New locality records for *Mesocyclops* Sars, 1914 and *Thermocyclops* Kiefer, 1927 in Luzon and Mindanao Islands in the University of Santo Tomas – Zooplankton Reference Collection (UST-ZRC)

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Copepods from the genera *Mesocyclops* and *Thermocyclops* have recently gained much attention due to recent studies, which revealed their wide geographical distribution in the country as well as the presence of several endemic species, which were not observed among other copepod groups (most notably Calanoids and Harpacticoids) in the Philippines. A study on the species composition and distribution of *Mesocyclops* and *Thermocyclops* in the two largest islands in the Philippines – Luzon and Mindanao was conducted to come up with a more comprehensive understanding of the distribution and occurrence of cyclopid copepods in the archipelago. Samples deposited in University of Santo Tomas – Zooplankton Reference Collection (UST-ZRC) (collected from 2006 to 2013) collected from 47 freshwater habitats in Luzon and Mindanao islands were examined and analyzed. New locality record of *Mesocyclops thermocyclopoides*, *Thermocyclops crassus*, *T. decipiens*, *T. taihokuensis*, *Eucyclops* sp. and cyclopoid copepodites were observed from 32 freshwater habitats. This brings the known locality records for cyclopid copepods from 99 (from all available published materials) to 131 localities throughout the Philippines.

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INTRODUCTION

Species from the genera *Mesocyclops* Sars, 1914 and *Thermocyclops* Kiefer, 1927 are the most abundant and dominant species among the family Cyclopidae (Boxshall 1992). It is the largest group which includes of 120 (sub) species that inhabits inland waters in South and South East Asia (Hołyńska and Papa 2013). Most species of Cyclopidae are known to occur in the pelagic environment (Dela Paz et al. 2016). They are major contributors in the trophic structure of aquatic ecosystems. Also, members of the genus *Mesocyclops* include the largest species (less or equal to 2 mm) of copepods with highly-developed mouth parts which are used in several studies as biological control agents for mosquito (*Aedes* sp., *Anopheles* sp. and *Culex* larvae) (Marten & Reid, 2007). In terms of diet, *Thermocyclops* are generally omnivorous plankton

while *Mesocyclops* are carnivorous or detritivorous (Fernando et al. 1990).

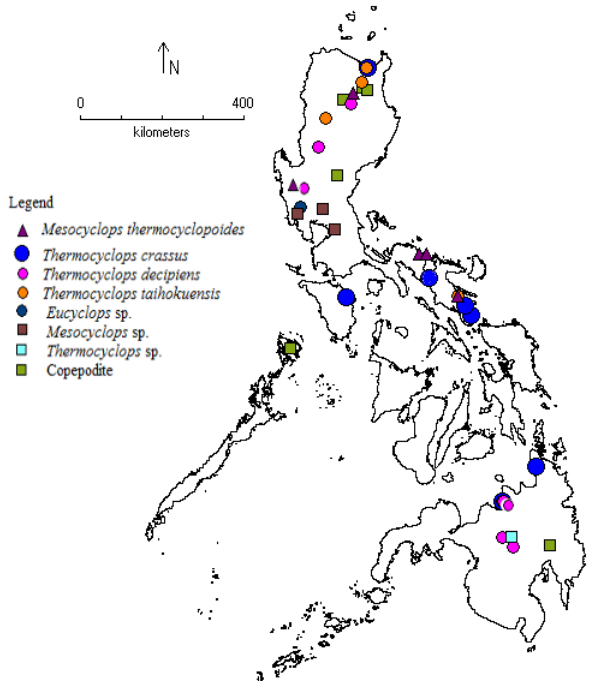

Figure 1: Distribution map of cyclopoid in Luzon and Mindanao observed in this study.

