Occurrence of Zooplanktons in the Eastern Part of Inle Lake, Nyaungshwe

Moe Kyi Han [1], Ni Ni Win [2] and Naw Mie Mie Tun [3]

Abstract

Occurrence of zooplanktons in the eastern part of Inle Lake was conducted during July 2017 to October 2018. In Inle Lake, four study sites were selected for research work such as Tha Le Oo village (site I), Inn Le (site II), Nyaung Wun village (site III), and Pae Pin village (site IV). Water samples from selected study sites were seasonally collected to observed zooplanktons. A total of zooplanktons observed was 40 genera belonging to 30 families, 20 orders, and 14 classes under 10 phyla from four study sites in Inle Lake. Among the ten phyla, Arthropoda was the most abundant (13 genera, 32.5 %) followed by Ciliophora (nine genera, 22.5 %) and Rotifera (seven genera, 17.50 %), and the least was Protozoa, Euglenozoa, Nematoda, Gastrotricha and Euarthropoda (one genus, 2.5 %), respectively. These zooplanktons could be identified down to genus level. Zooplanktons represented by 18 genera in site I, 19 in site II, 20 in site III and 28 in site IV. Seasonally, the most abundant and occurrence of zooplanktons (16 genera, 40.0 %) was found in rainy season of site IV and the hot season of site I followed by 15 genera (37.5 %) in the hot season of site IV, and the least (one genus, 2.5 %) in rainy season of site II.

Keywords: Zooplankton, Arthropoda, Ciliophora, Rotifera, Inle Lake

Introduction

Inle Lake is a freshwater lake situated on the Shan plateau and located in Nyaung-shwe Township, 30 km far from Taunggyi, Southern Shan State, Eastern part of Myanmar. The Lake is well-known as an eco-tourism site in Myanmar. The unique leg-rowing style of Intha cannot be found anywhere in the world. Therefore, Inle Lake becomes an attractive destination for tourists. In the year 2004, Inle Lake was assigned as an ASEAN Heritage Park. Inle Lake became Myanmar's first designated place of World Network of Biosphere Reserves in June 2015. In 2018 it has also been designated as a protected Ramsar site. In Inle Lake, the flora and fauna are very diverse with very high biomass. There are 16 endemic fish species. Thus, Inle Lake is designated as one of the most important lakes in Southeast Asia for fish generic and specific endemism. Inle Lake is the habitat for wetland residential and migratory bird species. For the protection of the bird fauna, Forest Department established the Inle Wetland Wildlife Sanctuary (IWWS) in 1985.

There are about 445 villages in and surrounding the lake including both sides of eastern and western part of the lake. Inle Lake is very popular and essential for our country for its aesthetic value, unique culture (life style), livelihood and its products. Streams flow into the lake from surrounding mountains since the lake is situated at low plain surrounded by high mountains. Influx of water from the surrounding streams of the lake carried the runoff chemical fertilizers and pesticides (such as herbicides, insecticides, fungicides) from the agricultural areas near the streams. This lead water pollution in the lake.

The main livelihoods of Intha are traditional farming and fishing. The lake provides the main animal protein source for the local populations and for the surrounding townships. Inle

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Lake is also now facing dramatically shrinking of water surface because sedimentation contributes loss of space for water in the lake. The water level of Inle Lake has reached its lowest record, causing water scarcity and difficulty for transport as well as for gardening. There are high diversity of planktons and aquatic plants in the Lake. Freshwater zooplanktons are found to be dominant as in four major groups: protozoa, rotifers, cladocerans and copepods. Dominant zooplanktons in freshwater lake are *Moina*, *Daphnia* and a group of rotifers. Seiner (2004) stated that *Daphnia* spp. are commonly used to detect various water pollutants because they are very sensitive to chlorine and various heavy metals. They can occupy a broad range of habitats.

Both phytoplankton and zooplankton have a major importance in the freshwater environment, both in terms of fundamental ecology and in relation to human use of natural resources (Bellinger and Sigee, 2010). Many species of zooplankton can be used as biological indicators for water pollution, water quality and eutrophication (Bonnet and Frid, 2004). The qualitative and quantitative studies of plankton are an important factor to access the water quality (Shekhar, 2008).

It is therefore the present study aimed to investigate the zooplankton in freshwater ecosystem of Inle Lake. The objectives of the present research are to observe and identify the zooplanktons in the eastern part of Inle Lake and to investigate the seasonal occurrence of zooplankton in different study sites.

