ISSN 1656-4707

The Palawan Scientist

Volume 7

July 2015

A Research Journal of the Western Philippines University
Aborlan, Palawan

www.wpu.edu.ph
www.palawanscientist.org

The Palawan Scientist is an annual multi-disciplinary journal published by the Western Philippines University, Palawan, Philippines. It accepts original research articles, notes and short communications in agriculture, fisheries and aquatic sciences, environment, education, engineering, mathematics, sociology and related disciplines (to include arts and humanities).

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Cover Photo

With a maximum disc width of up to 5 m, the Reef manta ray *Manta alfredi* is the second largest species of ray in the world. Its biology is poorly known but is thought to live up to 30 years. In Tubbataha Reefs Natural Park (TRNP), dive tourism enhances the economic value of manta rays in comparison to short-term returns from fishing. The confirmation of the presence of this threatened (IUCN vulnerable) species in TRNP further proves that Palawan is indeed a “Man and Biosphere Reserve”. *Photo credits: David Choy*

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https://doi.org/10.69721/TPS.J.2015.07.1.x

EDITORIAL

This 7th volume of The Palawan Scientist includes three very informative full research articles and two notes, all dealing on aquatic organisms and habitats.

The first article authored by Ma. Theresa R. Aquino et al. which confirmed the presence of *Manta alfredi* in Tubbataha Reefs Natural Park (TRNP) Cagayancillo, Palawan, Philippines could serve as basis in revising the list of protected species within park and in the Philippines. The second paper, authored by Lucila Garagara et al., which determined the water parameters and bird watching potentials of an abandoned open pit mine in Puerto Princesa City could be used as basis in developing the area as eco-tourism site. In the third paper, Mr. Rodulf Anthony T. Balisco reports that Gracious sea urchin *Tripneustes gratilla* in Pag-asa Island, West Philippine Sea are underexploited but management measures are needed to avoid overharvesting.

The research notes of Mr. Segundo F. Conales et al. provided data on high density of the giant clam *Tridacna crocea* in unexploited reefs of Tubbataha Reefs Natural Park, Philippines. And finally, the author of the notes on sizes and abundance of Red Striped sea cucumber *Thelenota rubralineata* in Cagayancillo, Palawan, suggests that the aesthetic and ecological values of the species could be higher than its dried value thus it could be better to conserve the species for eco-tourism purposes.

Roger G. Dolorosa
Editor-in-Chief

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Notes on the presence of *Manta alfredi* in the Tubbataha Reefs Natural Park, Cagayancillo, Palawan, Philippines

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https://doi.org/10.69721/TPS.J.2015.7.1.01

ABSTRACT

In 2011, a review of 33 photographs of mantas taken at the Tubbataha Reefs Natural Park (TRNP), Cagayancillo, Palawan, Philippines revealed that most of the mantas photographed were clearly reef manta rays (*Manta alfredi*) with only one photograph of *Manta birostris*. Previously identified in surveys within the park as oceanic manta ray *M. birostris*, the presence of *M. alfredi* has never been established until now. Using various parameters, the pictures in the Tubbataha Management Office (TMO) database were reviewed and noted. The identification of *M. alfredi* was more consistently based on the presence of black marks located posterolateral to the last gill slits and between the rows of gill slits. The identification of the species was further validated by experts after viewing three photographs from the said database. This represents a new elasmobranch species record for the TRNP and, technically, for the Philippines as well. Furthermore, the confirmed presence of both globally significant species of manta rays should have a strong bearing on the conservation policies of the park as well as that of the country. Further research on population dynamics, structure and abundance is recommended. Contributing to global efforts to generate better understanding of the species through partnership with international organizations is also recommended.

Keywords: *Manta alfredi*, Tubbataha Reefs Natural Park

INTRODUCTION

For quite some time in the past, the genus *Manta* was believed to be monotypic, represented only by the *Manta birostris*. All sightings of manta rays in the Philippines were attributed to this species, therefore no previous records of the presence of the *Manta alfredi* in the country existed. Because of this, the Philippine government protects only the species *M. birostris*. With recent studies resurrecting the *M. alfredi* as a separate species, a gap in the legal protection of the globally significant manta ray has come to light.

This paper aims to establish the occurrence of *M. alfredi* in the country by presenting evidence gathered in Tubbataha Reefs Natural Park

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(TRNP). Establishing its presence has implications on the conservation of the species because ignorance could lead to neglect and eventual loss of the population in the absence of conservation efforts. The Fisheries Code of the Philippines through Fisheries Administrative Order (FAO) No. 193 (DA-BFAR 1998) and the Palawan Council for Sustainable Development (PCSD) Resolution No. 04-226 protect the *M. birostris* but makes no mention of the *M. alfredi,* likely due to the taxonomic confusion involving the species at the time (PCSD 2004). This paper also aims to provide a basis for the amendment of FAO No. 193 to strengthen the protection of manta rays in the country.

Although Krefft has been credited with the discovery of the *Manta alfredi* (Figure 1) in 1868, it was not until several decades later that a description of the species was provided (National Library of Australia 2014). Stead (1906) first described the species, defining its head as truncated, free from pectoral flaps, and exhibiting horn-like accessories. He also noted a terminally-placed wide mouth unlike in most rays. Whitley (1932) further characterized the animal as large with its disc much wider than its length. He also pointed to one distinct dorsal fin without a spine at the base of the tail as opposed to that of the *M. birostris* which still retained a stinging spine. Schultz (1953) noted a V-shaped white shoulder patch on each side dorsally and several dark blotches on the ventral aspect of live specimens. He also found that his specimens differed with *M. birostris*.

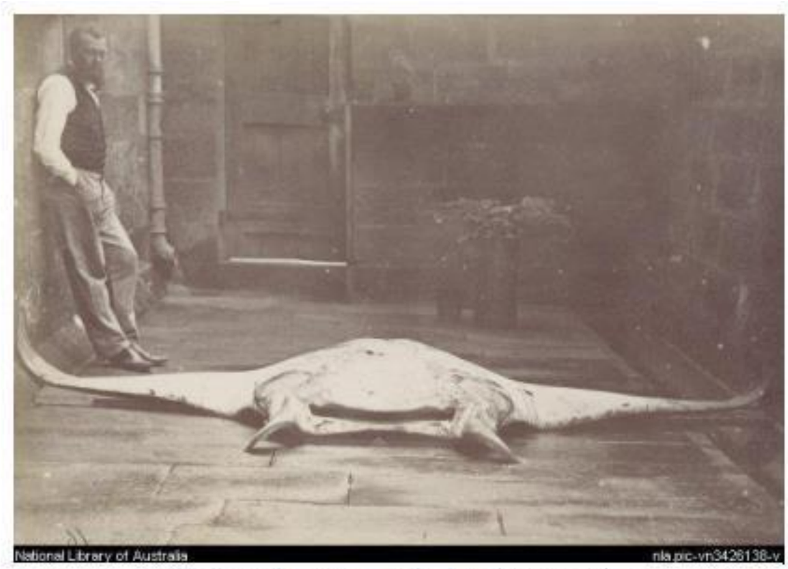

Figure 1. Krefft (1868) posing with the chirotype/type-specimen for the *Manta alfredi* which was not described until Stead in 1906 (National Library of Australia 2014).

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Over the years, several specimens have been collected and studied further to yield more defining characters of the species. At the same time, a long debate ensued on the appropriate taxonomic classification of the *M. alfredi*. For a long while after the *M. alfredi* was fully described, the genus *Manta* was again considered monotypic with only one recognized species, the *M. birostris*.

Recent information, however, showed that there are two visually distinct species based on morphometric measurements, external characteristics, maturity, and maximum disc width – hence the resurrection of the species *M. alfredi* (Marshall et al. 2009). The distinctiveness of the species was further supported by a study on the genus done by Kashiwagi et al. (2012) which analyzed the genetic signatures of the two species of *Manta*. While the results showed that assay with mitochondrial DNA CO1 failed to distinguish the two species, it also revealed that they did not share haplotypes. Qualitative evidence and statistical inferences from "Isolation-with-Migration" models strongly suggested a recent post-divergence gene flow estimated to have occurred about 500,000 to one million years ago. The authors further attributed the species genetic difference to distinct habitat choices, i.e., near-shore and off-shore environments, which they believed to have occurred at an early stage of the speciation. The distribution of the *M. alfredi* has been described as circumglobal in tropical through subtropical seas (Eschmeyer 2012). The species is often found near productive coastlines, bays, and atolls with constant upwellings (Marshall et al. 2009).

Studies about *M. alfredi* in the Philippines are limited. The last inventory of elasmobranch species in the Philippines (Compagno et al. 2005) only recorded the presence of one *Manta* species, *M. birostris*. The Fishbase website, however, revealed three photographs of *M. alfredi*, supposedly taken in 1996 and submitted to the website two years later (Mr. Robert Yin, pers. comm.). These were reported as having been taken in the Philippines but the specific site is unknown. It was later verified and identified as *M. alfredi* in 2010 by Mr. John McEachran and Ms. Andrea Marshall (Fishbase 2012), a development possibly attributable to the recent resurrection of the *M. alfredi* in 2009 as a separate species (Marshall et al. 2009). Beyond these pictures, it appears that no other published documentation of its presence in the country is available. Thus there is no information on the distribution or location of populations of *M. alfredi* in the Philippines.

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METHODS

The TRNP in Palawan, Philippines is located near the center of Sulu Sea and is composed of two atolls and a reef with bustling platforms that are mostly submerged. It is about 90 nautical miles south of the municipality of Cagayancillo and about 92 nautical miles east of Puerto Princesa City. TRNP is also significantly situated at the apex of the Coral Triangle, that area in the world with the highest level of coral and marine diversity. It was declared as a marine protected area (MPA) in 1988 and was recently expanded to include the Jessie Beazley Reef and a 10-nautical mile buffer zone in 2010. In recognition of its unique and highly diversed marine life, TRNP was inscribed in the UNESCO World Heritage List in 1993 and included in the Ramsar List of Wetlands of International Importance in 1999 (Tubbataha Management Office 2011).

The TRNP is also a globally renowned destination for scuba divers, researchers, and underwater photographers. Visitors often provide the Tubbataha Management Office (TMO) with copies of their photographs to be used in the various educational activities of the office. Such photographs are kept in a database for storage and easy access. In addition to this, the TMO conducts regular ecosystems research and monitoring activities together with its partner agencies. Thus the management has been well aware of the presence of manta rays in the park. Research reports, however, identified the species as *Manta birostris*, likely as a result of earlier taxonomic issues within the genus.

Thirty three photographs of manta rays kept in the database of the TMO were reviewed and evaluated for species identification. Three of these were sent to manta ray experts for confirmation. Sighting forms submitted by dive boat managers from 2008 to 2011 were likewise reviewed and entries of manta ray sightings were extracted. As a supplement, personal interviews with some dive masters that regularly visit the park were conducted.

The distinguishing characteristics used to identify photographs of *M. alfredi* followed those described in by Marshall et al. (2009) and were as follows:

- Y-shaped black on white shoulder patch on the dorsal aspect
- Light-colored mouth
- Predominantly white underside broken by its unique black spot and patch markings
- Presence of black spots between the columns of gill slits and/or on ventral aspect of the wings lateral to the body

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- Small black pattern/blotch found on the posterolateral aspect of the last gill slit that is limited to only a fraction of the gill length
- Absence of a stinging spine or prominent bulge at the base of the tail

RESULTS AND DISCUSSION

Twenty-nine of the 33 photographs were deemed useful for species identification. Four were difficult to identify to the species level due to the angle of the shot or distance of the animal from the photographer. Of the 29 photographs used, 24 were clearly *M. alfredi*, exhibiting characteristics distinct of the species (Figures 2 and 3). Three of these 24 photographs were sent to expert for confirmation of species identification. Dr. William White (pers. comm.) concurred and remarked that the lack of any report in the country was likely because previous records were all combined with the *M. birostris*. In addition to this, it was later revealed that the photographs submitted to the Fishbase were actually taken in Tubbataha Reefs in the summer of 2006 (Mr. Robert Yin, pers. comm.)

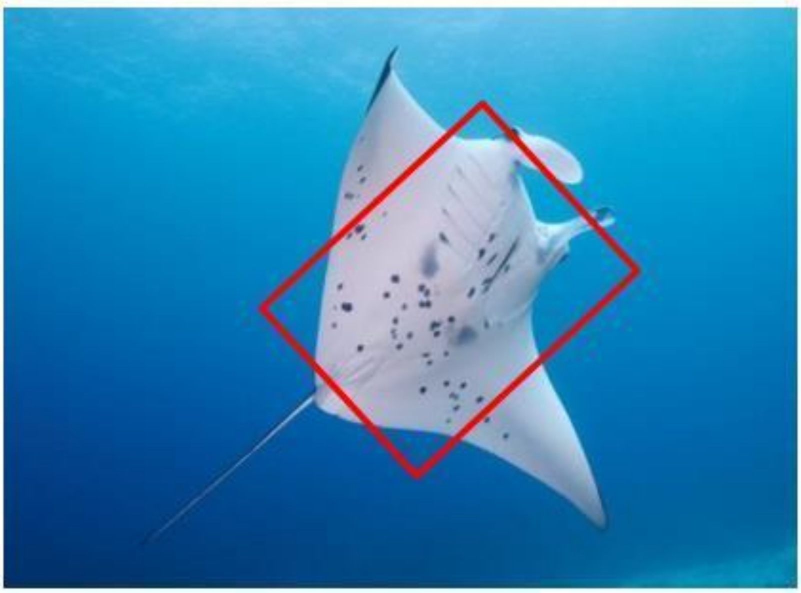

Figure 2. Presence of black spots and patterns medial to the gill slits and on the lateral aspects of the pectoral fins and the small black patch posterolateral to the last gill slits. Photo credit: Lene and Claus Topp.