The Philippines is situated (13.00 N, 122.00 E) in South East Asia, which comprises 7, 641 islands with 59-70 lakes (Davies et al. 1990, Guerrero III 2001, Mutia 2001), 18 rivers and river systems, 22 wetlands and several other water reservoirs according to the Philippine Department Environment and Natural Resources (2010). These freshwater habitats are highly utilized for fisheries and aquaculture, irrigation and eco-tourism. The archipelago is very unique and belongs to two biogeographical regions with the south and southwestern Philippines including Palawan, Sulu, and Mindanao islands belong to the Sino-Indian region while the northern part belongs to the Indo-West Pacific (Bănărescu 1992, 1995). The varying geographic origin of the Philippines has favored a high species richness and high levels of endemism for both flora and fauna (Ong et al. 2002). It has a typically humid climate, which receives high amount of precipitation (2,026 millimeters per annum) from the months of June to October (Martinez and Galera, 2011) and experience dry weather from January to May.

Early researches on Philippine Cyclopidae were conducted by Kiefer (1938) and Woltereck et al. (1914), thereafter, several studies have added information on the occurrence of freshwater copepods from different localities in the Philippines (Uéno 1966; Petersen and Carlos 1984; Mamaril 1986, 2001; Aquino et al. 2008; Tuyor and Baay 2011; Papa and Zafaralla 2011; Papa and Hołyńska 2013). The most recent study done on the freshwater cyclopoid copepods has been conducted in major Visayas islands (Dela Paz et al. 2016) which included the species description and distribution of species *Mesocyclops* and *Thermocyclops*. From all previously published studies, a total of 18 cyclopoid species have been recorded from the Philippines (Marsh 1932; Kiefer 1938, 1981; Woltereck et al. 1941; Uéno 1966; Mamaril and Fernando 1978; Petersen and Carlos 1984; Mamaril 1986, 2001; Hołyńska, 2000; Tuyor and Baay 2001; Aquino et al. 2008; Papa and Zafaralla 2011; Papa & Hołyńska 2013; Dela Paz et al. 2016a). Despite the revival of interest in studying cyclopoid copepods in Philippine freshwaters, information on the distribution of cyclopoid copepods from many areas throughout the country are still lacking, even in the two largest islands of the archipelago – Luzon and Mindanao. This hampers a comprehensive analysis of the insular distributional pattern and possible dispersal routes of cyclopoid copepods in the archipelago.

In this study, we updated the species composition and distribution of freshwater *Mesocylops* and *Thermocyclops* in Northern (Luzon) and Southern (Mindanao) Philippines using the specimens deposited at the University of Santo Tomas - Zooplankton Reference Collection (UST-ZRC), the only organized repository of freshwater zooplankton in the country, to date.

MATERIALS AND METHODS

We examined copepod samples from the UST - Zooplankton Reference Collection (UST-ZRC) which were collected from 47 freshwater habitats in Luzon and Mindanao islands from 2006 to 2013 (Table 1). The samples were all collected using an 80 µm conical plankton net and preserved with 70% Ethanol.

In the laboratory, selected ethanol-preserved adult female specimens of *Mesocyclops* and *Thermocyclops* were dissected and mounted in a glass slide within a glycerin medium. The slides were sealed using clear nail polish. Observations of specimens were done using a stereomicroscope BS-3044 stereomicroscope and Olympus CX21 compound microscope.

We identified the specimens up to the lowest possible taxonomic level using keys provided by Hołyńska (2000, 2006a), Hołyńska et al. (2003), Mirabdullayev et al. (2003), Chaicharoen et al. (2011), Papa and Hołyńska (2013), and Dela Paz et al. (2016a).

The identified species were compared with the descriptions and illustrations from previously published (Van de Velde 1984; Hołyńska 2000, 2006b; Hołyńska et al. 2003; Mirabdullayev et al. 2003; Chaicharoen et al. 2011; Dela Paz et al. 2016a) to validate their identity. All slides were deposited in the UST – ZRC and assigned accession numbers.

The location of the sampling sites and species distributions were mapped using DIVA Geographic Information System Software Version 7.4.

