ABUNDANCE OF RED-EARED SLIDER TURTLE *TRACHEMYS SCRIPTA ELEGANS* (WIED, 1839) AND THEIR POTENTIAL IMPACTS ON THE NATIVE TURTLE SPECIES IN THE TEMPLE PONDS, YANGON ENVIRONS

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Abstract

Species abundance of turtles and tortoises in the temple ponds, Yangon environs were observed in the study work. The study was conducted from 2015 to 2018. Distinctive characters and morphometric data of studied species were given systematically. Classification and identification of the individual specimens were also recorded with the sex. *Trachemys scripta elegans* (Red-eared slider turtle) is one of the world's most invasive species. They originated from North America and they have been considered as invasive species. The research designed was based on field study. It was observed on population status, the pet trade and distribution of the red-eared sliders turtle species. The population size of recorded turtles and tortoises were calculated for the sex and age groups (males, females, and juveniles) based on carapace length. *Morenia ocellata* and *Lissemys scutata* were the highest populations and the second highest population *T. s. elegans* were found to be recorded in all temple ponds. The population size of Red-eared slider (RES) turtle was composed of 6hatchlings, 10juveniles, 62adults (25males and 37females) with a percentage of 21% immature and 79% mature individuals. In Yangon, a large number of hatchling Red-eared sliders were sold at pet shops. The present study was the first attempt to record and present the current distribution and status of this invasive freshwater turtle.

. **Keywords**: red-eared sliders turtle, invasive species, population, abundance, pet

Introduction

Invasive Alien Species (IAS) are non-native species in a specific ecosystem whose introduction and subsequent establishment impact negatively on the economy, agriculture, biodiversity and/or animal and human health. They include animals, plants, fungi and microorganisms introduced from their original habitat and have the ability to outcompete native species for food and habitat. When invasive exotic species have persisted for a long time they may eventually be recognized by the public as "natural" or "native" due in part to the phenomenon of "shifting baselines" (Knowlton and Jackson, 2008). Invasive species are a major [1]threat to biodiversity (Simberloff *et al.* 2013) and are an ongoing concern for conservation practitioners (Kuebbing and Simberloff, 2015).

Little is known about the status of IAS in Myanmar but a few IAS have been observed throughout the country introduced by water, air and/or land transport (NBSAP Myanmar, 2011). The study species *Trachemys scripta elegans* (Red-eared slider turtle) was included on the list of invasive alien species that are one of the ''100 worst invasive alien species'' according to the International Union for Conservation of Nature (IUCN) (Lowe *et al.,* 2000; Cadi and Joly, 2003;

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Kikillus *et al*., 2010), which means that concrete action at the Union level is required to prevent their introduction, establishment or spread.

Trachemys scripta elegans RES is a semiaquatic turtle of the family Emydidae, order Testudines. It is one of the subspecies of the pond sliders *T. scripta*. The species *T. scripta* contains three subspecies: *T. s. elegans* (red-eared slider), *T. s. scripta* (yellow-bellied slider), and *T. s. troostii* (Cumberland slider) (Seidel, 2002), is native to the south-eastern USA and northeastern Mexico (Van Dijk *et al.* 2012). RES, an intentionally introduced species, is considered to be among the most common reptile pets traded worldwide (Salzberg, 1995, 1998; Lowe *et al.*, 2000; Telecky, 2001; Reed and Gibbons, 2003). In recent decades millions of hatchlings of this species, a popular pet, have been exported from USA farms to many countries. RES became very popular because of their small size, their simple husbandry requirements, and their reasonably low price. The colorful and small hatchlings are popular until they become adults that are more difficult to care for. Often, these unwanted pets are liberated into the local freshwater area where they become established as competitors and carriers of disease and parasites, with negative consequences for native turtle species (Pearson *et al.*, 2015).

RES now occurs in most temple ponds ecosystems throughout Myanmar. Although this species is well known and popular with the general public, few studies have investigated its impact on local ecosystems and native species, or its invasive status. The research paper was conducted at Yangon environ, by the following objectives; to determine the current range of the RES in Yangon environ, to record the species composition of native turtle and tortoise species in some turtle ponds, to examine abundance of turtle species in the temple ponds, to investigate the impact of invasive RES turtle at temple ponds in Yangon environs.