The remaining five photographs have to be reviewed further because of the presence of a small bump at the base of the tail just posterior to the dorsal fin (Figure 4). Upon consultation with Dr. William White and Dr. Andrea Marshall, all five photographs were later confirmed to be that of *M.*

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alfredi. It was further explained that some *M. alfredi* found in the South Pacific area apparently retain a very small bump at the base of the tail (Dr. Marshall, pers. comm.).

Figure 3. Y-shaped shoulder patch and absence of prominent bulge at the base of the tail (red circles). Photo credit: Lene and Claus Topp.

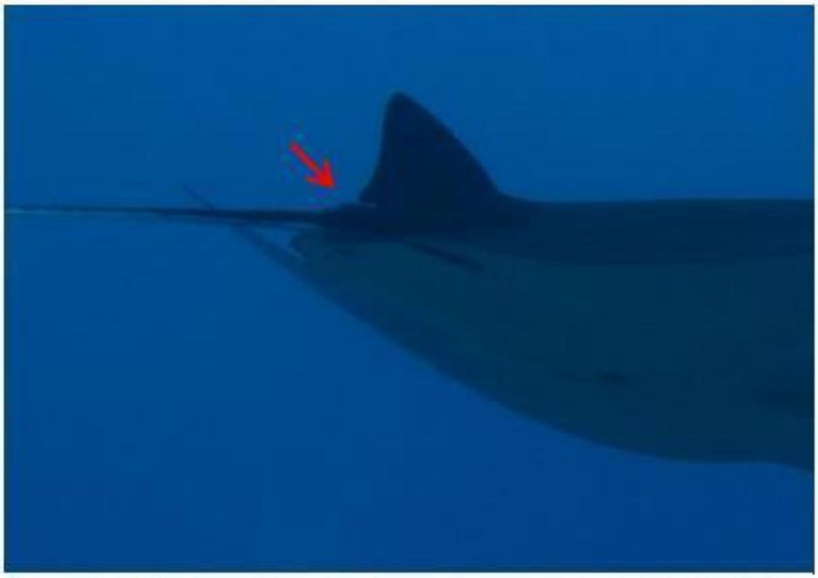

Figure 4. Some individuals were observed to have retained a small bump at the base of the tail. Photo credit: Heinz Rebmann.

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A few other anatomical and color aberrations were noted (Figure 5). Two distinct individuals were photographed in 2006 and 2008 exhibiting contorted or helical tails. Another individual seen in 2011 displayed a predominantly black dorsal aspect. A year later, another individual was observed with a mouth darker than those of other *M. alfredi* seen in TRNP. All were nevertheless identified as *M. alfredi* based on predominantly white undersides, the presence of black patches between the columns of gill slits, and the small black blotch posterolateral to the last gill slits.

Figure 5. Other aberrations in conformation (tail: top left) and color pattern (top right and bottom photos) were observed in some individuals. Photo credits: Kai Ledesma (top left), Yvette Lee (top right) and Heinz Rebmann (below).

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As part of the routine monitoring of TRNP, dive operators are asked to fill up sighting sheets for large predators on a voluntary basis and submit these to the TMO at the end of each dive season. Dive operators ask their guests to identify large predators sighted during their dives. Thus sighting data on manta rays, although sparse, has been recorded since 2008 (Figure 6, Table 1).

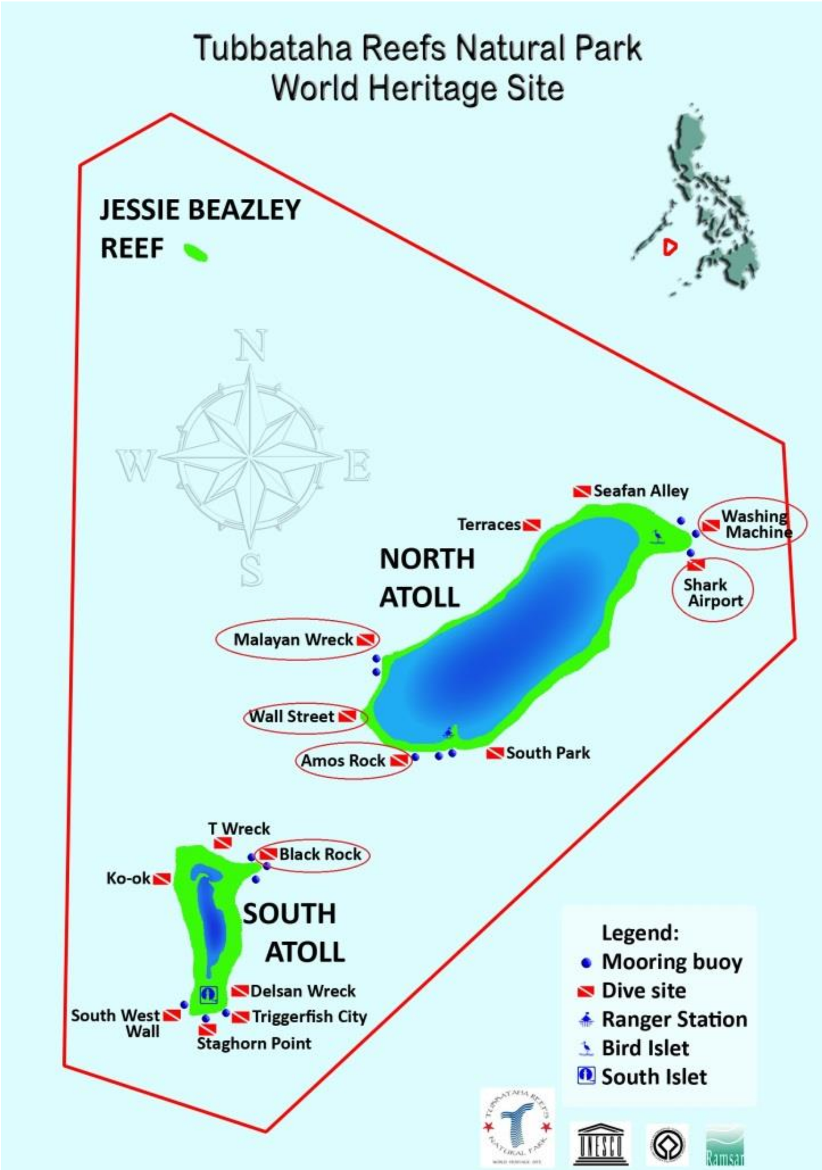

Figure 6. Map showing the various dive sites within TRNP. Dive sites where manta rays are frequently encountered are encircled in red.

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Table 1. Excerpts of the results of manta ray sighting sheets of dive operators from 2008 to 2011.

Vessel Name	Date	Location	Group Size
Dschubba	1 May 11	Malayan	2
	1 May 11	Malayan	2
	1 May 11	Malayan	2
	2 May 11	Wall Street	2
	20 March 11	North of Wall Street	2
Expedition Fleet	7 March 11	Shark Airport	-
	12 March 11	Washing machine	-
	15 June 11	Wall Street	-
Sakura	13 May 09	Shark Airport	
Borneo	2 May 09	Amos Rock	1
Palau Sport	21 April 08	Washing Machine	1
	22 April 08	Black Rock	1
	7 May 08	Black Rock	1
	3 June 08	Shark Airport	2

According to divers' accounts, manta rays are encountered most often near the Bird Islet area and at the Black Rock dive sites. These areas are known to have strong water currents, characterized by upwellings, a habitat type preferred by the *M. alfredi*. The study by Villanoy et al. (2004), in characterizing the circulation in the reefs, proposed that the high productivity in these areas as well as the southwest portion of the North Atoll (vicinity of Wall Street and Amos Rock) was the effect of the nutrient-rich water from the lagoon flowing out in pulses, driven by wind and tide. Another study by Campos et al. (2007) on the distribution and dispersal of fish larvae further revealed that these dive sites overlapped with the areas that recorded some of the highest densities of fish larvae and eggs outside of the lagoons in Tubbataha. In 2012, sightings were mostly concentrated at the Washing Machine, Shark Airport, and the area in between although other divers reported encounters in other dive sites as well (Figure 6).

Almost all individuals observed were travelling except for one individual encountered at the Shark Airport, measuring about 3 m wide was being cleaned by a group of Bluestreak cleaner wrasses *Labroides dimidiatus* and a few other species. Group estimates ranged from 4-5 in 2012 which was higher than previous years (2008-2011) (Table 1).

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No individuals were identified apart from two which had kinks in their tails so data on the length of their stay at the reefs could not be determined. Nevertheless, even the two individuals with bent tails were not reportedly sighted beyond one dive season, implying that the population is transient. It is thus presumed that the TRNP serves as a feeding and cleaning area for manta rays.

CONCLUSION AND RECOMMENDATIONS

The presence of the *M. alfredi* is noteworthy because it represents a new elasmobranch record for TRNP and possibly for the country given its absence from the elasmobranch species list for the Philippines compiled by Compagno et al. (2005). Confirmation of the presence of the *M. alfredi* in TRNP accentuates the value of the park for conservation. Although the population of manta rays in the park appears to be transient, it has also been noted as a cleaning station thus adding to the significance of this particular marine habitat.

Furthermore, the confirmed presence of the globally significant *M. alfredi* as well as that of the *M. birostris* would have a strong bearing on the formulation of national conservation strategies of the country and of TRNP. For starters, amendment of FAO No. 193 and PCSD Resolution No. 04-226 should be pursued to include the species in its protection. Further research on population dynamics, structure and abundance is recommended. Initiating a photo-catalog of individuals might also shed light on its life history and habitat range and use. Likewise, contributing images to the Ecocean Manta Matcher database would help improve understanding of the species.

REFERENCES

Campos WL, Beldia P II, Villanoy CL, Noblezada M and Asis JJC. 2007. Investigating Biodiversity Corridors in the Sulu Sea: Distribution and Dispersal of Fish Larvae. Poster presentation, 9th National Symposium in Marine Science, Iloilo City.

Compagno LJV, Last PR, Stevens JD and Alava MNR. 2005. Checklist of Philippine Chondrichthyes. CSIRO Marine Laboratories Report, 243. 103 pp.

Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR). 1998. Fisheries Administrative Order 193 Series of 1998. www.bfar.da.gov.ph/pages/legislation/FAO/fao193.html. Accessed on 9 October 2012.

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Eschmeyer WN. 2012. Catalog of Fishes; California Academy of Sciences. http://research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp. Accessed on 26 September 2012.

Fishbase. 2012. *Manta alfredi* picture (Mabir_u4.jpg) by Robert Yin. http://fishbase.org/photos/PicturesSummary.php?StartRow=1&ID=65179&what=species&TotRec=7 . Accessed on 9/26/2012.

Kashiwagi T, Marshall AD, Bennett MB and Ovenden JR. 2012. The genetic signature of recent speciation in manta rays (*Manta alfredi* and *M. birostris*). Molecular Phylogenic Evolution, 64: 212-218.

Marshall AD, Compagno LJV and Bennett MB. 2009. Redescription of the genus *Manta* with resurrection of *Manta alfredi* (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). Zootaxa, 2301: 1-28.

National Library of Australia. 2014. The Prince Alfred Ray, *Ceratoptera alfredi*, Gerard Krefft (picture), National Library of Australia, vn3426138. (http://nla.gov.au/nla.pic-vn3426138, downloaded 9/27/2014).

Palawan Council for Sustainable Development (PCSD). 2004. Resolution No. 04-226. Resolution adopting the list of threatened terrestrial and marine wildlife species in Palawan and other categories, and the list of other wildlife species pursuant to Republic Act no. 9147, otherwise known as the Wildlife Resources Conservation And Protection Act of 2001.

Schultz LP. 1953. Family Mobulidae: Devil Rays; Manta. In: LP Schultz, ES Herald, EA Lachner, AD Welander and LP Woods. Fishes of the Marshall and Marianas Islands. Vol. 1. US Government Printing Office, Washington. pp. 20-22.

Stead DG. 1906. Sharks and Rays (Sub-class Elasmobranchii). In: Stead SD. Fishes of Australia; a popular and systematic guide to study of the wealth within our seas. William Brooks and Co, Ltd, Sydney. p. 238.

Tubbataha Management Office. 2011. Management Plan: Tubbataha Reefs Natural Park and World Heritage Site; 2011-2021. Tubbataha Protected Area Management Board. 31 pp.

Villanoy CL, Silvano K and Palermo JD. 2004. Tubbataha Reef and Sulu Sea Oceanographic Study. Terminal Report submitted to WWF-Philippines. 35 pp.

Whitley GP. 1932. Studies in ichthyology. Records of the Australian Museum. 18(6): 327-329. DOI: 10.3853/j.0067-1975.18.1932.737

ARTICLE INFO

Received: 20 December 2014
Accepted: 16 June 2015

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Water parameters of Pulang Lupa Lake, an abandoned open pit mine in Puerto Princesa City, Palawan, Philippines and its potential as bird watching destination

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https://doi.org/10.69721/TPS.J.2015.7.1.02

ABSTRACT

Abandoned open pit mines when properly managed can be an important settlement and eco-tourism sites. The Pulang Lupa Lake – an abandoned mercury open mining pit in Puerto Princesa City supports a number of settlers and important wildlife. With limited information about its status, this study was conducted to determine the lake's water quality and its potential for eco-tourism. Water physico-chemical parameters were within the permissible limits sets by the Department of Environment and Natural Resources for Class C water during the rainy but not in summer season. Water samples for both seasons were positive for total and fecal coliform. The lake serves as important source of fish for informal settlers and the presence of several bird species makes it a potential bird watcher's destination. Information and education campaign among the residents around the lake and strategic environmental plans are needed for its sustainable utilization.