RESULTS AND DISCUSSION

Four species of cyclopoid copepods belonging to the two genera (*Mesocyclops* and *Thermocyclops*) from family Cyclopidae were identified in this study:
Class Maxillopoda Dahl, 1956
Subclass Copepoda Milne-Edwards, 1840
Order Cyclopoida Burmeister, 1834
Family Cyclopidae Rafinesque, 1815
Subfamily Cyclopinae Rafinesque, 1815

Mesocyclops thermocyclopoides Harada, 1931

Material Examined: Philippines: Luzon Island: Legaspi City, Arimbay Bridge, 13° 11’ 27.4’’ N 123 47 40 E, 2 adult females, slide USTZRC 0224A-0224F; Cagayan, Lake Cassily, 17° 40’ 18’’ N 121° 30’ 46.2’’ E, 3 adult females, slide USTZRC 0225A-0225F; Camarines Norte, Daet River, 14° 6’ 49.99’’ N 122° 57’ 21’’ E, 1 female adult, slide USTZRC 0226A-0226B; Tarlac, Santa Juliana, Tambo Lake, 15° 17’ 30.2’’ N 120° 22’ 45.2’’ E, 1 adult female, slide USTZRC 0227A-0227B; Camarines Sur, Naga, Bicol River, 13° 38’ 48.28’’ N 123° 6’ 38.34’’ E, 1 adult female, slide USTZRC 0228A-0228B.

Table 1: List of different sampling sites examined and the species observed in this study.

Site No.	USTZRC Ref. No. of sample bottles	Name	Municipality/City	Province	Island	Cyclopoid present
1	0376-0377	Malilipot Bridge	Tabaco	Albay	Luzon	NR
2	383	Rawis Bridge	Malinao	Albay	Luzon	NR
3	181-184	Ambuklao Dam	Bokod	Benguet	Luzon	TD*
4	151	Lake Nalbuan	Buguey	Cagayan	Luzon	TT*
5	152-158	Lake Calig	Buguey	Cagayan	Luzon	TC*
6	159-162	Lake Bangalau	Sta. Teresita	Cagayan	Luzon	Copepodite
7	163-165	Binag Dam	La-lo	Cagayan	Luzon	NR
8	171-172	Lake Cansiritan	Cansiritan	Cagayan	Luzon	TT*
9	166-170	Lake Nagatutuan	Gattaran	Cagayan	Luzon	NR
10	173-175	Cagayan River	Tuguegarao	Cagayan	Luzon	Copepodite
11	176-177	Lake Cassily	Tuao	Cagayan	Luzon	MT*
12	178-180	Callao Caves	Penablanca	Cagayan	Luzon	Copepodite
13	301-302	Daet River	Daet	Camarines Norte	Luzon	MT*
14	388-389	Pagsangahan Bridge	Bahug	Camarines Norte	Luzon	NR
15	394-396	Tulay na Bato	Daet	Camarines Norte	Luzon	NR
16	397-401	Bicol River	Naga	Camarines Sur	Luzon	MT*
17	315	Masuli Pond	Masuli	Camarines Sur	Luzon	NR
18	384-385	Yabo Bridge	Sipocot	Camarines Sur	Luzon	NR
19	386-387	Sooc Dam	Sipocot	Camarines Sur	Luzon	NR
20	402-403	Lago del Ray	Pili	Camarines Sur	Luzon	TC*
21	201-202	Chico River (Upstream)	Pinukpuk	Kalinga	Luzon	NR
22	189	Temporary Pool	Asibanglan	Kalinga	Luzon	Copepodite
23	191-192	Limos Stream	Limos	Kalinga	Luzon	NR
24	193-194	Laoagan Resort Fish Pond	Tabuk	Kalinga	Luzon	TD*
25	381-382	Arimbay Bridge	Bigaa	Legaspi City	Luzon	MT*, TT*
26	115	Marikina River	Marikina	Metro Manila	Luzon	*Mesocyclops* sp. (copepodite)
27	198-200	Lake Danum	Sagada	Mt. Province	Luzon	TT*
28	194-195	Underground River	Sagada	Mt. Province	Luzon	NR
29	203-204	Sumaging Cave	Sagada	Mt. Province	Luzon	NR
30	112-113	Lake Pantabangan	Pantabangan	Nueva Ecija	Luzon	Copepodite
31	116-121	Candaba Swamp	Pampanga	Pampanga	Luzon	*Mesocyclops* sp. (copepodite)
32	42, 64	Lake Bulusan	Mt. Bulusan	Sorsogon	Luzon	TC
33	332-339	Sorsogon Dam (Cawayan Bridge)	Sorsogon City	Sorsogon	Luzon	TC*
34	133-136	Lake Pinatubo	Mt. Pinatubo	Zambales	Luzon	*Eucyclops* sp.*
35	137-144	Lake Mapanuepe	San Marcelino	Zambales	Luzon	*Mesocyclops* sp. (copepodite)
36	122-125	Lake Tambo	Santa Juliana	Tarlac	Luzon	TD*, MT*
37	114	Brgy. Don Matias Pond	Burgos	Pangasinan	Luzon	TD*
38	73-78	Lake Malbato	Coron	Palawan	Palawan	Copepodite
39	79-81	Lake Kayangan	Coron	Palawan	Palawan	NR
40	48	Lake Naujan	Naujan	Oriental Mindoro	Mindoro	TC
41	40-41	Lake Mainit	Mainit	Agusan del Norte	Mindanao	TC