Materials and Methods

Study area and Study Sites

Inle Lake is the second largest lake in Myanmar. It is located between 20˚ 36′ and 20° 39.573′ N and 96˚ 55′ and 96˚ 57′ E, at about 900 m (2950 ft) above sea level. Estimated surface area of the Lake is 44.9 square miles (116 km^2). During the dry season, the average water depth is 5 ft (1.5 m) but during the rainy season, this can increase by 7 ft (2.1 m) with the deepest point being 12.2 ft (3.7 m). Although there are many villages can be found in and around the lake for the comparative study of zooplanktons, four study sites were selected. These study sites were based on agricultural gardens which are mixed with human settlement (Tha Le Oo village), site I; place of open water of the lake (Inn Le), which is the fishing ground, site II; places mixed with human settlement and agricultural gardens (Nyaung Wun village), site III and site IV (Pae Pin village). (Fig. 1)

Study Period

This study was lasted from July 2017 to October 2018.

Sample Collection, Observation and Identification

Water samples especially beneath the surface about 1 - 2 feet were collected seasonally (once per season) from these study sites, during July 2017 till April 2018. From these study sites each water sample was carried with relative plastic bottle to the laboratory of Department of Zoology, Taunggyi University. At the Department, some of these water samples were centrifuged for the observation of zooplanktons. Then the supernatant and bottom water from the test tube were used for examination. From these water samples, one drop of water was placed on glass slide and covered with cover slip for examination under light compound microscope with magnification (4 x, 10 x, 40 x). For high magnification (100 x), one drop of immersion oil was placed on the cover slip, and then the microphotographs were taken with camera attached to electric compound microscope. Identification of zooplanktons was made according to the model developed by Edmondson (1966) and Rao (2004).

Results

In the present study, many genera of zooplanktons were observed from four study sites within the eastern part of Inle Lake: these are site I (Tha Le Oo village), site II (Inn Le), site III (Nyaung Wun village) and site IV (Pae Pin village). A total of zooplanktons observed in four study sites was 40 genera belonging to 30 families, 20 orders, and 14 classes under 10 phyla (Table 1). These were one genus of phylum Protozoa namely *Amoeba*; four genera of Amoebozoa, *Vannella*, *Arcella*, *Difflugia* and *Centropyxis*; one of Euglenozoa, *Peranema*; two of Cercozoa, *Euglypha* and *Trinema*; nine of Ciliophora, *Coleps*, *Euplotes*, *Stylonychia*,

Plate 1 Map of Inle Lake showing the study sites (I = Tha Le Oo; II = Inn Le; III = Nyaung Wun; IV = Pae Pin) (Source: Google Earth)

Aspidisca, *Tetrahymena*, *Vorticella*, *Pleuronema*, *Uronema* and *Trichodina*; one of Nematoda, *Caenorhabditis*; seven of Rotifera, *Keratella*, *Notholca*, *Brachionus*, *Platyias*, *Trichocerca*, *Monostyla* and *Tripleuchlanis*; one of Gastrotricha, *Lepidodermella*; 13 of Arthropoda, *Daphnia*, *Alona*, *Chydorus*, *Lathonura*, *Candona*, *Physocypria*, *Cypris*, *Eucypris*, *Cyprinotus*, *Cypricercus*, *Chlamydotheca*, *Entocythere* and *Macrocyclops*; one of Euarthropoda, *Chironomus* (redworm, larva of midge fly). These zooplanktons could be identified down to

genus level, and parts of insects and unidentified zooplankton were also observed. Among the ten phyla, Arthropoda was the most abundant (32.5 %) followed by Ciliophora (22.5 %), Rotifera (17.50 %), and the least was Protozoa, Euglenozoa, Nematoda, Gastrotricha and Euarthropoda (2.5 %), respectively (Fig. 1).

Zooplankton represented by 18 genera in site I, 19 in site II, 20 in site III and 28 in site IV. The genera of zooplankton recorded in four study sites were shown in Table 2 and Fig. 2. In site I, zooplankton genera observed were one of Protozoa, Euglenozoa, Cercozoa, Nematoda, three of Amoebozoa and Rotifera, four of Ciliophora and Arthropoda; in site II, one of Protozoa, Cercozoa, Nematoda, three of Amoebozoa and Ciliophora, four of Rotifera, six of Arthropoda; in site III, one of Protozoa, two of Cercozoa, three of Amoebozoa and Arthropoda, four of Rotifera, seven of Ciliophora; in site IV, one of Protozoa, Euglenozoa, Gastrotricha and Euarthropoda, two of Cercozoa, four of Amoebozoa and Ciliophora, five of Rotifera, and nine of Arthropoda (Table 3, Fig. 3).