Keywords: water quality, fish species, Pulang Lupa Lake

INTRODUCTION

In the Philippines, several large-scale mines have been shut down in the past three decades because of economic loss, labour disputes, or a rejected mining application. However, none of these mines were rehabilitated right after closure. There are 20 abandoned mines across the country which may bring harm to the environment, animals and human being (Ilagan 2008). Unless proper mitigation and corrective actions are undertaken, the surrounding population and receiving environment will be continuously exposed to both chemical and physical risks from these abandoned mines (Ilagan 2008; Raymundo 2014).

Abandoned open pit mines can be created into a lake for a variety of purpose (Gammons et al. 2009). The Pulang Lupa Lake, an abandoned quicksilver open pit mine, serves as a fishing and recreation area for a

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number of families in Bgy. Santa Lourdes, Puerto Princesa City. The uncontrolled activities of the settlers may cause further deterioration of the lake, thus the need to document its status and other potentials.

This study sought to determine the (1) physico-chemical parameters (water and air temperature, dissolved oxygen, total dissolved solids, suspended solids, turbidity, pH, phosphates and nitrates), (2) total coliform and fecal coliform and (3) fish and avifauna in Pulang Lupa Lake.

METHODS

Locale of the Study

Pulang Lupa Lake, geographically located at 9°50'0"N and 118°43'29"E, is an 8.7 ha abandoned mined pit situated at the southeastern part of Bgy. Santa Lourdes, Puerto Princesa City (Figure 1), Palawan, Philippines. It is bounded in the north by the City Solid Waste Management, in the west by Santa Lourdes Elementary School, in the east by a deforested hill and in the south, by clusters of households. The lake is about 4 km away from Honda Bay, a popular island hopping tourist destination. About 400 individuals belonging to 25 households reside along the shore of the lake. Wastes of domestic animals raised in each household are directly drained into the lake.

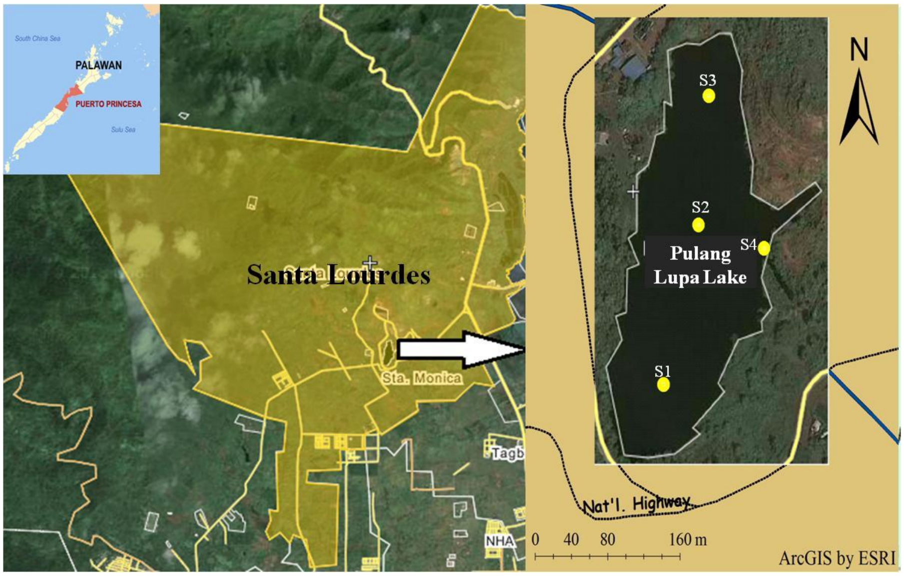

Figure 1. The location of Pulang Lupa Lake at Bgy. Santa Lourdes, Puerto Princesa City. Palawan.

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Sampling Procedure

Four sampling sites were selected (Figure 1). Sampling was conducted in January (Garagara 2014) and May 2014. All samples were collected using a depth-integrated grab sample method. Water samples were kept in 350 ml plastic bottles for physico-chemical analysis and 250 ml decontaminated bottles for bacteriological analysis and stored in an ice chest before transporting to the laboratory. Samples of different fish species were obtained from residents who fish in the lake. Photos of common birds were taken during the sampling periods. Identification of fishes was based on the works of Matillano 2002; Delijero 2012; Gabuat 2013. Birds were identified using the works of Kennedy et al. 2000; Hutchinson and Villa 2014.

Laboratory Analysis

For tests on physico-chemical parameters, the spectrophotometric method was used. Using Portable Data logging Spectrophotometer, the suspended solids, turbidity, phosphate and nitrate -concentration of water samples were determined; pH meter for pH and conductivity meter in measuring the total dissolved solids (Eaton et al. 2005). Multiple tube fermentation technique was used to analyze the total and fecal coliform of water (Eaton et al. 2005; Bitton 1994). The coliform density was calculated in terms of most probable numbers (MPN) technique (Bitton 1994).

Data Analysis

Averages (±sd) of the gathered data were computed and compared against the standard set by DAO 34, S. 1990 (DENR 1990). Data in wet season were compared against dry season using T-test.

RESULTS AND DISCUSSION

Physico-chemical Characteristics of Pulang Lupa Lake

The ranges of water temperature in January (between 27.32°C and 29.06°C) were relatively lower than in May (28.65°C and 32.60°C) (Figure 2). The air temperature ranged between 26.60°C to 28.70°C and 27.50°C to 32.80°C of the same months, respectively.

The mean water temperature in summer (31.49°C) is significantly higher ($P<0.05$) than in rainy season (28.05°C) but there is no significant difference ($P>0.05$) between the air temperature in dry and wet seasons.

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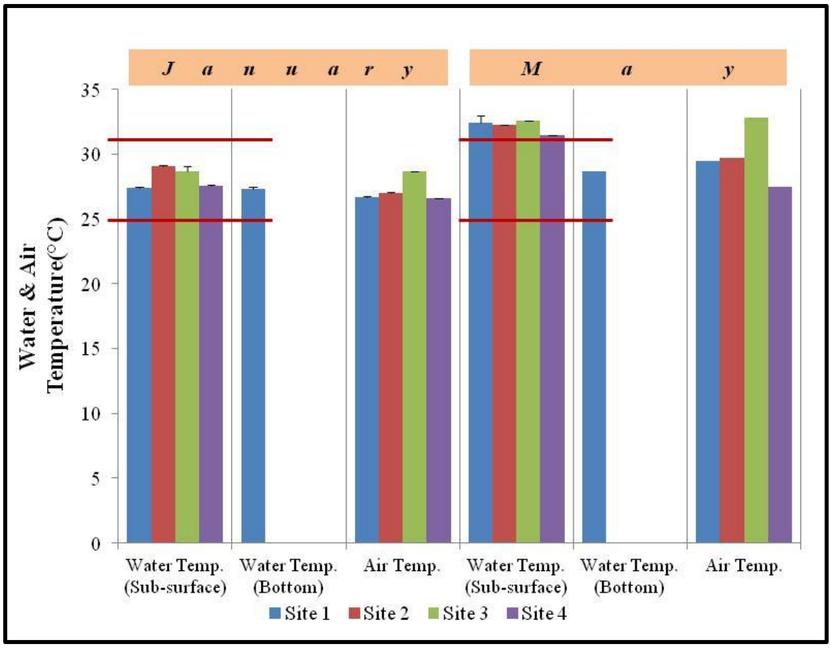

Figure 2. Average (±sd) water and air temperatures (°C) at four sampling sites in Pulang Lupa Lake. The red horizontal lines represent the maximum and minimum temperature in Class C body of water (DENR 1990).

The variation in temperatures could be the effect of the surrounding condition of the area (Lewis 1984), depth of the water (Michaud 1991; Johnson et al. 1999) and the presence of the vegetation canopy (Johnson et al. 1999).

The average range of DO concentration (Figure 3) in sub-surface and bottom layer ranged from 6.65 $mg.L^{-1}$ to 7.9l $mg.L^{-1}$. There is no significant difference (P>0.05) between the DO in dry and wet seasons. These values are far above the minimum limit (5 $mg.L^{-1}$) and are able to sustain aquatic life (Hallare et al. 2009). However, if domestic wastes are continuously thrown into the lake, the DO could become too low to sustain life especially fish in the future.

Total dissolved solids (TDS) in Pulang Lupa Lake ranged from 294.33 $mg.L^{-1}$ to 313.3 $mg.L^{-1}$ in January and 315 $mg.L^{-1}$ to 322 $mg.L^{-1}$ in May (Figure 4). The mean TDS in summer (317.6 $mg.L^{-1}$) is significantly higher than in rainy season (301.07 $mg.L^{-1}$). There was a little fluctuation in January than in May. There is no standard set for TDS in DAO 34 (DENR 1990). Thus, these levels are acceptable for a lake.

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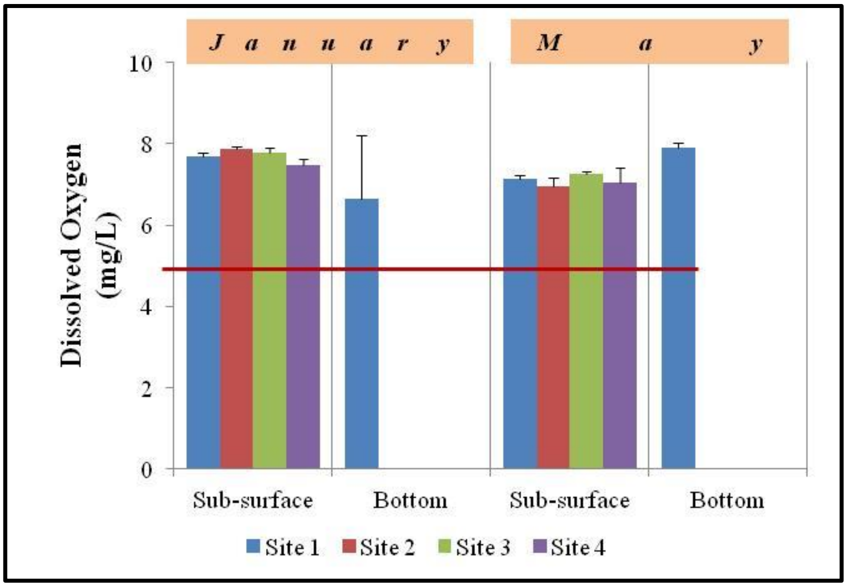

Figure 3. Average (±sd) dissolved oxygen concentration ($mg.L^{-1}$) at four sampling sites in Pulang Lupa Lake. The red horizontal line represents the minimum level of DO in Class C body of water (DENR 1990).

The variations in TDS concentrations often results from industrial effluent, changes to the water balance by increased water use or increased precipitation (Scannell and Duffy 2007). Run-off from the agricultural farms surrounding the lake can also increase the concentrations of TDS.

The suspended solids (SS) were relatively the same among sites except in one of the sites in May (Figure 5). There is no significant difference ($P>0.05$) between the suspended solids in dry and wet seasons. The suspended solids levels were within the maximum required standard for TSS of Class C water at 65 $mg.L^{-1}$ (DENR 1990).

Suspended solids indicate the extent of sedimentation resulting from land-based activities which can reduce the light penetration and photosynthetic activities of aquatic plants (National Water Quality Status Report 2005). Silt, stirred up bottom sediment, decaying plant matter, or sewage treatment effluent can also contribute to high suspended solids (Johnson et al. 1999). It is also possible that the water is more concentrated with domestic wastes in May because of the dry season than in January where it is diluted with rain.

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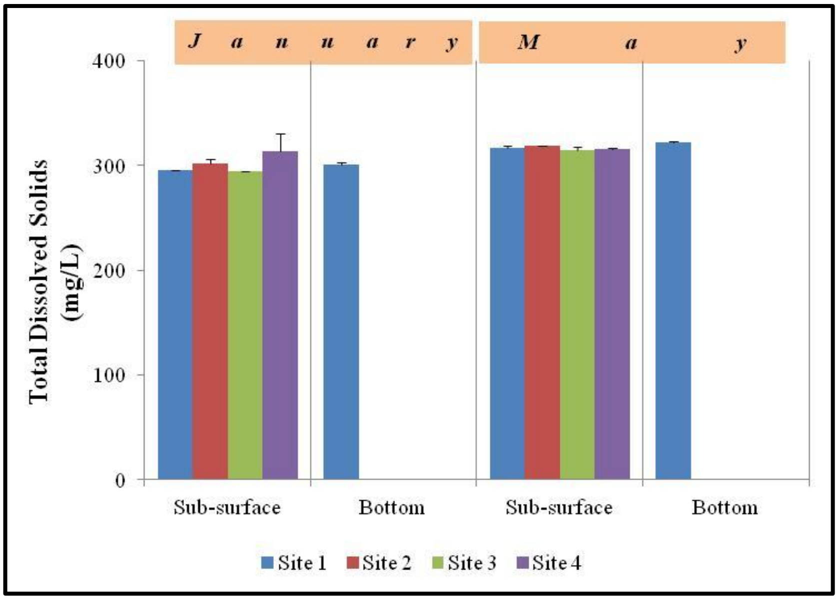

Figure 4. Average (±sd) total dissolved solids (TDS) values at four sampling sites in Pulang Lupa Lake.

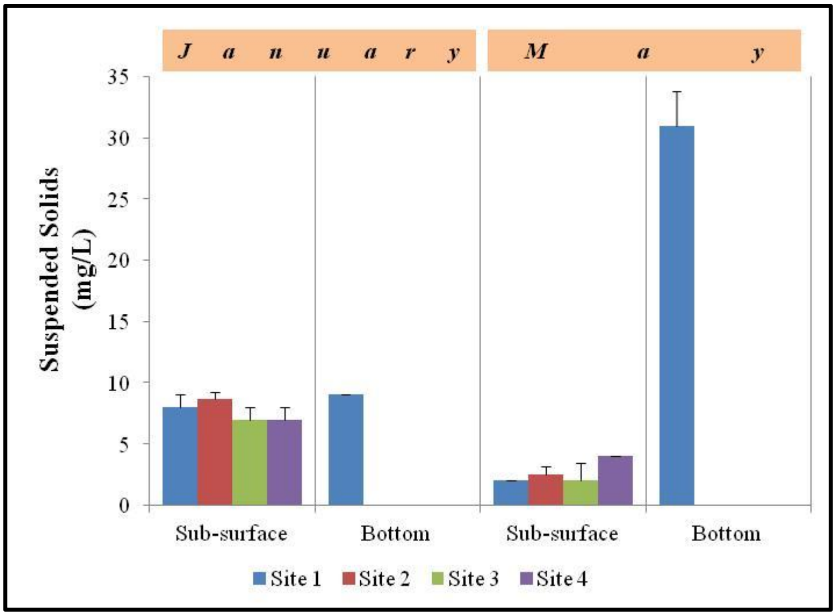

Figure 5. Average (±sd) suspended solids (SS) values at four sampling sites in Pulang Lupa Lake.