42	271	Lake Danao	Jasaan	Misamis Oriental	Mindanao	TC*, TD*
43	267-270	Lake Gumaod	Jasaan	Misamis Oriental	Mindanao	TD*
44	260-261	Lake Napalit	Pangantucan	Bukidnon	Mindanao	TD*
45	247-250	Lake Apo	Valencia	Bukidnon	Mindanao	*Thermocyclops* sp. (copepodite)
46	258-259	Lake Tutay	Don Carlos	Bukidnon	Mindanao	TD*
47	255-257	Lake Pinamaloy	Don Carlos	Bukidnon	Mindanao	Copepodite

Legend: MT, *Mesocyclops thermocylopoides*; TC, *Thermocyclops crassus;* TD, *Thermocyclops decipiens*; TT, *Thermocyclops taihokuensis*; NR, No record

This planktonic species is one of about 78 species from the genus *Mesocyclops.* This species is present in Oriental, Indochina, and Central America. The middle setae of P5 leg is inserted distally (Figure 2A). Pediger 5 contains dorsal and lateral hairs. The anterior margin of the lateral arms of the seminal receptacle meet the middle forming a strong indentation next to the copulatory pore (Figure 2B). No spinule at the insertion of the anterolateral and posterolateral of the caudal setae. Another character of *M. thermocyclopoides* which diverged from other species is the spinules pattern at the antennal coxobasis (caudal view) which followed the "leuckarti-type" with large spinules near the middle setae and row of few spinules at the distal rim (Figure 2C).

Thermocyclops crassus (Fischer, 1853)

Material examined: Philippines: Luzon Island: Cagayan, Buguey, Lake Calig, 18° 12' 23.1'' N 121° 49' 17.9'' E, 1 female adult, slide USTZRC 0230A-0230B; Camarines Sur, Pili, Lago Del Ray, 13° 35' 25'' N 123° 9' 36.5'' E, 1 adult female, slide 0231A-0231B; Sorsogon: Lake Bulusan, 12° 45' 41.7'' N 124° 5' 29.8'' E, 3 adult females, slide USTZRC 0239A-0239F; Cawayan Bridge, 12° 59' 11.4'' N 123° 57' 29.8'' E, 2 adult females, slide USTZRC 0242A-0242D. Mindanao: Misamis Oriental: Jasaan: Lake Danao, 1 adult female, 8° 39' 48.9996" N 124° 46' 48.2988" E, slide USTZRC 0204A-0204B; Surigao del Norte-Agusan, Lake Mainit, 9° 26' 2.0004" N 125° 31' 59.9982" E, 1 adult female, slide USTZRC 0207A-0207B. Identified *T. crassus* from Lake Naujan was not mounted due to animals are sporadic in the stored samples.

This species is common and widespread in Philippine general freshwaters. This species has been found in Oriental, Eurasia, Australasia and introduced in America regions. This species is easy to distinguish with other genera through the P5 which is characterized by the setae inserted at the middle margin (Figure 2D). The genital double-somite which contains the broad lateral arms of the seminal receptacle is forming a "T" shaped (Figure 2E). P4 endopodite 3 with lateral apical spine which is relatively longer than the middle spine. Also, the middle margin of P4 basipodite contains hairs (Figure 2F, arrow). The medial median terminal caudal setae have a strong tip curve.