According to the seasonal occurrence, in site I, two genera in the rainy season, four in the cold season and 16 in the hot season, were observed. These were only one each of Protozoa and Amoebozoa in the rainy season; one of Protozoa and Arthropoda, two of Amoebozoa in the cold season; and one of Protozoa, Amoebozoa, Euglenozoa, Cercozoa and Nematoda, three of Rotifera, four of Ciliophora and Arthropoda in the hot season. In site II, one genus in the rainy season, 13 genera in the cold season and six in the hot season; these were only one of Ciliophora in the rainy season; one of Protozoa, Amoebozoa, Cercozoa and Nematoda, two of Ciliophora, three of Rotifera, and four of Arthropoda in the cold season; and one of Rotifera, two of Arthropoda, and three of Amoebozoa in the hot season. In site III, three genera in the rainy season, eight in the cold season and 12 in the hot season; these were one of Protozoa, Amoebozoa and Ciliophora in the rainy season; one of Rotifera, two of Amoebozoa, five of Ciliophora in the cold season; and two of Amoebozoa, Cercozoa and Ciliophora, three of Rotifera and Arthropoda in the hot season. In site IV, 16 genera in the rainy season, five in the cold season and 15 in the hot season; these were one of Protozoa, Euglenozoa, Cercozoa and Ciliophora, two of Amoebozoa, four of Rotifera, six of Arthropoda in the rainy season; one of Amoebozoa, Ciliophora, Rotifera, Arthropoda and Euarthropoda in the cold season; and one of Cercozoa, Rotifera and Gastrotricha, two of Amoebozoa and Ciliophora, eight of Arthropoda in the hot season. (Table 4, Fig. 4)

At the end of the study period, the most abundant and occurrence of zooplanktons (16 genera, 40.0 %) found in rainy season of site IV and the hot season of site I followed by 15 genera (37.5 %) in the hot season of site IV, and the least (one genus, 2.5 %) in rainy season of site II (Table 4, Fig. 4). The most abundant genera was observed in Arthropoda (13 genera, 32.5 %) followed by Ciliophora (nine genera, 22.5 %) and Rotifera (seven genera, 17.5 %), (Table 1, Fig. 1).

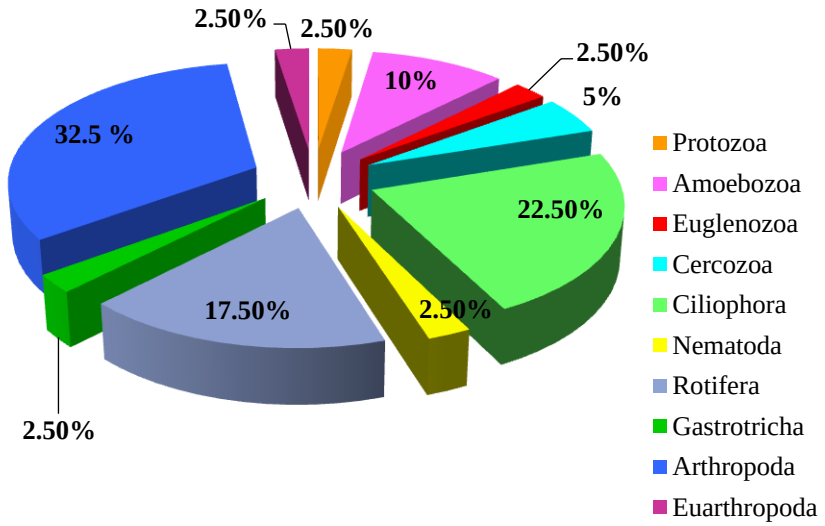

Fig. 1 Species composition of zooplanktons according to phyla found in four study sites during the study period