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The turbidity (Figure 6) ranged between 2.5 FTU to 48 FTU. There is no significant difference (P>0.05) between the turbidity in dry and wet seasons. Turbidity was not considered as one of the parameters in DAO 34 (DENR 1990). Thus, it is anticipated that these levels are suitable for a lake.

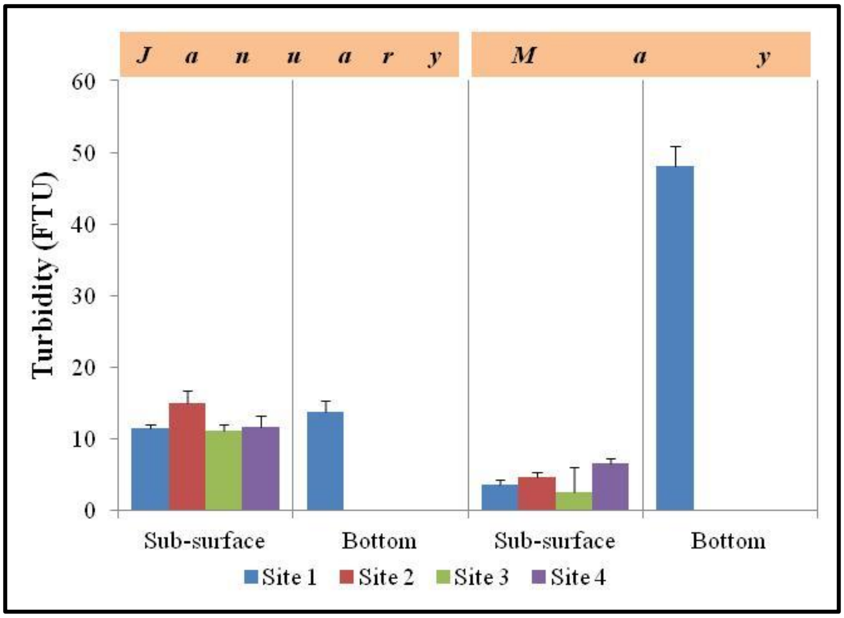

Figure 6. Average (±sd) turbidity (Formazin Turbidity Unit-FTU) values at four sampling sites in Pulang Lupa Lake.

The trend of turbidity is similar to the high suspended solids as discussed above. According to Zafaralla et al. (2005), when a lake is critically turbid, algae do not grow very well in its water. High turbidity decreases the amount of sunlight that penetrates the water thereby decreasing the rate of photosynthesis (Johnson et al. 1999). The observed gradual increase of turbidity in May at the bottom layer might be caused by the abundant of bottom dwelling organisms stirring up the sediment.

The recorded pH variation among sites in January was between 7.56 and 7.63 and it increased up to a range of 8.77 to 10.49 in May (Figure 7). There is no significant difference (P>0.05) between the pH in dry and wet seasons. The high pH value in May which exceeds DAO 34, S. 1990 (DENR 1990) standard for Class C water could be due to increasing concentration of domestic sewage and waste water containing detergent from nearby households.

The fluctuation of pH (Figure 7) may be due to the photosynthesis by algae and other aquatic plants, watershed run-off and other factors (Hudson

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1998). The significant increase of pH in May which reaches up to 10.5 can be lethal to other living organisms especially fishes if the exposure is prolonged (Johnson et al. 1999).

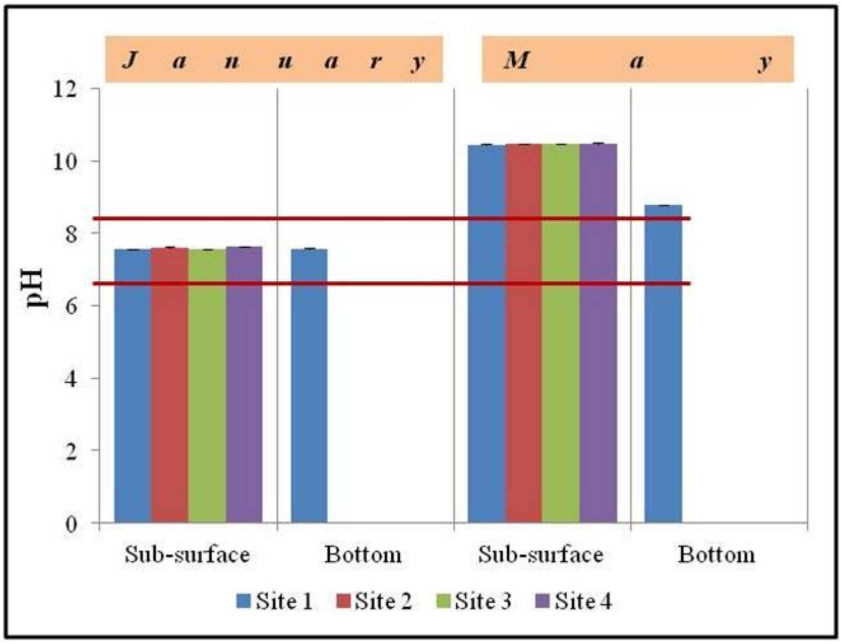

Figure 7. Average (±sd) pH values at four sampling sites in Pulang Lupa Lake. The red horizontal lines represent the maximum and minimum level of pH in Class C body of water (DENR 1990).

The variation of pH can also be attributed to the enrichment of nutrients and the clarity of the lake which indicate that there are decomposing organic matters at the bottom (Addy et al. 2004).

The average variations of phosphate among four sites fall below the maximum level for Class C water (DENR 1990) except in one station in May (Figure 8). Domestic and agricultural wastes can increase the naturally occurring phosphorus in the water (Martinez and Galera 2011). Phosphorus concentration determines the level of eutrophication of the lake or the increase of plants and algal growth due to the excess of nutrients (Johnson et al. 1999).

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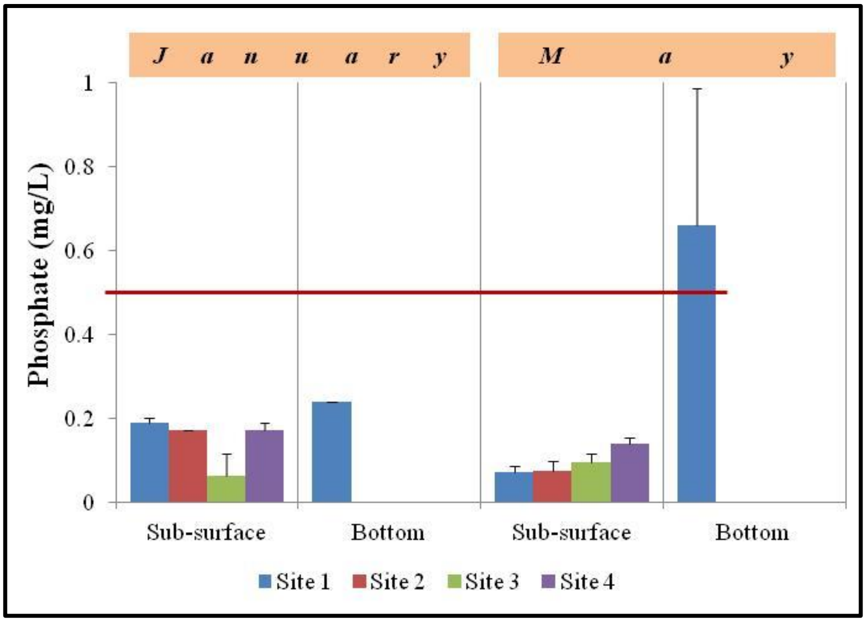

Figure 8. Average (±sd) phosphate concentrations ($mg.L^{-1}$) at four sampling sites in Pulang Lupa Lake. The red horizontal lines represent the maximum and minimum level of phosphate in Class C body of water (DENR 1990).

The nitrate concentration of Pulang Lupa Lake varies between 0.83 $mg.L^{-1}$ and 6.40 $mg.L^{-1}$ in January while it varies between 3.05 $mg.L^{-1}$ and 4.1 $mg.L^{-1}$ in May (Figure 9). There is no significant difference ($P>0.05$) between the nitrate in dry and wet seasons. Discharge from agricultural farms and/or domestic wastes could have caused the high level of nitrate particularly at site 4. High nitrate concentrations in the water can contribute to eutrophication and are often accompanied with an unpleasant odor and water taste. It reduces the water clarity as well (Johnson et al. 1999). While nitrate levels in four sites were within the DAO 34, S. 1990 standard (10.0 $mg.L^{-1}$) (DENR 1990), nitrate concentration may trigger algal growth which might lead to early eutrophication of the lake if loading will continue unabated.

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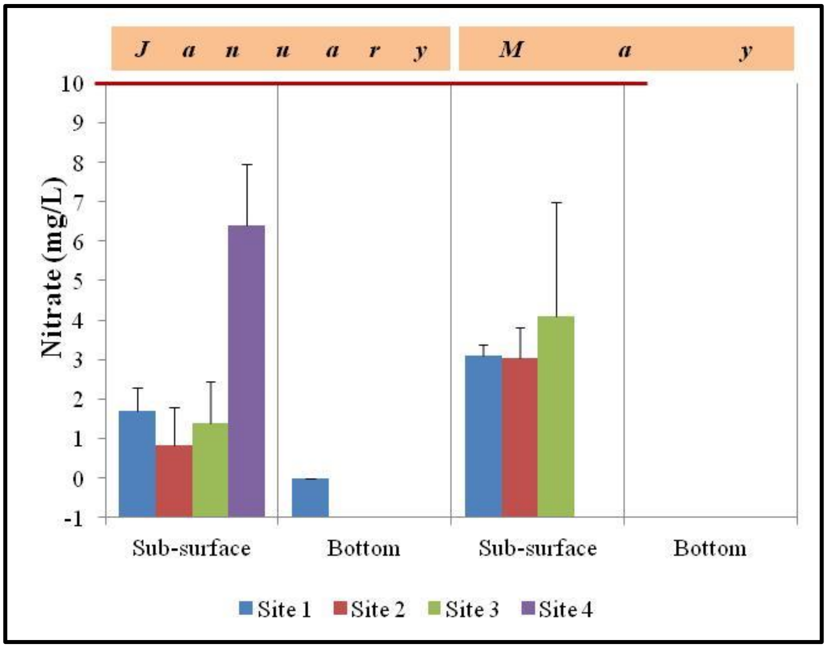

Figure 9. Average (±SD) nitrate concentrations (mg.L^{-1}) at four sampling sites in Pulang Lupa Lake. The red horizontal line represents the maximum level of nitrate in Class C body of water (DENR 1990).

Bacteriological Characteristics of Pulang Lupa Lake

Pulang Lupa Lake was positive for both total coliform and fecal coliform tests. Total coliform and fecal coliform counts of water samples from all sites were >8.0 MPN.100 ml^{-1} (Table 1).

The establishments of pigpens (National Water Quality Status Report 2005), vicinity of solid waste management (SWM), discharges of sewage from small establishments and the proximity of local communities that directly discharge organic and or inorganic wastes into the lake could have contributed for the presence of pathogenic and non-pathogenic bacteria in the water (Water Stewardship Information Series 2007; Swistock 2010).

Fecal coliforms are high during storm water run-off from urbanized areas because of the presence of disintegrating storm and sanitary sewers, misplaced sewer pipes and good breeding conditions (Michaud 1991; Swistock 2010). Children playing/swimming on the lake may accidentally ingest coliform contaminated water and may suffer from various stomach and intestinal illness and even death (Water Stewardship Information Series 2007). Provision of sanitary facilities and education campaign is needed to address these problems (Sagun 2012).

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Table 1. Bacteriological Characteristics of Pulang Lupa Lake at Bgy. Santa. Lourdes, Puerto Princesa City.

Samples	Total Coliform Test MPN/100mL	Fecal Coliform Test MPN/100mL
Station1 (bottom)	>8.0	>8.0
Station1 (surface)	>8.0	>8.0
Station 2	>8.0	>8.0
Station 3	>8.0	>8.0
Station 4	>8.0	>8.0
DAO 34, S. 1990 (DENR 1990)	5,000	-

Fish and Avifauna in the Lake

Fishes found in the lake include *Oreochromis niloticus*, *Puntius binotatus* and *Chana striata* (Figure 10). Most of these are caught by hook-and-line, spear gun and fish nets. The estimated fish catch of each fisherman is about 20 kg a month. Considering that 20 fishermen fish in the area, a total of 4,800 kg of fish per year is harvested from the lake. The fishes caught in the lake are either used for personal consumption, or sold as fresh or dried in the market. Dried fishes from the lake are also transported and sold in other cities.

The volume of fish catch depends upon weather conditions. During heavy downpour, the water gets turbid and the catch is high as fish tends to move to the surface to get enough oxygen while during summer, fishes in the lake are few (Mr. Tony Marshall, pers. comm.).