Thermocyclops decipiens (Kiefer, 1929)

Material examined: Philippines: Luzon: Pangasinan, Burgos, Brgy. Don Matias Pond, coordinates were not recorded, 2 adult females, slide USTZRC 0235A-0235D; Tarlac, Santa Juliana, Tambo Lake, 15° 17' 30.2'' N 120° 22' 45.2'' E, 1 adult female, slide USTZRC 0236A-0236B; Kalinga, Tabuk, Laoagan Resort Fish pond, 17° 25' 0.66'' N 121° 27' 28.6'' E, 1 adult female, USTZRC 0237A-0237B; Benguet, Bokod, Ambuklao Dam, 16° 27' 33.3'' N 120° 44' 41.9'' E, 2 adult females, slide USTZRC 0238A-0238D. Mindanao: Misamis Oriental: Jasaan: Lake Danao, 8° 39' 48.9996" N 124° 46' 48.2988" E, 1 adult female, slide USTZRC 0205A-0206B; Lake Gumaod, 8° 39' 7.14" N 124° 48' 24.74" E, 2 adult females, slide USTZRC 0209A-0209E; Bukidnon: Don Carlos, Lake Tutay, 7° 40' 00.8004" N 125° 01' 40.1988" E, 2 adult females, slide USTZRC 0206A-0206D; Pangantucan, Lake Napalit, 7° 52′ 5″ N 124° 47′ 3″ E, 1 adult female, slide USTZRC 0208A-0208B.

Among the four species we observed in our samples, *T. decipiens* is the most frequently occurring. *T. decipiens* can be distinguished through its slightly curved posteriorly lateral arms of seminal receptacle (Figure 2G). P4 basipodite middle margin contains spinules and P4 coupler contains spinules on the triangular middle margin extension (Figure 2H). The occurrence of *T. decipiens* have been reported in Neotropical, Oriental, Palearctic, Africatropical, Neacrtic, and Australasia.

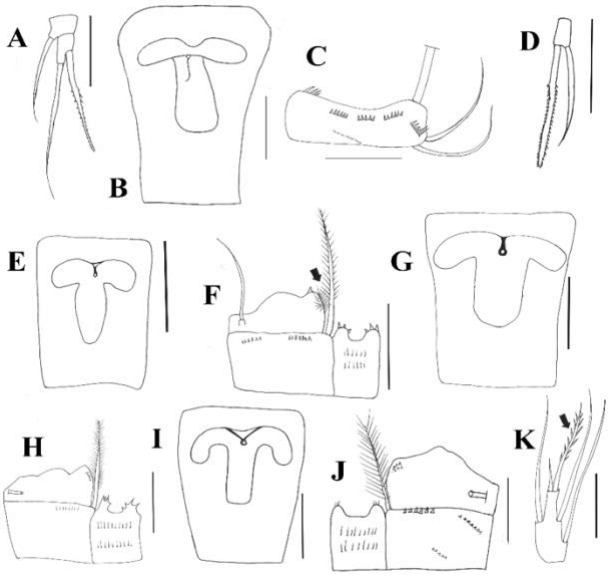

Figure 2: Morphological characters in species identification. Adult female specimen. A-C, *Mesocyclops thermocyclopoides*. D-F, *Thermocyclops crassus*. G-H, *Thermocyclops decipiens*. I-K, *Thermocyclops taihokuensis*. A, Fifth leg (USTZRC 0225B). B, Genital double-somite (USTZRC 0225F). C, Antennal coxobasis, caudal (USTZRC 0225D). D, Fifth leg (USTZRC 0239B). E, Genital double-somite (USTZRC 0239D). F, P4 coupler and protopodite, caudal (USTZRC 0239E). G, Genital double-somite (USTZRC 0235D). H, P4 coupler and protopodite, caudal (USTZRC 0235B). I, Genital double-somite (USTZRC 0234B). J, P4 coupler and protopodite, caudal (USTZRC 0234A). K, P4 endopodite 3 (USTZRC 0232A). Scale bar, A-K= 50 µm.