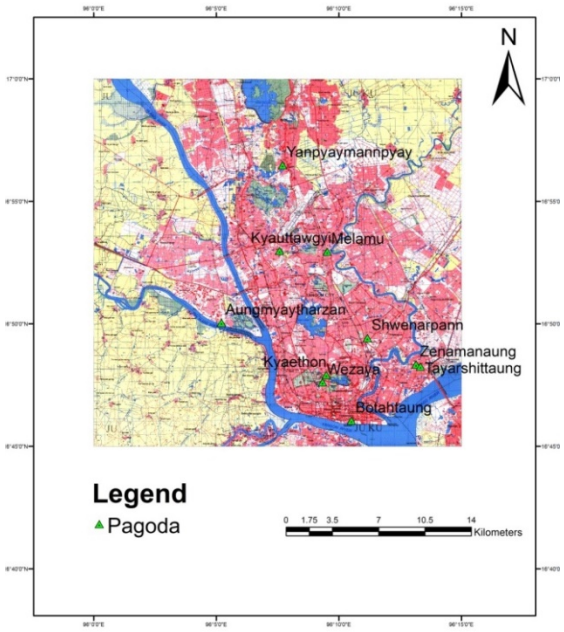
Materials and Methods

Study sites and study period

Ten artificial turtles ponds in pagodas and twelve pet shops in Yangon environ were selected for the present research design (Table1, Fiuger.1, Plate 1 and 2). Data collections were carried out from 2015 to 2018.

Table 1 Ten artificial turtles ponds of pagodas in Yangon environs

Sr No.	Study sites			
	Pagoda	Location	Pond type	Dimension (m)
1	Botahtaung	16˚ 46' N and 96˚ 10' E	Concrete	50×50×3
2	Zenamanaung	16˚ 48' N and 96˚ 12' E	Natural	80×80×3
3	Melamu	16˚ 53' N and 96˚ 09' E	Concrete	45×40×2
4	Kyaethon	16˚ 47' N and 96˚ 09' E	Concrete	60×60×2
5	Mahar Wezaya	16˚ 46' N and 96˚ 09' E	Concrete	50×50×2
6	Kyauttawgyi	16˚ 46' N and 96˚ 12' E	Semi-natural	50×50×3
7	Aungmyaytharzan	16˚ 19' N and 96˚ 05' E	Natural	80×80×2
8	Yanpyaymannpyay	16˚ 42' N and 96˚ 06' E	Concrete	45×45×2
9	Tayarshittaung	16˚ 48' N and 96˚ 13' E	Concrete	50×50×3
10	Shwenarpann	16˚ 49' N and 96˚ 10' E	Concrete	8×8×3



***Source:** Geography Department (YU)

Figure1 Location map of the study sites

Plate1 Artificial turtle pond of pagoda

Plate 2 Pet shop

Collection of the specimens

The present study has performed the techniques of direct sighting visual encounter survey (VES) and mark-recapture method for the abundance of turtle species in all different ponds. Basking turtle observation was the easiest to make on sunny days (between 7:00 am and 4:00 pm). The basking turtle was counted by visual eyes and photographic records were taken. Another survey was conducted by hand capturing turtles with the net. The hand capturing method survey determined the turtle species and approximate size class (hatchling, juvenile, adult).

Visual encounter surveys were conducted in 12 pet shops in Yangon between June 2017 and June 2018. Hatchling RES displayed in plain view or hidden in pet shops were photographed when permitted by pet shop owners. Interviews with pet shop owners were conducted to determine the price, quantity, source, and distribute of this species.



(A)Visual encounter survey (B) Hand capturing method (C) Using the net method

Plate 3 Collection of the specimens by various methods

Identification

Identification of the studied species was according to Smith (1931); CITES Identification Guide Turtles and Tortoises (1996); Win Maung and Win Ko Ko (2002) and Kalyar *et al.*, (2018).

Measuring of the specimens

Measurements were taken from the maximum carapace length (CL), carapace width (CW), plastron length (PL), plastron width (PW), height (H) and body weight (BW). Hatchling, <= 50 mm plastron length; Sub adult, 51 mm – 100 mm; and Adult,= > 101 mm plastron length for red-eared sliders were recorded (Cagle, 1946; Gibbons and Lovich, 1990 and Gibbons, *et. al.*, 1981).



