae and lived bacteria. They are soft-bodied organisms, so easy prey for many other organisms, including fish, crustaceans and leeches. They are important parts of the aquatic food chain. Moreover, they are food sources for young fish and used in the aquarium hobby as fish food. Because of their natural sources of proteins and polyunsaturated fatty acids, they are possible alternative aquaculture feeds. Chemical composition analysis of aquatic worms were 50-60% min Protein, 10% min Fat, 2% max Fiber, 4% max Moisture, 0.1% max Phosphorus and 0.1% max Ash. They do not need additional processing and can be fed directly to the fish. New reactor concepts and pre-processing technologies of organic waste streams to feed to the aquatic worms are needed in order to produce sufficient amount of aquatic worms for the aquaculture industry. Moreover, they also help breakdown pollutants in the mud at the bottom of lakes, ponds, marshes and streams (Brinkhurst and Chua, 1969; Wavre and Brinkhurst, 1971; Densem, 1982; Ratsak*et al*., 1993; Elissen, 2007). As yet, there has been no study on aquatic worms in ditch at Sansai District, Chiang Mai Province, THAILAND. The aim of this study was to investigate the abundance and diversity of aquatic worms (Oligochaetes) from ditch in Sansai District, Chiang Mai Province, THAILAND.

## Methods

### 1. Planning and period of explore

Samples of aquatic worms, sediment and water were collected from 3 sampling stations (3 replications/sampling stations) (Table 1 and Figure 1) and 3 seasons followed as summer in March 2014, rainy in July 2014 and winter in November 2013 at ditch in Sansai District, Chiang Mai Province, THAILAND.

**Table 1** Sampling station at ditch in Sansai District, Chiang Mai Province, THAILAND

| Sampling station | GPS | |
|---|---|---|
| | $^{o}$N | $^{o}$E |
| 1st | 18.971251 | 98.983027 |
| 2nd | 18.972431 | 98.982812 |
| 3rd | 18.973293 | 98.982681 |


**Figure 1** Sampling station at ditch in Sansai District, Chiang Mai Province, THAILAND

### 2. Collecting samples

Aquatic worms samples were collected by 15×15 cm Ekman dredge and split by sieve no. 40 mesh size after that fixed and stored in 70% alcohol. When required for identification, they should be transferred to 30% alcohol. For Oligochaetes, the identification was based on Edmonson (1968) and Brinkhurst (1971) using stereoscopic microscope.

**3. Statistical analysis**

Analysis and comparative distribution of community of aquatic worms in each sampling station were evaluated according to species abundance distribution (Clarke and Warwich, 1994). Species richness index were evaluated according to Margalef Index (Ludwig and Reynolds, 1988). Diversity index were evaluated according to Shanon-Weiner Diversity Index (Washingon, 1984; Ludwig and Reynolds, 1988). Evenness index were evaluated according to Pielou index (Washington, 1984; Ludwig and Reynolds, 1988). Similarities of distribution of aquatic worm species were determined according to Bray Curtis Similarity Index (Clarke and Warwick, 1994).

## Results

**Classification of aquatic worms**

Classification of all aquatic worms by sampling stations and seasons using external appearances was determined by Edmonson (1963) and Brinkhurst (1971) under the stereomicroscope. It was found that all aquatic worms were classified in 1 order 3 Family and 3 Genus as follows:

Phylum Annelida
Class Oligochaeta
Order Haplotaxida
Family Aeolosomatidae
*Aeolosoma* sp.
Family Tubificidae
*Branchiura sowerbyi*
Family Naididae
*Nais* sp.