Thermocyclops taihokuensis (Harada, 1931)

Material examined: Philippines: Luzon: Cagayan: Cansiritan, 17° 54' 13.15'' N 121° 41' 56.8'' E, 1 adult female, slide USTZRC 0232A-0232B; Buguey, Nalbuan, 18° 13' 23.6'' N 121° 46' 59.8'' E, 1 adult female, slide USTZRC 0233A-0233B; Mt. Province, Sagada, Lake Danum, 17° 5' 40.3'' N 120° 32' 25.7'' E, 1 adult female, slide USTCZRC 0234A-0234B. The identified cyclopoid in Arimbay Bridge was not mounted due to animals are sporadic in the stored samples.

This species is one of about 55 species of genus *Thermocyclops* worldwide. *T. taihkokuensis* is an East Asian cyclopoid. It is known in Eastern Palearctic (Taiwan, China, Korea, Japan, Kazakhstan, Uzbekistan, Tajikistan, Far East of Russia) Oriental (Vietnam and Philippines). It can be distinguished with other species through its strong posteriorly curved lateral arms of seminal receptacle (Figure 2I) and the presence of teeth at the middle margin of P4 basipodite (Figure 2J). Also, the prominent teeth at the apical spines of P4 endopodite 3 is a diagnostic character of this species (Figure 2K, arrow).

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From the total of 47 localities studied, 21 contained *Mesocyclops* and *Thermocyclops* (Table 1). The general distribution of these species in Luzon and Mindanao is presented in figure 1. These species are well-distributed and cosmopolitan (i.e., commonly occurring species in tropical freshwaters) and were already recorded in previous publications (Petersen and Carlos 1984; Mamaril 1986, 2001; Aquino et al. 2008; Tuyor and Baay 2011; Papa and Zafaralla 2011; Papa and Hołyńska 2013; Dela Paz et al. 2016a, 2016b). However, we have been able to add 18 new locality records for cyclopoid copepods from these two genera (Table 1). These are localities where several species belonging to Cladocera and the invasive calanoid *Arctodiaptomus dorsalis* (Marsh, 1907) had been identified in the past (please see Pascual et al. 2014 and Rizo et al. 2015). Interestingly, we observed *Eucyclops* sp. in the Lake Pinatubo however we still need sufficient samples for its further analysis and identification. Also, 11 samples of cyclopoid copepods were collected as copepodites (Table 1) which cannot be identified up to species level due to the lack available taxonomic keys for juvenile copepod stages.

Majority of the species recorded were found in lakes and were unlikely to occur in running waters (Perbiche-Neves et al. 2014, Dela Paz et al. 2016a). Species from the genus *Thermocyclops* which we were able to identify, such as *T. crassus* and *T. decipiens* are also well-distributed in Philippine freshwater ecosystems that had been surveyed for zooplankton. This was similar to the results gathered by Papa and Hołyńska, 2013 and Dela Paz et al. 2016. These species of genus *Thermocyclops* are able to survive varying physico-chemical conditions (Reid 1989) and have good dispersal capabilities (Dela Paz et al. 2016a). For example, *T. decipiens* an omnivorous plankton can maintain good population size in eutrophic waters (Sendacz 1984, López 1994, Padovesi-Fonseca et al. 2002). In this study, *T. crassus* were collected mostly from large lakes and a reservoir including Lake Calig, Lago del Ray, Lake Bulusan, Sorsogon Dam, Lake Naujan, Lake Mainit, Lake Danao in Misamis Oriental while *T. decipiens* were in Laoagan Resort Fish Pond, Ambuklao Dam, Brgy. Don Matias Pond, Lake Danao in Misamis Oriental, Lake Napalit, Lake Tutay, Lake Gumaod and Lake Tambo. Both *T. crassus* and *T. decipiens* are commonly found in the tropics, including Asia, America and Australia but may also be found in temperate Eurasia. Furthermore, *T. crassus* is the most widely distributed cyclopoid copepod in the world and it is supposed as a complex species having several similar congeners in the family Cyclopidae (Duchovnay et al. 1992).