(A) (B) (C)

Plate 4 Measurements of the specimens

Relative abundance

The relative abundance of the species was evaluated using the following formula (Bisht *et al.*, 2004) and (Bibby, Jones and Marsden, 1998).

$$\text{Relative abundance (RA)} = \frac{\text{Number of individual of a species (n)}}{\text{Number of individuals of all the species (N)}}$$

Dominance index

Analysis of the dominance index was done according to the method of Kumar and Sivaperuman (2005).

$$\text{Dominance index} = \frac{\text{No.of individual of each species}}{\text{Total number of individuals of all species}} \times 100$$

Community dominance index

A simple community dominance index was calculated as follows (Mc Naughton, 1968).

Community dominance index = percentage of abundance contributed by the two most abundant species

$$= 100 \times \frac{y_1+y_2}{y}$$

Where:

y_1= abundance of most abundant species
y_2= abundance of second most abundant species
y= total abundance for all species

Ordinal categories of abundance

Abundance category	Abundance score	Ordinal scale
< 0.1	1	Rare
0.1-2.0	2	Uncommon
2.1-10.0	3	Frequent
10.1-40.0	4	Common
40.1 +	5	Abundant

Results

Systematic position

The systematic position of the studied species was according to CITES Identification Guide Turtles and Tortoises (1996); Win Maung and Win Ko Ko (2002) and Kalyar *et al*., (2018).

Phylum - Chordata
Subphylum - Vertebrata
Class - Reptilia
Subclass - Anapsida
Order - Testudines
Suborder - Cryptodira
Family - Emydidae
Genus - *Trachemys*
Species - *T. scripta*
Subspecies - *T. s. elegans* (Wied, 1839)
Common name - Red-eared slider turtle
Vernacular name - Leik Parni or Na ywet ni leik
Type - Hardshell turtle

Description

The carapace is rounded or oval and flattened (especially in the male), has a dark green background with light and dark, highly variable markings (Plate5). The plastron is a light yellow with dark, paired, irregular markings in the center of most scutes. The plastron is highly variable in pattern. The plastron is slightly broader at the anterior than the posterior (Plate6). A red stripe

or red patch present behind each eye. Head, neck, and legs are green with many yellow lines. Juveniles have brighter markings and color. Toes are webbed and all bear foreclaws.

Sexual dimorphism

Males have longer claws on their front feet than the females. The male's tail is thicker and longer, it has a dark-colored retractable sexual organ known as their penis, inside the tail. The male's plastron is slightly concave, while that of the female is completely flat. The male is smaller than the female.

(A) (B) (C) (D) (E) (F)

Plate 5 Carapace color variation of Red-eared slider turtle (Young-Adult)

(A) (B) (C) (D) (E) (F)

Plate 6 Plastron patterns variation of Red-eared slider turtle (Young-Adult)

The research surveys confirmed the presence of *T. s. elegans* RES in all study sites (10 temple ponds) of Yangon environs. The total captured number of RES was found about 78 individuals from different temple ponds. The male and female sex ratio of the population was 1:1.5. The population size of RES was composed of 6-hatchlings, 10-juveniles, 62-adults (25-males and 37-females) with a percentage of 21% immature and 79% mature individuals (Fiuger 2 and 3). Mean value with the range of morphometric measurements for male, female, juveniles and hatchlings were shown in Table 2.

Market field surveys confirmed the presence of Red-eared sliders was sold in high numbers at the pet shops in Yangon (Plate7). Most hatchling specimens were observed in the pet shops, the average sold about 30> number per week. According to the interviews, many adult specimens had been released in the turtle ponds by their owners. Hatchlings RES prices ranged from 3000Ks to 25000Ks/ individual. The species was on the large scale and increasing levels of pet market activity in the Yangon environs.