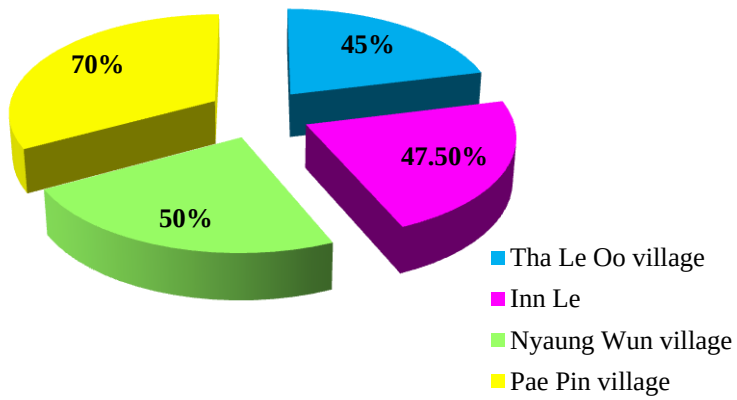

Fig. 2 Occurrence of zooplanktons found in four study sites during the study period

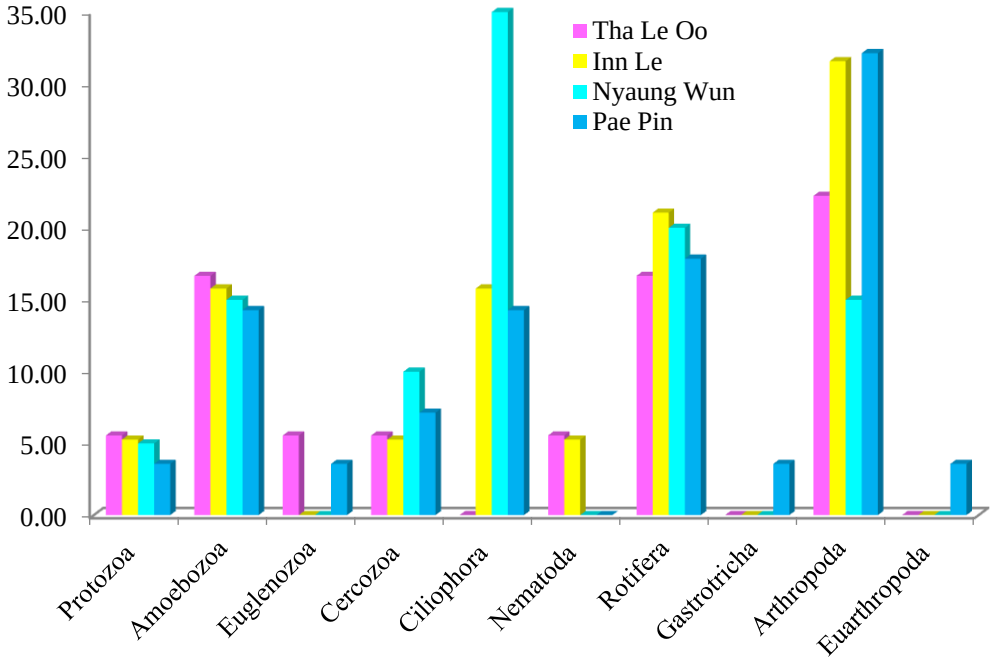

Fig. 3 Occurrence (%) of zooplankton genera found in respective study sites during the study period