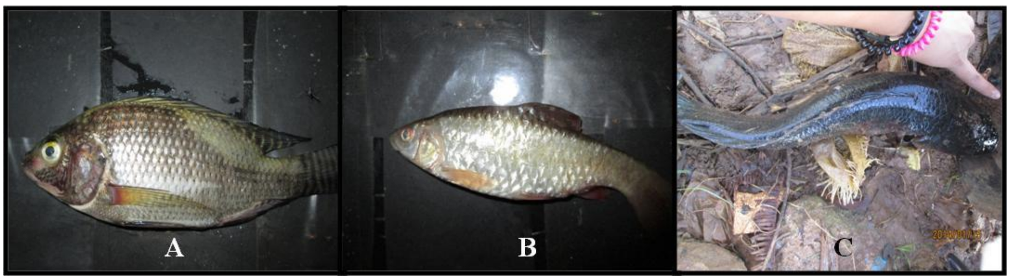

Figure 10. Some of the fish species caught in the Pulang Lupa Lake. A. Tilapia (*Oreochromis niloticus*), B. Carp (*Puntius binotatus*), and C. Mudfish (*Chana striata*).

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Documented bird species in the lake included *Nycticorax caledonicus*, *Nycticorax nycticorax*, *Haliastur indus*, *Egretta intermedia*, *Anas platyrhynchos*, and *Geopelia striata* (Figure 11). Most of these have been seen roosting at the known beaches of Palawan (Kennedy et al. 2000; Hutchinson and Villa 2014).

These birds are feeding on the variety of animals in the lake including fish. Some of these are sometimes trapped on the submerged fish nets. There were also some sunbirds and bulbul (Hutchinson and Villa 2014) but these were not photo-documented.

CONCLUSION

Most measured water physico-chemical parameters were within the DAO 34, S. 1990 standards (DENR 1990), however, domestic and agricultural wastes could have contributed to the enrichment and turbidity of lake. The enrichment of the lake is depicted by the positive results of the total and fecal coliform. The presence of fish and wildlife such as birds makes the lake a potential spot for tourists especially among bird watchers.

RECOMMENDATIONS

There is a need to disseminate information about the status of the lake. Community residing within its periphery must be informed of the hazard brought about by improper waste disposal. Habitat restoration can be done to conserve wildlife. Intensive survey of fish and other fauna is also recommended to reflect the true value and importance of the lake. Considering that the lake was a mine pit, it is important to determine the mercury level in the water and fishes. The presence of a number of bird species makes the lake a potential sanctuary and birding destination. Policies are needed to avoid further damaging impacts of the settlers into the lake, and prevention of further effects of any contaminants on the environment, the residents and the wildlife in Pulang Lupa Lake.

ACKNOWLEDGEMENTS

We are thankful to the support of Bgy. Chairman Hon. Erlinda Rodriguez and the residents of Bgy. Santa Lourdes especially to Mr. Tony Marshall for their support during the sampling.

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Figure 11. Some species of birds in Pulang Lupa Lake. A. Rufous Night-heron (*Nycticorax caledonicus*), B. Black-crowned Night-heron (*Nycticorax nycticorax*), C. Brahminy Kite (*Haliastur indus*), D. Intermediate Egret (*Egretta intermedia*), E. Mallard (*Anas platyrhynchos*), F. Zebra Dove (*Geopelia striata*).

REFERENCES

Addy K, Green L and Herron E. 2004. pH and alkalinity, URI watershed watch. Coastal Institute in Kingston, 1 Greenhouse Road, Kingston, Rhode Island. (3): 1-2.

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Bitton G. 1994. Wastewater Microbiology. Wiley Series in Ecological and Applied Microbiology, Wiley-Liss, Inc., 605 Third Avenue, New York, NY 10158-0012, 478 pp.

Delijero K. 2012. Freshwater fishes of Lake Manguao, Taytay, Palawan. Thesis, BS Fisheries, Western Philippines University- Puerto Princesa Campus, Palawan, Philippines, 41 pp.

DENR. 1990. Department of Environment and Natural Resources Administrative Order No. 34. Revised water usage and classification/water quality criteria amending section nos. 68 and 69, chapter III of the 1978 NPCC rules and regulations.

Eaton AD, Clesceri LS, Rice EW and Greenberg AE. 2005. Standard Methods for the Examination of Water and Wastewater, 21st edition. American Public Health Association, 800 I Street, NW, Washington, DC 20001-3710, 1207 pp.

Gabuat MG. 2013. Length-weight relationship of two endemic fish *Puntius bantolanensis* and *Puntius manguaoensis* in Lake Manguao, Taytay, Palawan. Thesis, BS in Aquatic Biology, Western Philippines University- Puerto Princesa Campus, Palawan, Philippines, 33 pp.

Gammons CH, Harris LN, Castro JM, Cott PA and Hanna BW. 2008. Creating lakes from open pit mines: Processes and considerations with emphasis on northern environments. Canadian Technical Report of Fisheries and Aquatic Sciences 2826, 116 pp.

Garagara LP. 2014. Water quality and fish species in Pulang Lupa Lake, Bgy. Sta Lourdez, Puerto Princesa City. Undergraduate Thesis. Western Philippines University-Puerto Princesa Campus. 71pp.

Hallare A, Factor PA, Santos EK and Hollert H. 2009. Assessing the impact of fish cage culture on Taal Lake (Philippines) water and sediment quality using the zebrafish embryo assay. Philippine Journal of Science, 138 (1): 91-104.

Hudson H. 1998. Lake notes – common lake water quality parameters. Illinois Environmental Protection Agency, 4 pp.

Hutchinson R and Villa M. 2014. Philippines; Subic Bay, Candaba Marsh, Palawan, Bohol, Negros, Mountains of Mindanao, 15th April – 3rd May 2014. Birdtour Asia, 24 pp.

Ilagan KAM. 2008. A mess of mines, Philippine Center for Investigative Journalism. http://pcij.org/stories/a-mess-of-mines/. Accessed on 10 October 2014.

Johnson RL, Holman S and Holmquist DD. 1999. Water Quality with CBL Vernier Software, Oregon. In: Chapman D (ed). Water Quality Assessments: A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring London, 1992, Chapman & Hall on behalf of UNESCO, WHO and UNEP, p. 13-23.

Kennedy RS, Gonzales PC, Dickinson EC, Miranda HC Jr and Fisher TH. 2000. A Guide to the Birds of the Philippines. Oxford University

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Press, J & L Composition Ltd, Filey, North Yorkshire, Hongkong, 369 pp.

Martinez F and Galera I. 2011. Monitoring and evaluation of the water quality of Taal Lake, Talisay, Batangas, Philippines. Academic Research International, (1): 229-236.

Matillano JD. 2002. The ichthyofauna of Lake Manguao, Taytay, Palawan, Philippines. Annals of Tropical Research, 24(2): 23-45.

Meybeck M, Kuusisto E, Mäkelä A and Mälkki E. 1996. Water quality. In: Bartram, J. and R. Balance (eds.). Water quality monitoring - a practical guide to the design and implementation of freshwater quality studies and monitoring programmes. United Nations Environment Programme and the World Health Organization, 22 pp.

Michaud J. 1991. A Citizens' Guide to Understanding and Monitoring Lakes and Streams. Department of Ecology Publications Office, Washington State, 73 pp.

National Water Quality Status Report. 2005. Department of Environment and Natural Resources, Environmental Management Bureau, 56 pp.

Raymundo RB. 2014. The Philippine Mining Act of 1995: Is the law sufficient in achieving the goals of output growth, attracting foreign investment, environmental protection and preserving sovereignty? A paper presented at DLSU Research Congress, Manila, Philippines.

Sagun J. 2012. Comprehensive development plan: a model in sustainable development, City of Puerto Princesa, 2011- 2013. 166 pp.

Scannell PW and Duffy L. 2007. Effects of total dissolved solids on aquatic organisms: A review of literature and recommendation for salmonid species. American Journal of Environmental Sciences, 3 (1): 1-6.

Swistock B. 2010. Interpreting water tests for ponds and lakes. College of Agricultural Sciences, Cooperative Extension, School of Forest Resources. Pennsylvania State University. 2 pp.

Water Quality Monitoring Manual. 2008. Department of Environment and Natural Resources, Environmental Management Bureau, Volume 1. 231 pp.

Water Stewardship Information Series. 2007. Total, fecal & *E. coli* bacteria in groundwater. 2 pp.

Zafaralla MT, Barril CR, Santos-Borja AC, Manalili EV, Dizon JT, Sta. Ana JG and Aguilar NO. 2005. Water resources. In: Lasco, R.D. and M.V.O. Espaldon (eds). Ecosystems and people: the Philippine millennium ecosystem assessment (MA) sub-global assessment. Environmental Forestry Programme College of Forestry and Natural Resources University of the Philippines Los Baños, College, Laguna, Philippines 4031. p. 63-114.

ARTICLE INFO

Received: 20 December 2014
Accepted: 18 June 2015

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Notes on the Gracious Sea Urchin *Tripneustes gratilla* (Echinodermata: Echinoidea) in Pag-asa Island, Kalayaan, Palawan, Philippines

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https://doi.org/10.69721/TPS.J.2015.7.1.03

ABSTRACT

The Gracious Sea Urchin *Tripneustes gratilla* is one of the most heavily exploited sea urchins in the Philippines. However, knowledge about its status in Palawan especially in Pag-asa Island, Kalayaan is wanting. The study was conducted to determine the size structure, population density and test diameter-weight relationship of *T. gratilla* in Pag-asa Island, Kalayaan. Transect surveys at the intertidal area of the island revealed an average density of 3,500 ind.ha^{-1}. The test diameter ranged between 2.6 and 8.8 cm, and body weight ranged between 8 and 248 g. Other than *T. gratilla*, four other echinoid species were recorded but in very less number. While it appears that *T. gratilla* is under exploited in Pag-asa Island, policies affecting its sustainable utilization are suggested.

Keywords: Pag-asa Island, sea urchins, size structure, *Tripneustes gratilla*

INTRODUCTION

Sea urchins are globular, spiny animals related to sand dollars under Phylum Echinodermata, Class Echinoidea. There are about 1,000 accepted sea urchin species worldwide, and 64 are described from the Philippines (Appeltans et al. 2012). They are distributed both in the tropical and temperate regions, and play key roles in nutrient recycling in the intertidal areas, seagrass and coral ecosystems in the tropical regions (Lawrence and Agatsuma 2007; Alcoverro and Marianni 2002). They are herbivorous and serve as biocontrol for invasive macroalgae inhabiting the seagrass and coral communities (Conklin and Smith 2005). In scallop culture, sea urchins are used to control fouling organisms (Zhanhui et al. 2013).

Sea urchins are one of the economically important echinoderms in the Indo-Pacific region. These are harvested for their roe (gonad) which is usually consumed locally as raw (Schoppe 2000). It is regarded as delicacies in many countries and high quality gonads are exported as “uni” in Japan and the USA which pitch high prices (Andrew et al. 2002).

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The sea urchin fishery, particularly of the Gracious sea urchin *Tripneustes gratilla,* generates multi-million exports annually (Talaeu-McManus and Kesner 1993). Such high market demand and aquaculture potentials attract researchers to study its biology and ecology. In the Philippines, some of the sea urchin studies include the species inventory (Schoppe 2000), gonadal development, growth and survivorship (Juinio-Meñez et al. 2008), population biology (Regalado et al. 2010), and genetic diversity, population structure, and exploitation (Casilagan et al. 2013) of *T. gratilla*.

Many studies have shown that, overharvesting has caused the decline of sea urchin populations in many localities (Juinio-Meñez et al. 2008). Efforts to enhance sea urchin populations include grow-out studies in cages (Malay et al. 2000; Juinio-Meñez et al. 2008).

Studies with regard to the status of this echinoid species in Pag-asa Island are inadequate. Only Gonzales et al. (2008) mentioned sea urchins in the reefs of Pag-asa. Fishing activities by claimant countries in Kalayaan Island Group (KIG) or Spratlys Islands are unregulated and could have impacted the once ubiquitous marine resources. As such, this study aimed to determine the size structure, population density and test diameter-weight relationship *T. gratilla* in Pag-asa Island, Kalayaan, Palawan, Philippines.

METHODS

The intertidal areas of Pag-asa Island, Kalayaan Island Group (KIG), Palawan, Philippines were surveyed between 28 April and 10 May 2014. Four stations were established: the northern and eastern stations were dominated by coral rubble, while stations at the southern and western sides were dominated by seagrass. Two 5 x 50 m belt transects were laid at least 100 m apart in each station (Figure 1). The survey was conducted either by wading or snorkeling during low tide up to the depths of 1.5 m from 07:00 to 09:00 and 18:00 to 20:00 hours (Figure 2). Sea urchins encountered within transects were counted and recorded.

To record the size structure and test diameter - weight relationships, 158 *T. gratilla* individuals were collected, measured for test diameter (cm) using a caliper, and weighed (g).

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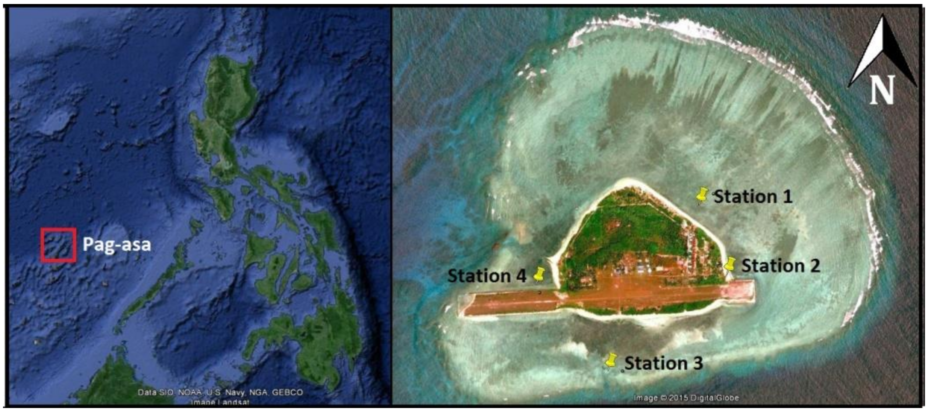

Figure 1. Map of Pag-asa Island, Kalayaan Island Group, Palawan, Philippines showing the sampling stations.