**Types and quantities of aquatic worms and their distribution**

When analyzing the quantities and distribution of aquatic worms according to sampling stations, it was found that station 3rd had the highest number of aquatic worms at 23,587 worms per square meter. However, there were only two types of aquatic worms such as *Aeolosoma* sp. and *Branchiura sowerbyi*. Secondly, station 2nd had 10,137 worms per square meter. And station 1st had 6,908 worms per square meter. The station 1st and 2nd had 3 aquatic worms such as *Aeolosoma* sp., *Branchiura sowerbyi* and *Nais* sp. Aquatic worms found at all stations were *Aeolosoma* sp. and *Branchiura sowerbyi*. *Aeolosoma* sp. found the most common at all stations and accounted for 91.71%. (Table 2)

When analyzing the quantities and distribution of aquatic worms according to seasons, it was found that in winter had the highest number of aquatic worms at 20,241 worms per square meter and *Aeolosoma* sp. found the most common. Secondly, in rainy had 12,981 worms per square meter. Summer had the lowest number of aquatic worms at 7,410 worms per square meter. Aquatic worms

found at all seasons were *Aeolosoma* sp., *Branchiura sowerbyi* and *Nais* sp. but found in different quantities. *Aeolosoma* sp. found the most common and accounted for 91.71%. (Table 2)

When analyzing the quantities and distribution of aquatic worms according to sampling stations and seasons, it was found that in winter at station 3rd had only *Aeolosoma* sp. and *Branchiura sowerbyi* and found the highest number of *Aeolosoma* sp. at 11,482 worms per square meter. At other stations in all seasons found at all were *Aeolosoma* sp., *Branchiura sowerbyi* and *Nais* sp. but found in different quantities. (Table 3)

**The Index indicates**

1. Richness Index

When calculated according to sampling stations found that station 1st had the index for more types of most was 0.23 and the lowest value was 0.10 in station 3rd. (Table 4) When calculated according to seasons, it was found that summer had the index for more types of most was 0.22 and winter had the lowest value was 0.20. (Table 5) When calculated according to season and sampling stations, it was found that summer station 1st had the index for more types of most was 0.28 and the lowest value was 0.11 in summer and winter station 3rd. (Table 6)

2. Evenness index

When calculated according to sampling stations, it was found that station 2nd had evenness index to the most was 0.48 and the lowest value was 0.24 in station 3rd. (Table 4) When calculated according to season, it was found that summer had evenness index to the most was 0.58 and the lowest value was 0.11 in winter. (Table 5) When calculated according to season and sampling stations, it was found that summer station 2nd had evenness index to the most was 0.76 and the lowest value 0.01 in winter station 3rd. (Table 6)

3. Diversity index

When calculated according to sampling stations, it was found that station 2nd had the index of a variety of the most was 0.53 and lowest value was 0.16 in station 3rd. (Table 4) When calculated according to season, it was found that summer had the index of a variety of the most was 0.64 and lowest value was 0.12 in the winter. (Table 5) When calculated according to season and sampling stations, it was found that summer station 2nd had the index of diversity the most was 0.84 and the diversity had the lowest value was 0.01 in winter station 3rd. (Table 6)

4. Similarity Index

When calculated according to season and sampling stations by Bray-Curtis Similarity and Multivariate Dimensional Scaling (MDS) from PRIMER (Plymouth Routine in Multivariate Ecology Research), it was found that similarity index had valuable between 40.26-91.25. In rainy station 1st and

station 2nd had similarity most equals to 91.25. While summer station 1st and winter station 3rd had valuable similarity index least equals to 40.26 (Table 7). Bring all data index to determine in picture get dendrogram at 75% levels of Bray-Curtis Similarity. Analysis MDS found that had stress value equal to 0.01 showed that had good reliability and had high accuracy. Almost aquatic worms in this research had similarity according to season and sampling station and it can be divided in to 2 group clearly ($p<0.05$) (Fig 2-3). Group 1 composed of aquatic worms in all season station 1st and 2nd and summer station 3rd and had similarity percentage equal to 80.35. It showed that there were 2 families of aquatic worms which had resemblance (Particular valuable more than 10.00%). *Aeolosoma* sp. had valuable similarity percentage equals to 53.84 and *Branchiura sowerbyi* had valuable similarity percentage equals to 20.07 (Table 8). Group 2 composed aquatic worm in rainy and winter station 3rd and had similarity percentage equal to 84.88. There was just one family which was valuable similarity percentage more than 10.00%, *Aeolosoma* sp., by valuable average similarity percentage equaled to 81.32 which were found regularly and had high valuable confidence of the accuracy (Table 9). When considered average dissimilarity percentage between group 1 and 2, it was observed that it was equal to 36.21 by *Aeolosoma* sp. which had the most valuable dissimilarity percentage equal to 27.01 and was found most in both of in group 1 and 2 while *Nais* sp. did not show in group 2.