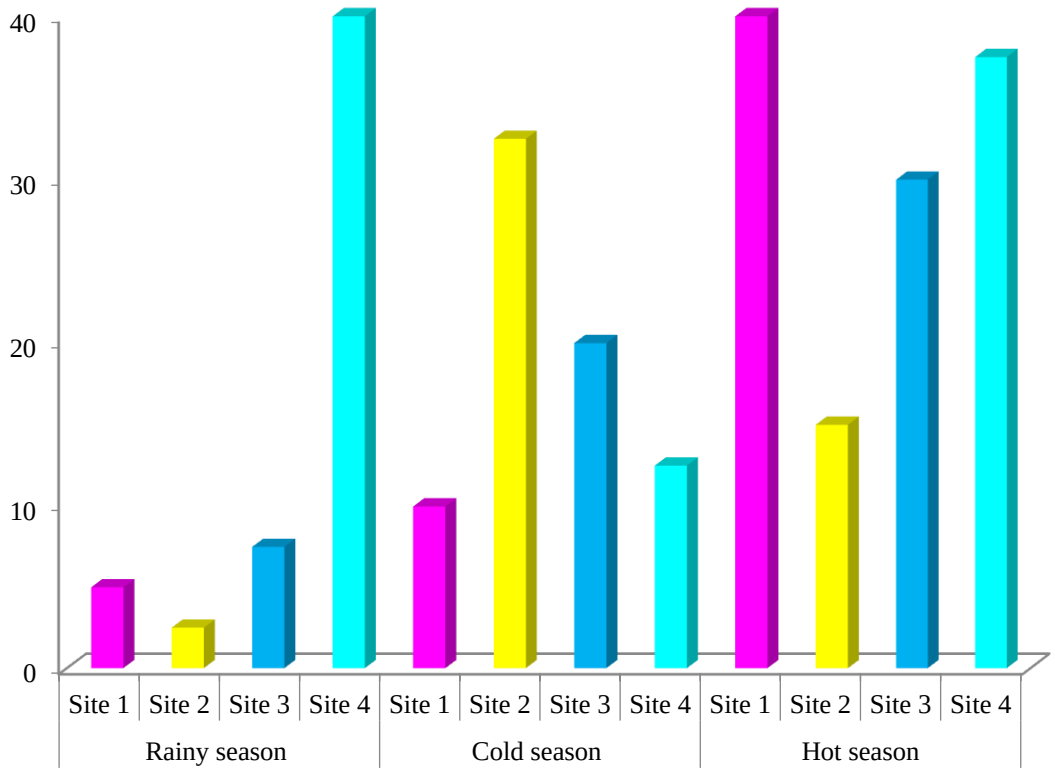

Fig.4 Seasonal occurrence of zooplankton genera found in the four study sites during the study period (Site I = Tha Le Oo village; Site II = Inn Le; Site III = Nyaung Wun village; Site IV = Pae Pin village)

Discussion and Conclusion

In the present study, 40 genera belonging to 30 families, 20 orders, and 14 classes under ten phyla of zooplanktons were observed. These could be identified down to genus level only. Thus, the zooplanktons found in the present study need to be identified down to species level. Among them, the most abundant genera were observed in Arthropoda (13 genera, 32.5 %) followed by Ciliophora (nine genera, 22.5 %) and Rotifera (seven genera, 17.5 %). Singh *et al.* (2014) also reported that rotifers are the important part of the freshwater zooplankton being a major food source for aquatic organisms such as fish and prawn. The rotifer *Branchionus* species can be mass cultivated in large quantities and is an important live feed in aquaculture. In the present result, the abundant rotifers may therefore be the natural food source of fishes was in good situation. Besides, Goel and Chavan (1991) stated that the genus *Brachionus* is the pollution tolerant species and indicates accumulation of organic matters. In this study, the genus *Brachionus* was abundantly observed in all study sites except in site I. Therefore, it can be used to interpret as the indicator of water quality.

The zooplanktons observed were 18 genera in site I, 19 in site II, 20 in site III and 28 in site IV. Therefore, zooplankton was the most abundant in site IV. In the ten phyla of zooplankton, Arthropoda was the most abundant (9 genera, 22.5 %) in site IV followed by (6 genera, 15 %) in site II. It could be assumed that the more zooplankton due to the more phytoplankton according to their food chain in site IV (Pae Pin village) than the others (sites) as zooplankton and phytoplankton are the good source of live food for fishes.

Table 1 Systematic position of zooplanktons found during the study period

Phylum	Class	Order	Family	Genus
Protozoa	Sarcodina	Amoebida	Amoebidae	*Amoeba*
Amoebozoa	Discosea	Vannellida	Vannellidae	*Vannella*
	Tubulinea	Arcellinida	Arcellidae	*Arcella*
			Difflugiidae	*Difflugia*
			Centropyxidae	*Centropyxis*
Euglenozoa	Euglenoidea	Euglenales	Peranemaceae	*Peranema*
Cercozoa	Imbricatea	Euglyphida	Eyglyphidae	*Euglypha*
				Trinema
Ciliophora	Prostomatea	Prorodontida	Colepidae	*Coleps*
	Spirotrichea	Sporadotrichida	Euplotidae	*Euplotes*
			Oxytrichidae	*Stylonychia*
	Oligohymenophora	Euplotida	Aspidiscidae	*Aspidisca*
		Hymenostomatida	Tetrahymenidae	*Tetrahymena*
		Peritrichida	Vorticellidae	*Vorticella*
		Pleuronematida	Pleuronematidae	*Pleuronema*
		Philasterida	Uronematidae	*Uronema*
		Mobilida	Trichodinidae	*Trichodina*
Nematoda	Secernentea	Rhabditida	Rhabditidae	*Caenorhabditis*
Rotifera	Monogononta	Ploima	Brachionidae	*Keratella*
				Notholca
				Brachionus
				Platyias
			Trichocercidae	*Trichocerca*