The third species from the genus *Thermocyclops*, which was identified from our samples, was *Thermocyclops taihokuensis* – a known East Asian species first recorded in the Philippines by Papa and Hołyńska (2013). This was collected from large fish ponds in Leyte island, as well as lakes and ponds in Mindanao island. Our results point to the possibility of this having wider distribution than previously thought. In the Arimbay Bridge, *T. taihokuensis* co-occurred with *M. thermocyclopoides*, which is a native cyclopoid copepod in the Philippines (Papa & Hołyńska 2013); it is the only *Mesocyclops* we encountered in our samples. Previous papers have recorded *Mesocylops leuckarti* (Claus, 1857) from the Philippines (Mamaril and Fernando, 1978; Mamaril 1986; Mamaril 2001), which was recently confirmed to be restricted to Paleartic regions (Hołyńska et al. 2003). However, Papa and Hołyńska (2013) observed that since most of the localities where *M. leuckartii* are recorded from the past contained *M. thermocyclopoides*, it is possible that all previous confirmed records of *M. leuckarti* are actually referring to *M. thermocyclopoides*, which has very minimal morphological differences. The biogeographical range of *M. thermocyclopoides* in the Philippines extends from north to the south of the archipelago. This species has been observed from in diverse habitats in Luzon, Panay, and Mindanao Islands (Kiefer 1930; Uéno 1966; Petersen and Carlos 1984; Mamaril 1986, 2001; Tuyor and Baay 2001; Aquino et al. 2008; Dela Paz et al. 2016a). Species from the genus *Mesocyclops* are considered the largest species belonging to family Cyclopidae (> 1.4 mm) thus making these animals good predators of mosquito larvae (Rivière and Thirel, 1981; Kumar and Rao 2003; Marten and Reid 2007). Their occurrences in a wide range of habitats in parts of Luzon, Visayas, and Mindanao may help in the natural control of mosquito-borne diseases. Unfortunately, no studies have been done to test this in the Philippines.

Of the 18 freshwater cyclopoid copepods known in the Philippines, four from these species were identified in the 21 localities studied (Table 1). The *Mesocyclops* and *Thermocyclops* species we observed in this study were commonly present in tropical freshwaters and species members belonging to Oriental region. This present inventory showed that the main species composing the Philippine freshwater cyclopoid group are *M. thermocyclopoides, T. crassus, T. decipiens,* and *T. taihokuensis*. Also, this study has added distributional records of Philippine cyclopoid copepods, increasing the known locality records from 99 to 131 freshwater habitats (Marsh 1932; Kiefer 1938, 1981; Woltereck et al. 1941; Uéno 1966; Mamaril and Fernando 1978; Petersen and Carlos 1984; Mamaril 1986, 2001; Hołyńska, 2000; Tuyor and Baay 2001; Aquino et al. 2008; Papa and Zafaralla 2011; Papa & Hołyńska 2013; Dela Paz et al. 2016a, 2016b). Concerning the species richness of this animal group in the country, according to Rocha et al. (1999) several factors might have to be considered including reservoir ageing, residence time, trophic state, biological interactions, endemisms, and even to sampling effects and the expertise of zooplankton investigators. Re-sampling the areas which only contains copepodites is recommended for thorough identification and further analysis.

Our results highlight the importance of having an organized repository for freshwater zooplankton in the country, which lessens the need to conduct frequent samplings in hard-to-reach localities. All the samples examined here had been collected in previous expeditions, but were processed and organized according to standard protocols. As such, all needed information were available to the investigators, allowing them to easily

conduct the taxonomic analyses. We highly recommend this initiative to be replicated for other taxa, especially those taxa that have limited experts in the country, in order to provide a venue for more in-depth taxonomic analyses.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

CONTRIBUTION OF INDIVIDUAL AUTHORS

RDSP conceptualized the research design, ESDP worked on the analyses of the samples including the sorting, dissection, mounting, identification of the cyclopoid and preparation of line drawing and distribution map. Both ESDP and RDSP worked on the writing of the manuscript.

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