**Table 2** Distribution of aquatic worms in ditch according to sampling stations or seasons (Chiang Mai, THAILAND)

| Aquatic worms | Sampling station | | | Seasons | | | Average | % |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | Summer | Rainy | Winter | | |
| *Aeolosoma* sp. | 6,150 | 8,446 | 22,668 | 5,705 | 11,794 | 19,765 | 12,421 | 91.71 |
| *Branchiura* | 564 | 1,364 | 919 | 1,423 | 993 | 431 | 949 | 7.01 |
| *Nais* sp. | 194 | 327 | 0 | 282 | 194 | 45 | 174 | 1.28 |
| Total | 6,908 | 10,137 | 23,587 | 7,410 | 12,981 | 20,241 | 13,544 | 100 |
| Average | 2,303 | 3,379 | 7,862 | 2,470 | 4,327 | 6,747 | | |

**Table 3** Distribution of aquatic worms in ditch according to sampling stations and seasons (Chiang Mai, THAILAND)

| Aquatic | Sampling station 1 | | | Sampling station 2 | | | Sampling station 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| worms | summer | rainy | winter | summer | rainy | winter | summer | rainy | winter |
| *Aeolosoma* | 845 | 1,793 | 3,512 | 1,497 | 2,178 | 4,771 | 3,363 | 7,823 | 11,482 |
| *Branchiura* | 178 | 252 | 134 | 667 | 415 | 282 | 578 | 326 | 15 |
| *Nais* sp. | 104 | 60 | 30 | 178 | 134 | 15 | 0 | 0 | 0 |

**Table 4** Structure and community of aquatic worms in ditch according to sampling stations (Chiang Mai, THAILAND)

| Stations | Richness | Evenness | Diversity |
|---|---|---|---|
| 1 | 0.23 | 0.37 | 0.41 |
| 2 | 0.22 | 0.48 | 0.53 |
| 3 | 0.10 | 0.24 | 0.16 |

**Table 5** Structure and community of aquatic worms in ditch according to seasons (Chiang Mai, THAILAND)

| Season | Richness | Evenness | Diversity |
|---|---|---|---|
| Summer | 0.22 | 0.58 | 0.64 |
| Rainy | 0.21 | 0.32 | 0.35 |
| Winter | 0.20 | 0.11 | 0.12 |

**Table 6** Structure and community of aquatic worms in ditch according to sampling stations and seasons (Chiang Mai, THAILAND)

| Seasons & Sampling Stations | Richness | Evenness | Diversity |
|---|---|---|---|
| Summer St 1st | 0.28 | 0.66 | 0.73 |
| Summer St 2nd | 0.26 | 0.76 | 0.84 |
| Summer St 3rd | 0.12 | 0.60 | 0.42 |
| Rainy St 1st | 0.26 | 0.45 | 0.49 |
| Rainy St 2nd | 0.25 | 0.56 | 0.61 |
| Rainy St 3rd | 0.11 | 0.24 | 0.17 |
| Winter St 1st | 0.24 | 0.19 | 0.20 |
| Winter St 2nd | 0.23 | 0.21 | 0.23 |
| Winter St 3rd | 0.11 | 0.01 | 0.01 |