Table 2 Morphometric measurements of *T. s. elegans* (Red-eared slider turtle)

Sex	Parameter					
	CL (cm)	CW (cm)	PL (cm)	PW (cm)	H (cm)	BW (g)
Males (n=25)	18.45±4.90	15.28±4.64	15.41±4.17	12.43±4.03	7.49±1.89	1135.29±641.44
Females (n=37)	21.12±3.40	18.90±4.18	18.98±2.32	11.50±1.97	8.08±1.05	2119.41±391.44
Juveniles (n=10)	7.48±0.55	6.37±1.20	6.61±0.74	4.91±0.80	3.72±0.40	121.50±17.96
Hatchlings (n=6)	3.35±0.35	3.25±0.08	2.73±0.23	1.70±0.19	1.27±0.18	40.67±4.71

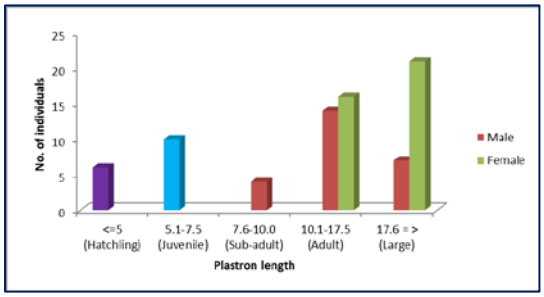


Figure 2 Plastron length on different life stages

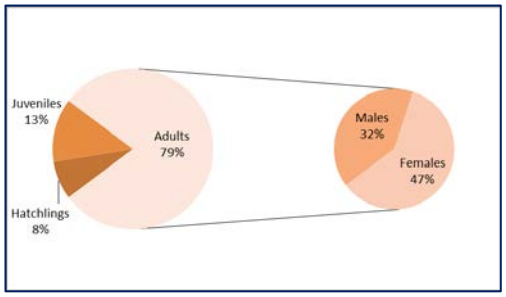


Figure 3 Percentage of immature and mature RES

(A) (B) (C)

Plate 7 Hatchlings RES at the pet shops in Yangon environs

Species composition and conservation status

A total of 11 species were recorded representing two species of tortoises and nine species of freshwater turtles belonging to four families, Testudinidae (two species), Trionychidae (five species), Geoemydidae (three species), Emydidae (one species) under Order Testudines. *Indotestudo elongata* (Yellow tortoise), *Manouria emys* (Asian Brown tortoise), *Amyda ornata phayrei* (Burmese softshell turtle), *Lissemys scutata* (Myanmar flap shell turtle), *Lissemys punctata* (Indian flap shell turtle), *Nilssonia formosa* (Myanmar peacock softshell turtle), *Chitra vandijki* (Myanmar narrow-headed softshell turtle), *Morenia ocellata* (Myanmar eyed turtle), *Cyclemys fusca* (Myanmar brown leaf turtle), *Batagur baska* (Northern mangrove terrapin), and *Trachemys scripta elegans* (Red-eared slider turtle) were found from different study sites in Yangon environs (Table 2, Fiuger.4). Among them, six species were observed as the endemic species.

As the conservation status according to the IUCN Red List (2015), two species were critically endangered (CR), three were endangered (EN), two were vulnerable (VU), one was

nearly threatened (NT), two were least concerned (LC), and one was data deficient (DD). According to CITES (2015), out of 11 species, three species were listed in Appendix I, five species as Appendix II and three were not listed. All of the species were listed as the protected species under MWPL (1994) (Table3, Fiuger.5).

Table 3 Recorded tortoises and turtles at the temple ponds in Yangon environs

Order	Family	Genus	Species/Subspecies	Common name
Testudines	Testudinidae	*Manouria*	*M. emys*	Asian Brown Tortoise
		Indotestudo	*I. elongata*	Yellow Tortoise
		Lissemys	*L. scutata*	Myanmar Flapshell Turtle (Endemic)
			L. punctata	Indian Flap shell Turtle
	Trionychidae	*Nilssonias*	*N. formosa*	Myanmar Peacock Softshell Turtle (Endemic)
		Amyda	*A. ornata phayrei*	Burmese Softshell Turtle (Endemic)
		Chitra	*C. vandijki*	Myanmar Narrow-headed Softshell Turtle (Endemic)
	Geoemydidae	*Morenia*	*M. ocellata*	Myanmar Eyed Turtle (Endemic)
		Cyclemys	*C. fusca*	Myanmar Brown Leaf Turtle (Endemic)
		Batagur	*B. baska*	Northern Mangrove Terrapin
	Emydidae	*Trachemys*	*T. scripta elegans*	Red-eared Slider Turtle

Table 4 National and International protection/ conservation status of recorded species