			Lecanidae	*Monostyla*
			Euchlanidae	*Tripleuchlanis*
Gastrotricha	-	Chaetonotida	Chaetonotidae	*Lepidodermella*
Arthropoda	Crustacea	Cladocera	Daphniidae	*Daphnia*
			Macrothricidae	*Alona*
			Chydoridae	*Chydorus*
	Ostracoda	Cladocera	Chydoridae	*Lathonura*
		Podocopida	Candonidae	*Candona*
			Cyprididae	*Physocypria*
				Cypris
				Eucypris
				Cyprinotus
				Cypricercus
				Chlamydotheca
			Entocytheridae	*Entocythere*
	Maxillopoda	Cyclopoida	Cyclopidae	*Macrocyclops*
Euarthropoda	Insecta	Diptera	Chironomidae	*Chironomus*

Table 2 Zooplankton genera found in respective study sites during the study period

Phylum	Site I	Site II	Site III	Site IV
Protozoa	*Amoeba*	*Amoeba*	*Amoeba*	*Amoeba*
Amoebozoa	-	-	-	*Vannella*
	Arcella	*Arcella*	*Arcella*	*Arcella*
	Difflugia	*Difflugia*	*Difflugia*	*Difflugia*
	Centropyxis	*Centropyxis*	*Centropyxis*	*Centropyxis*
Euglenozoa	*Peranema*	-	-	*Peranema*
Cercozoa	*Euglypha*	*Euglypha*	*Euglypha*	*Euglypha*
	-	-	*Trinema*	*Trinema*
Ciliophora	*Coleps*	-	*Coleps*	-
	Euplotes	-	*Euplotes*	-
	-	-	*Stylonychia*	-
	-	*Aspidisca*	-	-
	Tetrahymena	-	*Tetrahymena*	*Tetrahymena*
	-	*Vorticella*	-	*Vorticella*
	Pleuronema	*Pleuronema*	*Pleuronema*	*Pleuronema*
	-	-	*Uronema*	-
	-	-	*Trichodina*	*Trichodina*
Nematoda	*Caenorhabditis*	*Caenorhabditis*	-	-
Rotifera	-	-	-	*Keratella*
	Notholca	*Notholca*	-	*Notholca*
	-	*Brachionus*	*Brachionus*	*Brachionus*
	Platyias	-	*Platyias*	-
	-	-	*Trichocerca*	*Trichocerca*
	-	*Monostyla*	-	-
	Tripleuchlanis	*Tripleuchlanis*	*Tripleuchlanis*	*Tripleuchlanis*

Gastrotricha	-	-	-	*Lepidodermella*
	-	-	*Daphnia*	*Daphnia*
	-	*Alona*	-	-
	Chydorus	*Cypris*	-	-
	-	*Eucypris*	-	-
	-	*Candona*	-	*Candona*
	-	*Physocypria*	-	-
Arthropoda	*Cypris*	-	-	*Cypris*
	Eucypris	-	*Eucypris*	*Eucypris*
	-	*Cyprinotus*	*Cyprinotus*	*Cyprinotus*
	-	-	-	*Cypricercus*
	-	-	-	*Chlamydotheca*
	-	-	-	*Entocythere*
	Macrocyclops	-	-	*Macrocyclops*
Euarthropoda	-	-	-	*Chironomus*
Total No. of genus	18	19	20	28
Occurrence (%)	45	47.5	50	70

Table 3 Number and occurrence (%) of zooplankton genera found in respective study sites during the study period

Site	Protozoa	moebozoa	Euglenozoa	Cercozoa	Ciliophora	Nematoda	Rotifera	Gastrotricha	Arthropoda	Euarthropoda
Site I	1 (5.56 %)	3 (16.67 %)	1 (5.56 %)	1 (5.56 %)	4 (22.2 %)	1 (5.56 %)	3 (16.67 %)	0	4 (22.2 %)	0
Site II	1 (5.26 %)	3 (15.79 %)	0	1 (5.26 %)	3 (15.79 %)	1 (5.26 %)	4 (21.0 %)	0	6 (31.58 %)	0
Site III	1 (5.0 %)	3 (15.0 %)	0	2 (10.0 %)	7(35.0 %)	0	4 (20.0 %)	0	3 (15.0 %)	0
Site IV	1 (3.57 %)	4 (14.28 %)	1 (3.57 %)	2 (7.14 %)	4 (14.28 %)	0	5 (17.85 %)	1 (3.57 %)	9 (32.14 %)	1 (3.57 %)