**Table 7** Similarity index of aquatic worms in ditch according to sampling stations and seasons (Chiang Mai, THAILAND)

| Season | Mar_st.1 | Mar_st.2 | Mar_st.3 | Jul_st.1 | Jul_st.2 | Jul_st.3 | Nov_st.1 | Nov_st.2 | Nov_st.3 |
|---|---|---|---|---|---|---|---|---|---|
| Mar_st.1 | | | | | | | | | |
| Mar_st.2 | 80.65 | | | | | | | | |
| Mar_st.3 | 63.00 | 78.47 | | | | | | | |
| Jul_st.1 | 84.60 | 86.65 | 78.67 | | | | | | |
| Jul_st.2 | 80.18 | 90.29 | 83.46 | 91.25 | | | | | |
| Jul_st.3 | 53.31 | 61.56 | 80.67 | 67.51 | 69.93 | | | | |
| Nov_st.1 | 71.55 | 72.31 | 87.87 | 83.49 | 82.26 | 77.50 | | | |
| Nov_st.2 | 65.03 | 70.83 | 87.07 | 79.76 | 79.99 | 87.51 | 89.98 | | |
| Nov_st.3 | 40.26 | 45.07 | 64.09 | 52.22 | 53.30 | 84.88 | 67.40 | 72.67 | |

**Table 8** Analysis similarity percentage of community of aquatic worms in ditch according to sampling stations and seasons (Chiang Mai, THAILAND)

| Arrangement | Average Similarity % | Average Abundance % | Contribution % | Cumulative % |
|---|---|---|---|---|
| group 1 | 80.35 | | | |
| *Aeolosoma* sp. | 53.84 | 49.01 | 67.01 | 67.01 |
| *Branchiura sowerbyi* | 20.07 | 18.26 | 24.98 | 91.99 |
| group 2 | 84.88 | | | |
| *Aeolosoma* sp. | 81.32 | 97.8 | 95.8 | 95.8 |

**Table 9** Analysis dissimilarity percentage of community of aquatic worms in ditch according to sampling stations and seasons (Chiang Mai, THAILAND)

| Arrangement | Group 1 Average | Group 2 | Average Dissimilarity% | Contribution % | Cumulative % |
|---|---|---|---|---|---|
| Group 1 and 2 had valuable average dissimilarity percentage 36.21 | | | | | |
| *Aeolosoma* sp. | 49.01 | 97.8 | 27.01 | 74.57 | 74.57 |
| *Branchiura* | 18.26 | 10.96 | 5.07 | 13.99 | 88.56 |
| *Nais* sp. | 7.46 | 0 | 4.14 | 11.44 | 100 |