Figure 2. Extensive seagrass in the western side (Station 4) of Pag-asa Island, Kalayaan, Palawan, Philippines.

RESULTS

Size Structure of *Tripneustes gratilla*

The sizes of *T. gratilla* were generally dominated (97.5%) by large individuals having test diameters of 5.8 to 8.8 cm. Very few individuals (2.5%) with test diameter 2.6 - 4.0 cm were recorded. The body weight

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ranged from 50 to 250 g and most individuals (77.8%) fell within a body weight of 101-200 g (Table 1).

Table 1. Test-diameter and body weight distribution of *T. gratilla* in Pag-asa Island, Kalayaan, Palawan, Philippines.

Test diameter range (cm)	Mean test diameter (cm)	Frequency	%	Weight range (g)	Mean weight (g)	Frequency	%
1.0 – 2.5	-	-	-	0 – 50	16.0	4	2.5
2.6 – 4.0	3.2	4	2.5	51 – 100	92.8	14	8.9
4.1 – 5.5	0	0	0	101 – 150	122.9	68	43.0
5.6 – 7.0	6.5	61	38.6	151 – 200	173.4	55	34.8
7.1 – 9.0	7.7	93	58.9	201 – 250	226.8	17	10.8

Population Density of *T. gratilla*

The estimated average population density of *T. gratilla* in the island was 3,500 ind.ha^{-1}. The highest densities were noted in Station 1 (6,380 ind.ha^{-1}) and Station 2 (6,940 ind.ha^{-1}). Densities in the other two stations (Stations 3 and 4) were lesser than 400 ind.ha^{-1} (Figure 3).

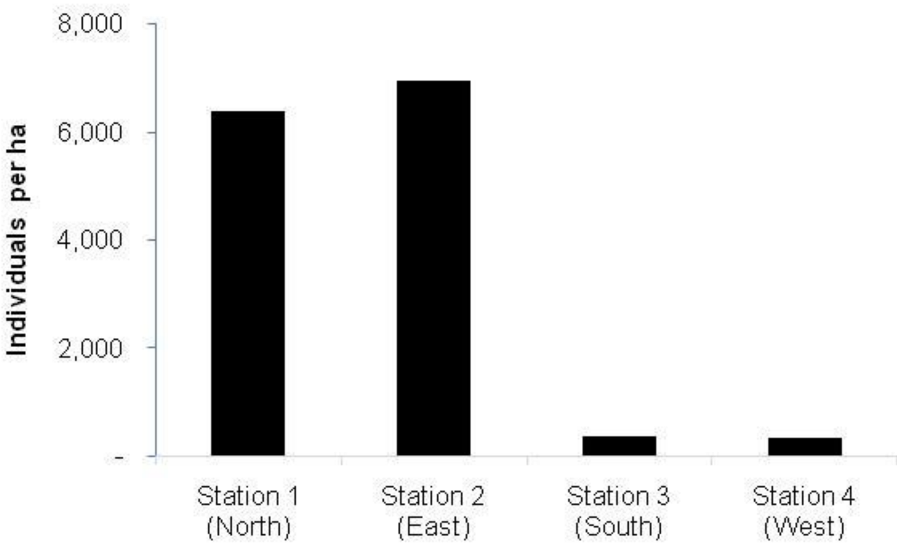

Figure 3. Population density of *T. gratilla* in different sampling stations in Pag-asa Island, Kalayaan, Palawan, Philippines.

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Test Diameter-Weight Relationship of *Tripneustes gratilla*

Most (97.5%) of the samples had a test diameter larger than 6 cm, and weighed at least 125 g. The relationship between the test diameter and body weight is best explained by the equation W = 0.7334*TD$^{2.6725}$ (Figure 4), where "W" is the weight and "TD" stands for test diameter.

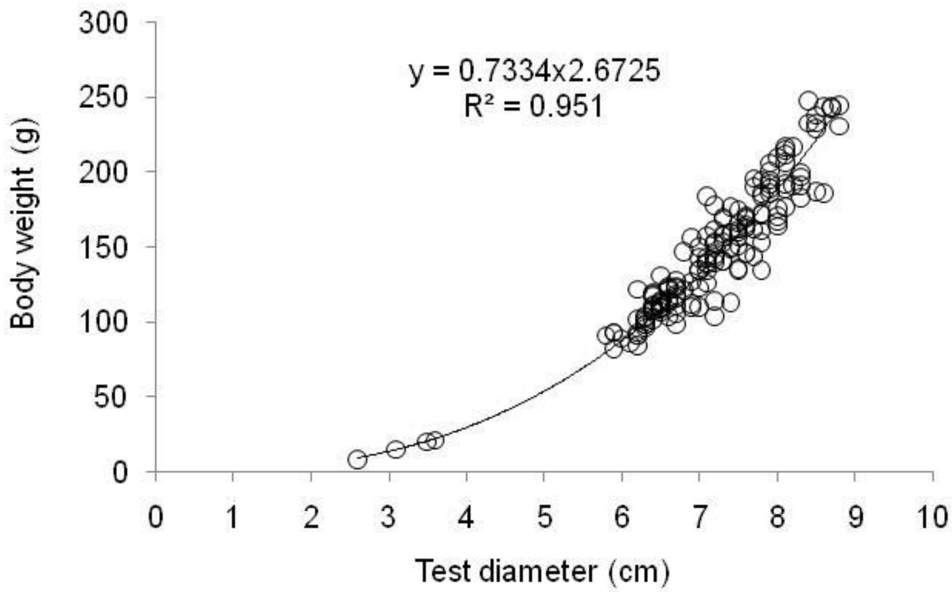

Figure 4. Test diameter-weight relationship of *T. gratilla* in Pag-asa Island, Kalayaan, Palawan, Philippines.

DISCUSSION

The dominance by large individuals (size range: 5.8-8.8 cm) in the sample could be sampling and exploitation related. Juvenile sea urchins are cryptic in nature and usually found hiding on algae and leaves of seagrasses. The prevalence of large individuals could be due also to the low fishing pressure for the species. Pag-asa Island is relatively inaccessible, inhabited by a few families and assigned military personnel, thus the degree of exploitation on the species is lesser compared with highly accessible areas such as in mainland Palawan.

The sizes of *T. gratilla* in Pag-asa Island is comparable in Curimao and Burgos in northwestern Luzon (Juinio-Meñez et al. 2008).The largest (8.8 cm)*T. gratilla* in Pag-asa Island is much smaller than the largest (16 cm)

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world record (Lawrence and Agatsuma 2001). However, the largest size obtained in Pag-asa Island is larger than those in Balaoan, La Union (Prado et al. 2012), and southern Guimaras in Iloilo (Regalado et al. 2010) (Table 2). Commercially important species are often small in size and less abundant in overharvested than in protected areas (Ablan et al. 2004, Alcala et al. 2005; Russ and Alcala 2011).

Table 2. Size range of *T. gratilla* from other locations in the Philippines.

Location	**Test diameter range (cm)**	**Source**
Southern Guimaras	4.4 – 8.2	Regalado et al. 2010
Balaoan, La Union	4.0 – 5.0	Prado et al. 2012
Pag-asa Is., Kalayaan, Palawan	2.6 – 8.8	This study

The skewed distribution in favor of large individuals (Table 1) suggests low fishing pressure, but can be affected by the sampling methods with the tendency to catch the more visible large individuals. It may also suggest that the surveyed area may not be the preferred habitat of juveniles or they may burrow in the sand or inhabit crevices. For some species of snail like *Tectus niloticus*, juveniles are encountered at shallow areas while large individuals occupy a wider range of depths (Nash 1993, Dolorosa et al. 2015).

The variations in population density in the four sites could be habitat related and could have been influenced by the Northeast monsoon. *Tripneustes gratilla* are known to occur in seagrass beds (Alcoverro and Mariani 2002), but densities were much lower at the seagrass beds of the island during the survey. It is presumed that the northeast monsoon has favored the recruitment and growth of sea urchins at the northern and eastern stations, thus many urchins (large individuals) were noted in rubble dominated areas. A year round survey at the four stations could help verify the effects of monsoons on the abundance of sea urchins in Pag-asa Island. While the recorded densities in Pag-asa Island were higher compared with other locations in the country (Table 3), surveys in other islands of the KIG could provide a clearer picture of the status of the species.

There is a high positive relationship between the test diameter and weight of *T. gratilla.* The data also revealed that 95.1% of the increase in weight of the samples is accounted to the increase in its test diameter. In the study of Regalado et al. (2010), only 77% of the increase in weights are attributed to the increase in test diameter ($W = 0.0048*TD^{2.3952}$) of *T. gratilla*.

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The variation in the influence of diameter on the increase in weight of a species is related to their diet, season, and number of samples (Hossain 2010). Understanding the reproductive biology and abundance of *Tripneustes gratilla* and many other understudied species in the KIG is recommended.

Table 3. Population density of *T. gratilla* in different sites in the Philippines.

Location	Population density (ind. ha^{-1})	Source
Northwestern Luzon	1,000	Juinio-Meñez and Bangi 2008
Southern Guimaras, Iloilo	2,600	Regalado et al. 2010
Balaoan, La Union	600	Prado et al.2012
Pag-asa Is., Kalayaan, Palawan	3,500	This study

ACKNOWLEDGMENTS

The assistance of Hon. Mayor Eugenio B. Bito-onon Jr. and Mr. Joey Vincent Rabanal of Municipality of Kalayaan, Palawan is greatly acknowledged.

REFERENCES

Ablan MCA, McManus JW and Viswanatha K. 2004. Indicators for management of coral reefs and their applications to marine protected areas. Naga, WorldFish Center Quarterly, 27: 31-39.

Alcala AC, Russ GR, Maypa AP and Calumpong HP. 2005. A long-term, spatially replicated experimental test of the effect of marine reserves on local fish yields. Canadian Journal of Fisheries and Aquatic Sciences, 62: 98-108.

Alcoverro T and Mariani S. 2002. Effects of sea urchin grazing on seagrass (*Thallasoma ciliatum*) beds of a Kenyan lagoon. Marine Ecology Progress Series, 226: 255 – 263.

Andrew NL, Agatsuma Y, Ballesteros E, Bazhin AG, Creaser EP, Barnes DKA, Botsford LW , Bradbury A, Campbell A, Dixon JD, Einarsson S, Gerring PK, Hebert K, Hunter M, Hur SB, Johnson CR, Juinio-Meñez MA, Kalvass P, Miller RJ, Moreno CA, Palleiro JS, Rivas D, Robinson SML, Schroeter SC, Steneck RS, Vadas RL, Woodby DA and Xiaoqi Z. 2002. Status and management of world sea urchin fisheries. Oceanography and Marine Biology Annual Review: 343 – 425.

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Appeltans, W, Ahyong ST, Anderson G, Angel MV, Artois T, Bailly N, Bamber R, Barber A, Bartsch I, Bera A, Blazewicz-Paszkowyz M, Bock P, Boxshall G, Boyko CB, Brandão SN, Bray RA, Bruce NL, Cairns SD, Chan TY, Cheng L, Collins AG, Cribb T, Curini-Galletu M, Dahdouh-Guebas F, Davie PJF, Dawson MN, Clerck OD, Decock W, De Grave S, de Voogd NJ, Domning DP, Emig CC, Erseus C, Eschmeyer W, Fauchald K, Fautin DG, Feist SW, Fransen CHJM, Furuya H, Garcia- Alvarez O, Gerken S, Gibson D, Gittenberger A, Gofas, S, Gomez-Daglio L, Gordon DP, Guiry MD, Hernandez F, Hoeksema BW , Hopcroft RR, Jaume D, Kirk P, Koedam N, Koenemann S, Kolb JB, Kristensen RM, Kroh A, Lambert G, Lazarus DB, Lemaitre R, Longshaw M, Lowry J, Macpherson E, Madin LP, Mah C, Mapstone G, McLaughlin PA, Mees J, Meland K, Messing CG, Mills CE, Molodtsova TN, Mooi R, Neuhaus B, Ng PKL, Nielsen C, Norenburg J, Opresko DM, Osawa M, Paulay G, Perrin W, Pilger JF, Poore GCB, Pugh P, Read GB, Reimer JD, Rius M, Rocha RM, Saiz-Salinas JI, Scarabino V, Schierwater B, Schmidt-Rhaesa A, Schnabel KE, Schotte M, Schuchert P, Schwabe E, Segers H, Self-Sullivan C, Shenkar N, Siegel V, Sterrer W, Stohr S, Swalla B, Tasker ML, Thuesen EV, Timm T, Todaro MA, Turon X, Tyler S, Uetz P, van der Land J, Vanhoorne B, van Ofwegen LP, van Soest RWM, Vanaverbeke J, Walker-Smith G, Walter TC, Warren A, Williams GC, Wilson SP and Costello MJ. 2012. The magnitude of global marine species diversity. Current Biology, 22: 2189 – 2202.

Casilagan ILN, Junio-Meñez MA and Crandall ED. 2013. Genetic diversity, population structure, and demographic history of exploited sea urchin populations (*Tripneustes gratilla*) in the Philippines. Journal of Experimental Marine Biology and Ecology, 449: 284 – 293.

Conklin EJ and Smith JE. 2005. Abundance and spread of the invasive red algae, *Kappaphycus* spp. in Kane'ohe Bay, Hawai'i and an experimental assessment of management options. Biological Invasions, 7(6): 1029 – 1039.

Dolorosa, RG, Grant A and Gill JA. 2015. Spatial and temporal abundance of *Tectus niloticus* in marine protected areas in Palawan, Philippines: prospects for conservation. Proceedings of the 4th International Conference on Environmental Research and Technology, 45-56.