Site I = Tha Le Oo village; Site II = Inn Le; Site III = Nyaung Wun village; Site IV = Pae Pin village

Table 4 Seasonal occurrence of zooplankton genera found in four study sites during the study period

Phylum	Rainy season (No. of genus)				Cold season (No. of genus)				Hot season (No. of genus)			
	Site I	Site II	Site III	Site IV	Site I	Site II	Site III	Site IV	Site I	Site II	Site III	Site IV
Protozoa	1	0	1	1	1	1	0	0	1	0	0	0
Amoebozoa	1	0	1	2	2	1	2	1	1	3	2	2
Euglenozoa	0	0	0	1	0	0	0	0	1	0	0	0
Cercozoa	0	0	0	1	0	1	0	0	1	0	2	1
Ciliophora	0	1	1	1	0	2	5	1	4	0	2	2
Nematoda	0	0	0	0	0	1	0	0	1	0	0	0
Rotifera	0	0	0	4	0	3	1	1	3	1	3	1
Gastrotricha	0	0	0	0	0	0	0	0	0	0	0	1
Arthropoda	0	0	0	6	1	4	0	1	4	2	3	8
Euarthropoda	0	0	0	0	0	0	0	1	0	0	0	0
Total No. of genera	2	1	3	16	4	13	8	5	16	6	12	15
Occurrence (%)	5	2.5	7.5	40	10	32.5	20	12.5	40	15	30	37.5

Site I = Tha Le Oo village; Site II = Inn Le; Site III = Nyaung Wun village; Site IV = Pae Pin village

Although Protozoa are highly abundant in all aquatic habitats and greatly involved in food chain (Finlay, 1997), in the present study, only one genus of Protozoa was observed. Verma and Munshi (1987) described that in aquatic ecosystems, zooplanktons not only play a critical role in converting plant food to animal food, but also serve as a source of food for higher organisms (for instance fishes) and can be used as indicators of the trophic status of water bodies. Therefore, it may be assumed that the more zooplankton could supply food for fishes in the study area since all study sites were fishing ground in the Inle Lake.

Rotifers are regarded as bioindicators of water quality (Sladecek, 1983; Saksena *et al*., 2006) and high rotifer density has been reported to be a characteristic of eutrophic lakes (Balakrishna *et al*., 2013). In the present study, therefore, rotifers as bioindicator may indicate that the lake water showed the eutrophic conditions in the study sites. Bonnet and Frid (2004) also reported that many species of zooplankton can be used as bioindicators for water pollution, water quality and eutrophication. Economically, they are the major mode of energy transfer between phytoplankton and other aquatic animals including fish because zooplanktons occupy the second trophic level in the food chain, the first being occupied by phytoplankton. Ekpo (2013) stated that zooplanktons are ecologically the most important biotic components influencing all the functional aspects of all aquatic ecosystems, viz., food chains, food webs, energy flow/transfer and cycling matters.

In the rainy season, the most abundant zooplankton (16 genera) found in site IV and 13 genera in site II in the cold season, and 16 in site I followed by site IV (15 genera) in the hot season. Among ten phyla, Arthropoda was the most abundant (eight genera) in the hot season followed by six genera in the rainy season of site IV. In the cold season only one genus of Arthropoda was found. It may be the seasonal changes of the weather and water fluctuation. On the other hand, the abundant zooplanktons showed that the study area, the Inle Lake possesses the rich natural live food for fishes.

In conclusion, 40 genera of zooplanktons were recorded from selected study sites. Among ten phyla of zooplanktons, Arthropoda was the most abundant (32.5 %) and the least was Protozoa, Euglenozoa, Nematoda, Gastrotricha and Euarthropoda (2.5 %), respectively. In the four study sites, zooplanktons were abundant in site IV, Pae Pin village (28 genera) followed by site III, Nyaung Wun village (20 genera). Thus, the present study may provide some information for further studies dealing with the Inle Lake.

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