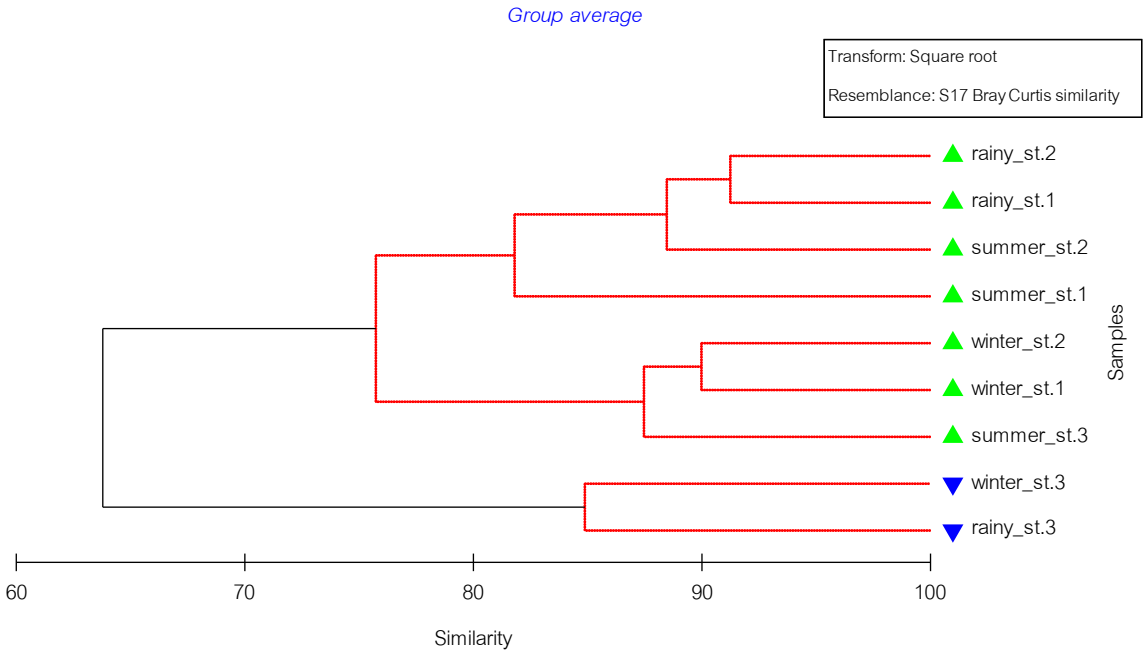


**Figure 2** Group arrangement of aquatic worms in ditch according to sampling stations and seasons (Chiang Mai, THAILAND)

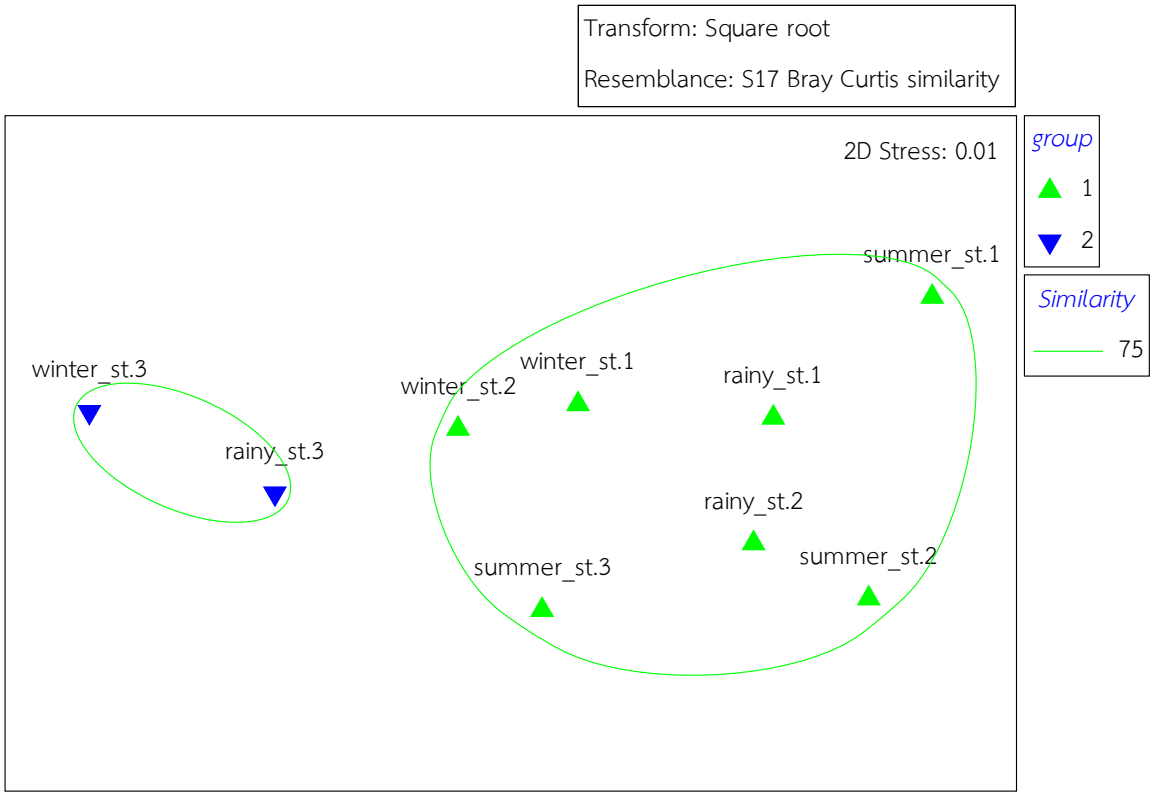


**Figure 3** Distribution of group arrangement of aquatic worms in ditch according to sampling stations and seasons (Chiang Mai, THAILAND)