Species	Conservation Status			
	IUCN Red List (2012)	CITES (2010)	MWL (1994)	MFL (1993)
M. emys	Endangered	Appendix I	Protected	Not Listed
I. elongata	Endangered	Appendix II	Protected	Not Listed
L. scutata	Data Deficient	Appendix II	Protected	Protected
L. punctata	Least Concerned	Appendix II	Protected	Protected
N. formosa	Endangered	Not Listed	Protected	Not Listed
A. o. phayrei	Vulnerable	Appendix II	Protected	Protected
C. vandijki	Critically Endangered	Appendix II	Protected	Protected
M. ocellata	Vulnerable	Appendix I	Protected	Protected
C. fusca	Nearly Threatened	Not Listed	Protected	Protected
B. baska	Critically Endangered	Appendix I	Protected	Protected
T. s. elegans	Least Concerned	Not Listed	Protected	Protected

IUCN (International Union for Conservation of Nature and Natural Resources), CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), MWL (Myanmar Wildlife Law), and MFL (Myanmar Fisheries Law)

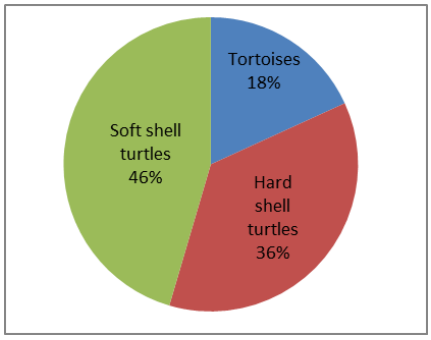


Figure 4 Percentage shell types of the recorded species

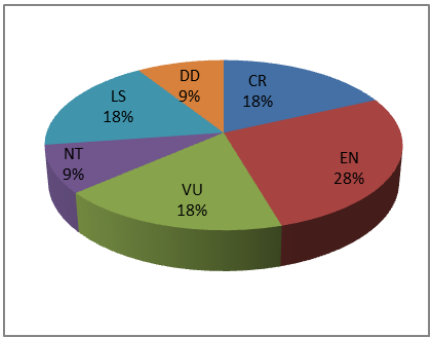


Figure 5 Conservation status of the recorded species

Abundance of species

According to the survey, *M. ocellata* (Myanmar eyed turtle) and *L. scutata* (Myanmar flap shell turtle) were the highest populations and the second highest population was *T. s. elegans* (Red-eared slider turtle) in all temple ponds. The lowest population of four species, *M. emys* (Asian Brown tortoise), *C. vandijki* (Myanmar narrow-headed softshell turtle), *C. fusca* (Myanmar brown leaf turtle), and *B. baska* (Northern mangrove terrapin) were observed (Fiuger.6).

The calculated community dominance index indicated that the common (CDI=21.11) ordinal scale of turtle species were recorded in Yangon environs. An ordinal category of recorded turtle and tortoise species in Yangon environs was shown in Table5. The mean value with the range of carapace length and body weight for the recorded species were shown in Table 6.

Table 5 Ordinal categories of recorded turtle and tortoise species in Yangon environs

Sr. No.	Species	Relative abundance index	Dominance index	Ordinal scale*
1	*M. emys*	0.0034	0.34	Rare
2	*I. elongata*	0.0135	1.35	Uncommon
3	*L. scutata*	0.3041	30.41	Common
4	*L. punctata*	0.010	1.01	Uncommon
5	*N. formosa*	0.0439	4.393	Frequent
6	*A. o. phayrei*	0.0304	3.04	Frequent
7	*C. vandijki*	0.0034	0.34	Rare
8	*M. ocellata*	0.3209	32.09	Common
9	*C. fusca*	0.0034	0.34	Rare
10	*B. baska*	0.0034	0.34	Rare
11	*T. s. elegans*	0.2635	26.35	Common

*Abundance score and Ordinal scale: < 0.1 (Rare), 0.1-2.0 (Uncommon), 2.1-10.0 (Frequent), 10.1-40.0 (Common), 40.1 + (Abundant)