Gonzales, BJ, Becira JG and Gonzales JG. 2008. Macro-invertebrates in coral reefs of Pag-asa Island, Kalayaan Island Group, Palawan, Philippines. *In*: B.J. Gonzales (eds). Pag-asa Island and adjacent reef resource assessment, Kalayaan Island Group, Kalayaan, Palawan. WPU – Technical Report. pp. 30 – 34.

Junio-Meñez MA, Bangi HG, Malay MC and Pastor D. 2008. Enhancing the recovery of depleted *Tripneustes gratilla* stocks through grow-out culture and restocking. Reviews in Fisheries Science, 16 (1-3): 35 – 43.

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Lawrence JM and Agatsuma Y. 2007. The ecology of *Tripneustes.* Developments in Aquaculture and Fisheries Science, 37: 499-520.

Malay MCD, Bangi HGP and Junio-Meñez MA. 2000. Enhancement effect of sea urchin grow-out cages in Lucero, Bolinao, Pangasinan. Science Diliman, 12(2): 1 – 9.

Nash WJ. 1993. Trochus. In: Wright A, Hill L (eds) Nearshore Marine Resources of the South Pacific: Information for Fisheries Development and Management. Institute of Pacific Studies, Suva and International Centre for Ocean Development, Canada, pp 451-496

Prado VV, Galvez GN and R Rivera. 2012. Size structure and density of sea urchin *T. gratilla* along Balaoan waters, La Union, Philippines. E-International Scientific Research Journal, 4(3): 197 – 203.

Regalado JM, Campos WL and Santillan AS. 2010. Population biology of *Tripneustes gratilla* (Linnaeus) (Echinodermata) in seagrass beds of Southern Guimaras, Philippines. Science Diliman, 22(2): 41 – 49.

Russ GR, Alcala AC. 2011. Enhanced biodiversity beyond marine reserve boundaries: The cup spillith over. Ecological Applications, 21: 241-250

Schoppe S. 2000. A guide to common shallow water sea stars, brittle stars, sea urchins, sea cucumbers and feather stars (Echinoderms) of the Philippines. Times Media Private Limited, Singapore. 144 p.

Talaue - McManus L and Kesner KPN. 1993. Valuation of a Philippine municipal sea urchin fishery and implications of its collapse. In: Junio-Meñez MA and Newkirk GF. (eds). Philippine coastal resources under stress. 229 - 239.

Williams H. 2002. Sea urchin fisheries of the world: a review of their status, management strategies and biology of the principal species. Marine Resources. Department of Primary Industries, Water and Environment, Tanzania. 1 - 4.

Zhanhui Q, Jun W, Yuze M, Jihong Z, Zengjie J and Jinguang F. 2013. Use of sea urchin *Hemicentrotus pulcherrimus* for biological control of fouling in suspended scallop cultivation in Northern China. Aquaculture, 420-421: 270-275.

ARTICLE INFO

Received : 24 January 2015
Accepted: 21 July 2015

The Palawan Scientist, 7: 27-35
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Research Notes

High density of *Tridacna crocea* in exposed massive corals proximate the Ranger Station of Tubbataha Reefs Natural Park, Cagayancillo, Palawan, Philippines

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https://doi.org/10.69721/TPS.J.2015.7.1.04

The crocus clam *Tridacna crocea*, one of the seven known giant clam species in the Philippines (Poutiers 1998), is widely distributed in the Indo-Pacific Region but is possibly extinct in Guam and Northern Mariana Islands (IUCN 2014). In the Philippines, the exploitation of all giant clam species is prohibited under Fisheries Administrative Order No. 208, series of 2001 (DA 2001). However, illegal exploitation of giant clams in many parts of the country has greatly reduced natural stock populations (Gomez and Mingoa-Licuanan 2006; Gonzales et al. 2014; Picardal and Dolorosa 2014), and only in marine protected areas such as Tubbataha Reefs Natural Park (TRNP) where high densities (100-220 ind.100 m^{-2}) of *T. crocea* (Calumpong and Cadiz 1993; Ozoa 1995; Dolorosa and Schoppe 2005) have been reported. Methods to quantify the abundance of this species involved the use of either belt transect with 1 x 1 m quadrat placed every 10 m or 2 x 100 m belt transect. No data are so far available on the density of *T. crocea* embedded in coral rocks exposed at low tide.

To quantify the abundance of *T. crocea* in massive corals with heads exposed at low tide, some exposed corals near the vicinity of the Ranger Station of TRNP were randomly sampled in June 2010. The area of coral heads was measured by using a quadrat and then by measuring the shell lengths of *T. crocea* with calipers (Figure 1).

Among the ten coral heads surveyed (area =40.75 m^2), a total of 236 *T. crocea* was noted. The densities of *T. crocea* ranged from 200-2,200 ind.100 m^{-2} with an average (±sd) of 767 (±559) ind.100 m^{-2} (Table 1). The sizes of *T. crocea* varied between 10-135 mm with an average (±sd) shell length of 67.67 (±32.26) mm (Figure 2). *Tridacna crocea* can attain 150 mm maximum shell length but commonly 110 mm (Poutiers 1998). There is no available literature on the size at which *T. crocea* becomes sexually mature, however, if *T. crocea* begins to reproduce after attaining nearly 40% (60 mm) of its maximum shell length (150 mm) as recorded for *Tridacna maxima* by Jameson (1976), then at least more than half (57%) are sexually mature.

The Palawan Scientist, 7: 40-42
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About 14% of samples were very small (10-29 mm) and such may indicate a self seeding reef.

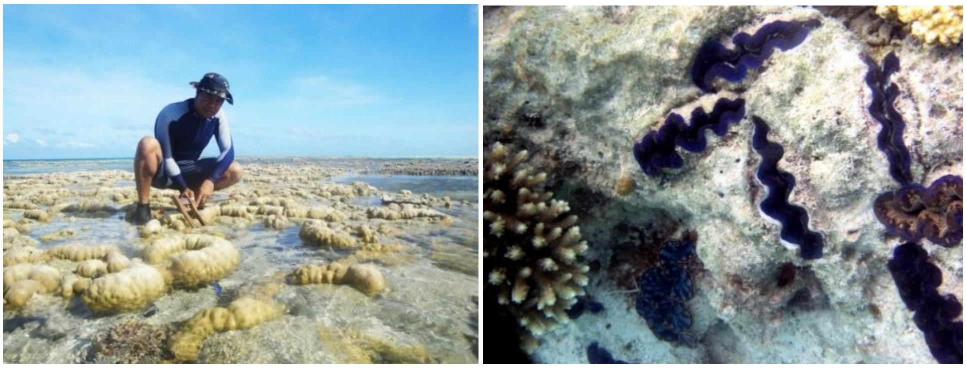

Figure 1. Measuring the shell lengths of *T. crocea* with the use of calipers (left) and a close-up view of several individuals embedded in exposed coral rock in Tubbataha Reefs Natural Park (right).

Table 1. Density of *Tridacna crocea* in coral heads near the Ranger Station of Tubbataha Reefs Natural Park (TRNP), Palawan, Philippines.

Area (m^2) of coral head	Number of *T. crocea*	Density (ind.m^{-2})	Density (ind.100 m^{-2})
3.75	17	4.53	453
5.00	18	3.60	360
7.50	15	2.00	200
4.00	21	5.25	525
4.50	31	6.89	689
1.00	10	10.00	1,000
8.00	49	6.13	613
4.00	28	7.00	700
1.50	14	9.33	933
1.50	33	22.00	2,200
Average		**7.67**	**767**
SD		**5.59**	**559**

These high densities of *T. crocea* could be due to the manner of survey which only accounted for the coral heads exposed at low tides. In 2009, a survey involving 40 transects (20 x 2 m) in the surrounding reefs within the Ranger Station of TRNP recorded an average density of 39.25 ind.100 m^{-2} (range: 3.13-126.25 ind.100 m^{-2}) (Dolorosa unpublished data). Previous densities obtained along the transect lines at intertidal (13 ind.100^{-2} m) and 5 m deep (3 ind. 100^{-2} m) areas of the park (Dolorosa and Schoppe

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2005) were lower than the present data. Lower densities (31 ind.100^{-2} m) were also recorded using transect surveys in Apulit Island, Taytay, Palawan (Gonzales et al. 2014) and many other areas of the Philippines (see bin Othman et al. 2010). Much lower were the densities in Seribu Island (2.80 ind. 100 m^{-2}) and Manado Waters, Indonesia (0.85 ind. 100 m^{-2}) (Yusuf et al. 2009), and in intertidal (0.037 ind. 100 m^{-2}) and subtidal (0.027 ind. 100 m^{-2}) reefs of Singapore (Neo and Todd 2012).

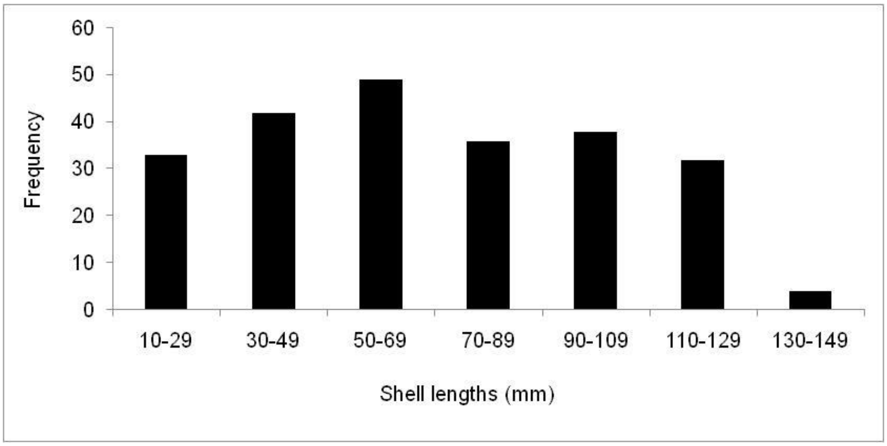

Figure 2. Size structure of *T. crocea* (n=236) embedded in coral rocks at the intertidal area proximate to the Ranger Station of Tubbataha Reefs Natural Park, Palawan, Philippines.

Giant clams are important component of the reef ecosystems. Their ecological roles have recently been reviewed and quantified which include their capacity to promote a balanced reef ecosystem (Neo et al. 2015). Any reef restoration project should therefore at least include the revival of giant clam populations. The current higher abundance of *T. crocea* within the Ranger Station of TRNP therefore requires effective protection, as the park represents an important natural genetic bank and seed source for clam-depleted reefs within its vicinity and other reefs in the Sulu Sea.

REFERENCES

bin Othman AS, Goh GHS and Todd PA. 2010. The distribution and status of giant clams (Family Tridacnidae) - a short review. Raffles Bulletin of Zoology, 58: 103-111.

Calumpong HP and Cadiz P. 1993. Observations on the distribution of giant clams in protected areas. Silliman Journal, 36: 107-113.

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Department of Agriculture (DA). 2001. Fisheries Administrative Order No. 208, Series of 2001. Conservation of rare, threatened and endangered fishery species.

Dolorosa RG and Schoppe S. 2005. Focal benthic mollusks (Mollusca:Bivalvia and Gastropoda) of selected sites in Tubbataha Reefs National Marine Park, Palawan, Philippines. Science Diliman, 17: 1-10.

Gomez ED and Mingoa-Licuanan SS. 2006. Achievements and lessons learned in restocking giant clams in the Philippines. Fisheries Research, 80: 46-52.

Gonzales BJ, Dolorosa RG, Pagliawan HB and Gonzales MMG. 2014. Marine resource assessment for sustainable management of Apulit Island, West Sulu Sea, Palawan, Philippines. International Journal of Fisheries and Aquatic Studies, 2: 130-136.

IUCN. 2014. IUCN Red List of Threatened Species. Version 2014. 3. www.iucnredlist.org. Downloaded on 23 December 2014.

Jameson SC. 1976. Early life history of the giant clams *Tridacna crocea* Lamark, *Tridacna maxima* (Röding), and *Hippopus hippopus* (Linnaeus). Pacific Science, 30: 219-233.

Neo ML, Eckman W, Vicentuan K, Teo SL-M and Todd PA. 2015. The ecological significance of giant clams in coral reef ecosystems. Biological Conservation, 181: 111-123.

Neo ML and Todd PA. 2012. Population density and genetic structure of the giant clams *Tridacna crocea* and *T. squamosa* on Singapore's reefs. Aquatic Biology, 14: 265-275.

Ozoa MAJ. 1995. Benthic macroinvertebrates. In: Results of research and monitoring of Tubbataha Reefs National Marine Park (TRNMP). Silliman University Marine Laboratory.

Picardal RM and Dolorosa RG. 2014. The molluscan fauna (gastropods and bivalves) and notes on environmental conditions of two adjoining bays in Puerto Princesa City, Palawan, Philippines. Journal of Entomology and Zoology Studies, 2: 72-90.

Poutiers JM. 1998. Bivalves (Acephala, Lamellibranchia, Pelecypoda). In: Carpenter KE, Niem VH (eds) FAO species identification guide for fishery purposes. The Living Marine Resources of the Western Central Pacific. Seaweeds, Corals, Bivalves and Gastropods. FAO, Rome, pp 123-362.

Yusuf C, Ambariyanto and Hartati R. 2009. Abundance of Tridacna (Family Tridacnidae) at Seribu Islands and Manado Waters, Indonesia. Ilmu Kelautan, 14: 150-154.

ARTICLE INFO

Received: 22 December 2014
Accepted: 29 May 2015

The Palawan Scientist, 7: 40-42
© 2015, Western Philippines University

Research Notes

Size and abundance of Red Striped sea cucumber *Thelenota rubralineata* in Cagayancillo, Palawan, Philippines

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On 22 April 2015 at around 14:00 - 15:00 hours, six divers/researchers composed of representatives from Tubbataha Management Office, World Wildlife Fund for Nature and Western Philippines University explored the reef walls in Bandila, Cagayancillo, Palawan, Philippines. At a depth of about 15 m, two *Thelenota rubralineata* (Figure 1) measuring 35 and 40 cm were encountered on a small patch of sand. Subsequently, three individuals measuring 40, 38 and 30 cm, respectively were noted on an adjoining patch of sand and rock at 20 m deep.