## Discussions and Conclusions

Abundance of benthic fauna depends on its surrounding environment such as property of water, mineral, bottom of water. Almost benthic fauna were lived plentifully in clean water without decay except some species can live in the decayed environment. (Siri *et al.*, 1976) Species diversity index of benthic fauna showed a relationship between species and quantity of benthic fauna in source of water. Under suitable environment, an index value was high showing that the environment had plentiful of benthic fauna and each species had amount resemblance. On the other hand, under inappropriate environment or polluted water, an index was low showing that environment had few benthic fauna and each species had different amounts. (Bung-on, 1996) Similarity index was determined in community of living things to compare between 2 areas for observing benthic fauna in 2 areas whether had resemblance or different or not. General similarity index will be high when comparing in the resemblance area. (Tudorancea *et al.,* 1979)

From the results, it can be concluded that *Aeolosoma* sp. was distribution in public abundance through all year, it was found to be the most in winter station 3$^{rd}$ and the least in summer station 1$^{st}$. When considered according to season found *Aeolosoma* sp. was the most in winter which resembled with research of Veerasak (2000) studying abundance and distribution of benthic fauna in Tajin River found aquatic worms which were found the most in the winter especially November. When considered according to sampling station, it was found *Aeolosoma* sp. to be the most in station 3$^{rd}$.

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## References

Brinkhurst, R.O. 1971. A Guide for the Identification of British Aquatic Oligochaeta. University of Toronto, 53 p.

Brinkhurst, R. O. and K. E. Chua. 1969. Preliminary investigation of the exploitation of some potential nutritional resources by three sympatric tubicid oligochaetes. Journal of the Fisheries Research Board of Canada, 26, 59-68.

Bung-on, T. 1996. Water quality, species and quantity of benthic fauna in Mae Kong River. Master degree, Kasetsart University, Bangkok. 142 p. [in Thai]

Clarke, K. R. and R. M. Warwick. 1994. Change in Marine Community: an Approach to Statistical Analysis and Interpretation. Plymouth: Plymouth Marine Laboratory.

Densem, J. W. 1982. Growth studies of *Tubifex tubifex* (Oligochaeta: Tubificidae) on sewage sludge. Ph.D. thesis, University of Wales, UK,

Edmonson, W. T. 1963. Freshwater Biology. John.Willey & Sons Inc., New York, 1248 p.

Elissen, H.J.H. 2007. Sludge reduction by aquatic worms in wastewater treatment with emphasis on the potential application of *Lumbriculus variegates*. Ph.D. thesis Wageningen University, The Netherlands, 192 p.

Ludwig, J. A. and J. F. Reynolds. 1988. Statistical ecology: A primer on methods and Computing. New York: John Wiley & Sons.

Ratsak, C. H. and J. Verkuijlen. 2006. Sludge reduction by predatory activity of aquatic oligochaetes in wastewater treatment plants: science or fiction. Hydrobiologia, 564, 197-211.

Tudorancea, C., R. H. Green and J. Huebner. 1979. Structure, dynamics and production of the benthic fauna in Lake Manitoba. Hydrobiology, 64, 59-95.

Tukvinad, S., S. Sudja, P. viruch, A. woravit, N. Jaruwat and P. Patnuch. 1976. Property Survey and combine result of water for living of benthic fauna in Thajin River. Bangkok: Department of fisheries.

Suatao, V. 2000. Abundance and distribution of benthic fauna in Tajin River. Master Degree, Kasetsart University, THAILAND.

Washington, H. G. 1984. River of diversity, biotic and similarity indices. *Water Res*, 18(6), 653-694.

Wavre, M. and R. O. Brinkhurst. 1971. Interactions between some tubificid oligochaetes and bacteria found in the sediments of Toronto Harbour, Ontario. Journal of the Fisheries Research Board of Canada, 28, 335-41.