Table 6 Mean number of carapace length and bodyweight of the recorded species

Sr.No	Species	No. of individuals	CL (cm) Mean±SD	BW (kg) Mean±SD	Males	Females	Juveniles
1	*M.emys*	1	60	37	-	1	-
2	*I. elongata*	4	22.5±2.6	2±0.26	-	4	-
3	*L.scutata*	90	15.8±4.9	0.85±0.54	35	40	15
4	*L.punctata*	3	17.4±2.5	0.96±0.57	1	2	-
5	*N.formosa*	13	50.9±13.4	17.9±10.9	3	9	1
6	*A. o. phayrei*	9	61.2±6.2	26.3±8.2	3	6	-
7	*C. vandijki*	1	61	23.08	-	1	-
8	*M. ocellata*	95	15.5±4.8	0.80±0.54	38	47	10
9	*C. fusca*	1	20	1.32	-	1	-
10	*B.baska*	1	58	33.9	-	1	-
11	*T. s. elegans*	78	16.22±6.46	1.19±0.84	25	37	16

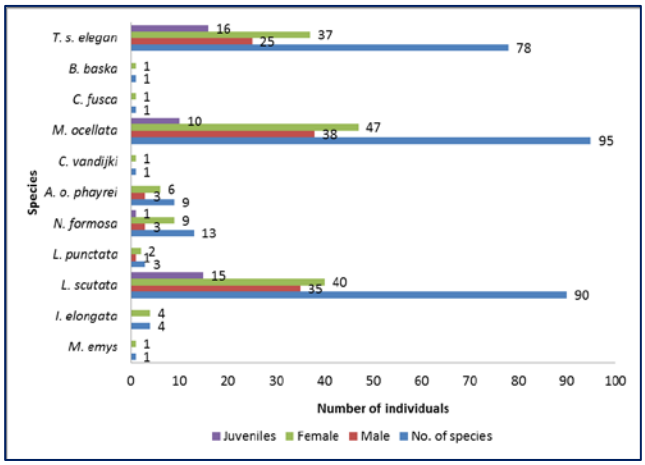


Figure 6 Comparison between the individual numbers of species recorded from different sites

Impacts of Red-eared sliders on the native turtle species

During the study periods, the impacts of the red-eared sliders on native turtles were competition for nesting and basking sites.

Basking turtle observation

According to the survey, the turtles spent most of their time basking between 8:00 and 16:00 hrs. There were 48 photo records for the basking sites during the study times; the number of RES was most abundant than the other native turtle species on the basking area (Table7 and 8, Plate8).

Table 7 Comparison between the numbers of basking native and RES turtle species

Groups	Count	Sum	Average	Variance
M.ocellata	48	141	2.938	19.592
L.scutata	48	214	4.458	18.594
T.s.elegans	48	226	4.708	28.722
Other	48	7	0.1458	0.170

Table 8 Comparative value on the numbers of basking native and RES turtle species

Source of Variation (ANOVA)	SS	Df	MS	F	P-value	F crit
Between Groups	632.625	3	210.875	12.575	1.576	2.653
Within Groups	3152.625	188	16.769			
Total	3785.25	191				

F>Fcrit (12.575>2.653); reject the null hypothesis (null hypothesis H0:µ1= µ2= µ3); significantly differences within groups.

(A) (B) (C)

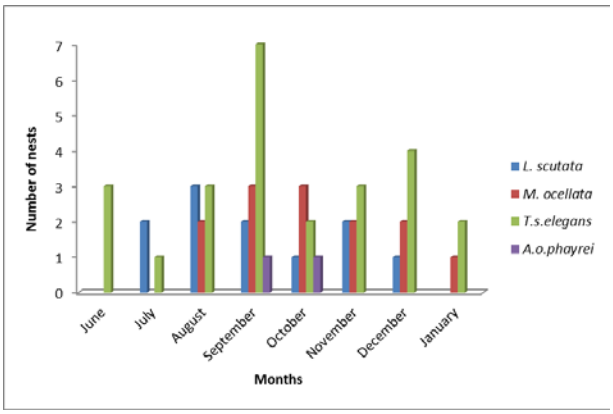
Plate 8 Competition for the basking sites between RES and native species

Nesting turtle observation

Four species of turtles *M. ocellata* (Myanmar eyed turtle), and followed by *L. scutata* (Myanmar flap shell turtle), *A.o.phayrei* (Burmese softshell turtle) and *T.s.elegans* (Red-eared slider turtle) were recorded as egg-laying species and their nests from the nest sites of turtle ponds during the breeding seasons. The nesting season was observed from June 2015 to January 2016 (Fiuger.7). The clutch size of *L.scutata* was 3-12 eggs (5.25 ± 2.19eggs), *M.ocellata* was 2-11 eggs (6.50 ± 4.03eggs), *T.s.elegans* was 2-21 eggs (8.25 ± 5.19eggs) and *A.o.phayrei* was only one egg of a single nest (Table9, Fiuger.7, and Plate9).