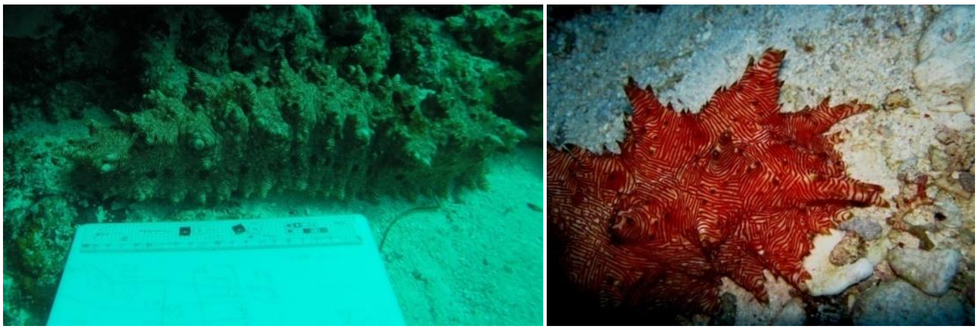

Figure 1. *Thelenota rubralineata* in Bandila, Cagayancillo, Palawan (left); a photo (taken with a flash showing the crimson pattern on white background) of *T. rubralineata* at Tubbataha Reefs Natural (right; photo by Jennifer Selgrath).

Thelenota rubralineata (family Stichopodidae) with its striking patterns of crimson line on white background is considered one of the most beautiful macrobenthic reef invertebrates. They are widely distributed in the Indo-Pacific Region but considered a rare species (Lane 1999; Kinch 2005). They are seldom encountered in the reefs of Palawan (Jontila et al. 2014; Dolorosa 2015), possibly because of the nature and depths of their habitats, and effects of harvesting. Since its description in 1991 (Massin and Lane

The Palawan Scientist, 7: 40-42
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1991), not much has been detailed about its biology (Conand et al. 2013). According to Kerr (2006) the species can reach a maximum length of 50 cm. An individual measuring 50 cm in length was also reported in Tubbataha Reefs Natural Park (TRNP), but the density was very low (0.19 ind.ha^{-1}) compared with other sea cucumber species (Dolorosa 2015). The estimated area covered during the dive was about 6,000 m^2 (600 x 10 m) thus suggesting a density of about 8 individuals per hectare. However, the sighting was only in one out of seven dives covering a total area of at least 9,0000 m^2. An average density of at least one individual per 220 m^2 (or 45.45 ind.ha^{-1}) was reported only in Bunaken Marine Reserves, Sulawesi (Lane 1999) but densities in other areas are less than 1 individual per hectare (Conand et al. 2013).

Together with many other sea cucumber species, *Thelenota rubralineata* is exploited in the Philippines (Schoppe 2000; Jontila et al. 2014) and in its known distribution range (Lane 1999; Kinch 2005; Purcell et al. 2012).

Sea cucumbers are prone to overharvesting (Schoppe 2000; Hasan 2005; Hasan and Abd El-Rady 2012; Purcell et al. 2012, 2013) and this could affect the people mainly dependent on their fishery. Monitoring the natural recovery of populations in marine protected areas and studies involving breeding and restocking of this species is suggested. Given its beauty, the tourism value of the species is important and could exceed its dried market value, thus there is a need to protect the species, at least at the local level.

REFERENCES

Conand C, Gamboa R and Purcell S. 2013. *Thelenota rubralineata*. The IUCN Red List of Threatened Species. Version 2014. 3. <www.iucnredlist.org>. Downloaded on 24 April 2015.

Dolorosa RG. 2015. The sea cucumbers (Echinodermata: Holothuroidea) of Tubbataha Reefs Natural Park, Philippines SPC Beche-de-Mer Information Bulletin, 35: 10-18.

Hasan MH. 2005. Destruction of a *Holothuria scabra* population by overfishing at Abu Rhamada Island in the Red Sea. Marine Environmental Research, 60: 489-511

Hasan MH and Abd El-Rady SEA. 2012. The effect of fishing pressure on the ecology of sea cucumber populations in the Gulf of Aqaba, Red Sea. SPC Beche-de-Mer Information Bulletin, 32: 53-59.

Jontila JBS, Balisco RAT and Matillano JA. 2014. The sea cucumbers (Holothuroidea) of Palawan, Philippines. AACL Bioflux, 7: 194-206.

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Kerr AM, Netchy K and Gawel AM. 2006. Survey of the shallow-water sea cucumbers of the central Philippines. A Report to the Municipalities of Negros Oriental, Cebu and Bohol, local Bantay Dagat groups, Coastal Conservation and Education Foundation, Inc., and Silliman University-Angelo King Center for Research and Environmental Management. University Of Guam Marine Laboratory.

Kinch J. 2005. The commercial use of *Thelenota rubralineata* in the Solomon Islands. SPC Beche-de-Mer Information Bulletin, 21: 3-4.

Lane DJW. 1999. Distribution and abundance of *Thelenota rubralineata* in the western Pacific: Some conservation issues. SPC Beche-de-Mer Information Bulletin, 11: 19-21.

Massin C and Lane DJW. 1991. Description of a new species of sea cucumber (Stichopodidae, Holothuroidea, Echinodermata) from the eastern Indo-Malayan archipelago: *Thelenota rubralineata* n. sp. Micronesica, 24: 57-64.

Purcell SW, Samyn Y and Conand C. 2012. Commercially important sea cucumbers of the world. FAO Species Catalogue for Fishery Purposes. No. 6. Rome, FAO. 223 pp.

Purcell SW, Mercier A, Conand C, Hamel J-F, Toral-Granda MV, Lovatelli A and Uthicke S. 2013. Sea cucumber fisheries: global analysis of stocks, management measures and drivers of overfishing. Fish and Fisheries, 14: 34-59.

Schoppe S. 2000. Sea cucumber fishery in the Philippines. SPC Beche-de-Mer Information Bulletin, 13: 10-12.

ARTICLE INFO

Received: 23 April 2014
Accepted: 1 July 2015

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Guide for Authors

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ABSTRACT	**ABSTRACT**
INTRODUCTION	**INTRODUCTION**
METHODS or MATERIALS AND METHODS	**METHODS or MATERIALS AND METHODS**
RESULTS AND DISCUSSION	**RESULTS**
CONCLUSION AND RECOMMENDATIONS	**DISCUSSION**
ACKNOWLEDGEMENTS	**ACKNOWLEDGEMENTS**
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1. All organisms must be identified by their English, scientific names and local names if possible.
2. Scientific names must be cited for all organisms at first mention. Subsequently, only the initial of the genus should be written except when starting a sentence with a scientific name. All scientific names should be italicized. Example: *Tectus niloticus*; *Anadara* sp. *Musa* spp. Do not italicize the higher levels of taxonomic classification (example: family Echinometridae).
3. Local names should be in double quotes (example: locally called “saging” not ‘saging’; “palay” not ‘palay’).
4. Research articles dealing on species list should provide the authorities for each species (example: *Conus magus* Linnaeus, 1758; *Phos vandenberghi* Fraussen & Poppe, 2005).

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1. Unfamiliar terms, abbreviations, and symbols must be defined/spelled out at first mention.
2. Mathematical equations should be clearly presented so that they can be interpreted properly. Equation must be numbered sequentially in Arabic numerals in parentheses on the right-hand side of the equations.
3. Numbers lesser than 10 should be spelled out (for example: eight trees, 10 fish) except when followed by a unit of measure (for example: 9 cm, not nine cm). Numbers should be spelled-out when starting in a sentence (example: Nine fishermen were…).
4. No apostrophes in years (example: 2014s not 2014’s)
5. No periods in acronyms (example: UNESCO not U.N.E.S.C.O.; CITES not C.I.T.E.S.)
6. Write dates in this manner: day-month-year (example: 20 October 2012 or 20 Oct 2012).
7. Use the International System of Units of measurements. Separate the value and the unit of measure (example: 5 mm, 25 g, 30 m^3, 100 µm, 9 ind ha^{-1}, 10 sacks ha^{-1}, 2 kg h^{-1} day^{-1}). To fix a single space between the value and its unit of measure, use the MS word command “CTR+SHIFT+SPACE BAR” to provide a space between the value and its unit of measure.
8. Do not separate a percent sign with the number (example: 5%, 30%).
9. Use 24-h system for time (example: 13:00 instead of 1:00 pm). To express a measured length of time, abbreviations for hour (h), minutes (min) and seconds (sec) will be used (example: 2 h and 30 min; or 2.5 h).
10. Use a single capital letter when writing latitude and longitude (example: 9°44’27.80”N and 118°41’2.01”E).

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11. Compass points (north, south, east, west) and their derivations (northern, southern, eastern, western) are lowercased (example: north of Palawan) except when they form part of the place name (example: South Cotabato; Eastern Samar).

References

References to the literature citations in the text should be by author and year; where there are two authors, both should be mentioned; with three or more authors, only the first author's family name plus "et al." need be given. References in the text should be cited as:

- Single author: (Frietag 2005) or Frietag (2005)
- Two authors: (De Guzman and Creencia 2014) or De Guzman and Creencia (2014)
- More than two authors: (Sebido et al. 2004) or Sebido et al. (2004).

1. Use a semi-colon followed by a single space when citing more than two authors. Arrange by date of publication with the latest being the last in the list (example: Sebido et al. 2004; Frietag 2005; De Guzman and Creencia 2014).

2. Use a comma followed by a single space to separate citation of different references authored by the same author (example: Jontila 2005, 2010). If the same author and year are cited, use a "letter" to distinguish one paper over the other (example: Creencia 2010a,b).

3. Alphabetize authors with the same year of publications (example: Balisco and Babaran 2014; Gonzales 2014; Smith 2014).

4. Write journal's name in full (examples: The Palawan Scientist, not Pal. Sci; Reviews in Fisheries Science, not Rev. Fish. Sci.).

5. The list of citation at the end of the paper should include only the works mentioned in the text and should be arranged alphabetically.

6. Citing journal articles– name(s) and initial(s) of author(s), year, full title of research article (in sentence form), name of the journal (not abbreviated), volume number, issue number (if given), range of page numbers, DOI number (if available) and/or web link:

   Dolorosa RG, Grant A and Gill JA. 2013. Translocation of wild *Trochus niloticus*: prospects for enhancing depleted Philippine reefs. Reviews in Fisheries Science, 21(3-4): 403-413. DOI: 10. 1080/ 10641262. 2013. 800773.

   Jontila JBS, Balisco RAT and Matillano JA. 2014. The sea cucumbers (Holothuroidea) of Palawan, Philippines. AACL Bioflux, 7(3): 194-206. http://www.bioflux.com.ro/docs/2014.194-206.pdf

7. Citing of books – name(s) of author(s), year of publication, full title of the Book (capitalize each main word), publisher, place of publication and total number of pages.

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Gonzales, BJ. 2013. Field Guide to Coastal Fishes of Palawan. Coral Triangle Initiative on Corals, Fisheries and Food Security, Quezon City, Philippines. 208p.

8. Citing a chapter in a book – name(s) of author(s), year, full title of the chapter in a book (capitalize each main word), last name of editor and title of book, edition, publisher, place of publication and page range of that chapter:

Poutiers JM. 1998. Gastropods. In: Carpenter KE and Niem VH (eds). FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific Seaweeds, Corals, Bivalves and Gastropods. Food and Agriculture Organization, Rome. p364-686.

9. Citing a Webpage – names of the author (s), year, Title of the article, webpage address and date accessed.

Morrison H and Pfuetzner S. 2011. Australia Shells. http://www.seashells.net.au/Lists/ TEREBRIDAE. html. Accessed on 4 Sept 2011.

CITES (Convention on International Trade of Endangered Species. 2014. The CITES Appendices. Convention on International Trade in Endangered Species of Wild Flora and Fauna. www.cites.org. Accessed on 5 Jan 2014.

10. Citing a thesis or dissertation – author's family name, initial names of the author, year, title of the thesis, degree, name of institution, address of the institution, total number of pages (p).

Guion SL. 2006. Captive breeding performance of *Crocodylus porosus* (Schneider 1901) breeders at the Palawan Wildlife Rescue and Conservation Center. BS in Fisheries. Western Philippines University-Puerto Princesa Campus, Palawan, Philippines. 28p.

Lerom RR. 2008. Biosystematics study of Palawan landraces of rice (*Oryza sativa* L.). Doctor of Philosophy, Institute of Biological Sciences, University of the Philippines-Los Baños College, Laguna, Philippines. 197p.

11. Citing a Report

Picardal RM and Dolorosa RG. 2014. Gastropods and bivalves of Tubbataha Reefs Natural Park, Cagayancillo, Palawan, Philippines. Tubbataha Management Office and Western Philippines University. 25p.

12. In Press articles when cited must include the name of the journal that has accepted the paper.

Alcantara LB and Noro T. In press. Growth of the abalone *Haliotis diversicolor* (Reeve) fed with macroalgae in floating net cage and plastic tank. Aquaculture Research.

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13. Citing an article from an online news paper.

Cuyos JM (2011) Endangered deep-sea shells seized from Mandaue firm. Inquirer Global Nation, Cebu. http://globalnation.inquirer.net/cebudailynews/news/view/20110325-327558/Endangered-deep-sea-shells-seized-from-Mandaue-firm. Accessed on 31 May 2012.

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The Palawan Scientist

Volume 7, 2015

Western Philippines University
San Juan, 5302 Aborlan, Palawan
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Articles

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