Table 9 Comparison between the clutch size of RES and native turtle species

Sr. No	Species	Mean	Std. Dev.	Maximum	Minimum
1	*M. ocellata*	6.5	4.03	11	2
2	*L. scutata*	5.25	2.19	12	3
3	*T. s. elegans*	8.25	5.19	21	2
4	*A. o. phayrei*	1	0	1	1



Fiuger 7 Comparison between the numbers of nest recorded from different months

(A) *T.s.elegans* (B) *L.scutata* (C) *M.ocellata*

Plate 9 Comparison between the nest of RES and native turtle species

Discussion

There are 27 species of native freshwater turtles and tortoises in Myanmar (Kalyar *et al*., 2018), including several species classified as rare and threatened in Myanmar. According to the results, the most population number of *T. s. elegans* (Red-eared slider turtle) was found to be recorded in all temple ponds. Moreover, a large number of hatchling Red-eared sliders were sold at pet shops and there was no monitoring to a higher proportion of RES sales. The recent surveys indicated that the occurrence of RES in these numbers posed a threat to the native turtle populations.

In the present study, a total of 78 individuals RES (6-hatchlings, 10-juveniles, 62-adults) were recorded in the study ponds. Therefore, it can be assumed that the RES populations are successfully reproducing in the temple ponds. Accordingly, the population under study was composed of 21% immature and 79% mature individuals. It is believed this composition reflects a healthy population with enough adults for continuous reproductions.

Species of native turtles and tortoises were also observed during the study periods. Among them, the two critically endangered species *Chitra vandijki* (Myanmar narrow-headed softshell turtle) and *Batagur baska* (Northern mangrove terrapin) were recorded. The most common species were *M. ocellata* (Myanmar eyed turtle) and *L. scutata* (Myanmar flap shell turtle) in all temple ponds. During the study periods, the abundance of RES was common species but the individual number size was smaller than that of the native turtle species *M. ocellata* and *L. scutata.*

RES has several attributes that seem to confer a competitive advantage over locally native turtle species because they mature at a younger age, are more aggressive, have higher fecundity and have a larger adult body size (Scalera, 2006). A range of studies provides evidence that red-eared sliders can compete successfully with native turtles for food, nesting sites and basking sites (Scalera, 2006). Basking sites are a key resource for evaluating the competition between aquatic turtle species because these sites are critical for proper thermoregulation, which directly influences vital physiological parameters like disease control as well as growth and reproductive rates (Ernst and Lovich, 2009).

During the course of study, RES and native turtle species were competition for basking places, because most of the basking sites were a restricted resource in the ponds. Most of the study sites, the turtles were in an overcrowded space with a ratio of 1-2 turtles/m2 and have limited food, basking, and nesting sites. In the present study, the highest population numbers of RES have been recorded in most basking sites.

The sliders usually lay eggs from April to July in their native distribution, and the development of eggs depends on moisture and temperature (Ernst *et al.,* 1994). Females could lay up to six clutches every year, varying 2-30 eggs in a clutch; the incubation period is 59 - 112 days and is extended in low temperatures (Ernst *et al.,* 1994; Bringsøe 2006). During the study periods, nesting occurrence was high from September to December. Differences in clutch size, number, shape, and dimension of eggs between the RES and native turtle species were observed. Comparative analysis of the nesting data, the clutch sizes of RES was larger than that of the native turtle groups. Existing RES in all turtle ponds causes unbalancing the ecology of those ponds because their potential impacts basking and breeding behaviors that cause reduced growth rates, and reproductive rates of native turtle species.

Conclusion

Most of the Red-eared slider turtles occurred in the temple ponds ecosystems throughout in Yangon. Thus, the present study was the first attempt to record and present the current distribution and status of this invasive freshwater turtle. This paper highlights the need for further research to assess the impacts of *T. s. elegans* on native species and proactive efforts to prevent its further spread.

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