

Dietary assessment of Little Egrets (*Egretta garzetta*) by analyzing regurgitated materials during their breeding seasons in Sri Lanka

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ABSTRACT

During the breeding seasons the Little Egrets' feeding grounds become limited to the vicinity of the heronries. Therefore the food availability and their diversity of these areas are important for the survival of offspring. The study was conducted during the breeding seasons from May to September in 2014 and 2015 at five heronries representing different climatic zones in the country (Wet, intermediate and dry) in three districts, Gampaha, Kandy and Anuradhapura in Sri Lanka. Ten fledglings of Little Egrets were randomly caught representing each breeding heronries (n=50) and the regurgitated materials were collected and identified to species level by using standard field guides. A total of 25 faunal species belonging to 5 classes were recorded. Of them, 18 species in year 2014 and 7 new species in 2015 were recorded. Class Pisces had the highest number of species both in year 2014 (13 Nos) & 2015 (11 Nos). These data revealed that the most diversified diet was identified from egrets in Kandy Lake heronry by the values of overall Shannon-Weiner Diversity and Margalef's Indexes for year 2014 and 2015, while birds in Jaffna Junction heronry were recorded as who owned the lowest diversified diet. Presence of diversified habitat types such as tank ecosystem, canals, marshy areas and paddy fields within the foraging area of Little Egrets in Kandy Lake may be the reason for highest diversity. Also two small brooks with unique micro habitats like runs, riffles and pools support the species diversity of aquatic and semi aquatic fauna. Class Pisces is the most species-rich class of faunal species in regurgitated materials of all sites, however Amphibians, Insects, Crustaceans and reptilians also present in the diet of Little Egrets.

KEYWORDS

Little Egrets, Regurgitated materials, Dietary assessment

Introduction

The dietary assessment of birds is mainly achieved by three methods including the analysis of pellets, regurgitated food materials, and contents of the stomach. According to the Carss *et al.*, 1997 there are many drawbacks of all three methods. Using regurgitated samples does not necessitate to it kill the bird. Lewis, 1929, noted that birds regurgitated stomach contents when disturbed. The Kushlan, 1978 report that regurgitation is an anti predatory mechanism, where nestlings make become lighter and thus can quickly move and escape from predators (Owen, 1955; Voisin, 1978).

Regurgitated materials are easily collected from the base of breeding colonies. Wires *et al.*, 2003 observed that use of regurgitated materials was a vital method for the dietary assessment of nestlings in the breeding colonies rather than that of adults.

In this study the diet of Little Egrets (*Egretta garzetta*) was assessed by using regurgitated materials. The foraging behavior, food, and feeding ecology of the Little Egret has been well studied worldwide (Fraser, 1974; Fasola *et al.*, 1981; Hafner

et al., 1982; Hafner & Britton, 1983; Hafner *et al.*, 1986; Kersten *et al.*, 1991; Fasola *et al.*, 1993; Hancock & Kushlan, 1984). There is however no published study available regarding feeding ecology by using regurgitated materials of Little Egret in Sri Lanka.

Little Egrets (*Egretta garzetta*) (Linnaeus 1766) are the smallest of the three 'White Egrets'. It has worldwide distribution. The height of adult little egret is 55–65 cm and wingspan 88–106 cm. Adults normally weight up to 350–550 g. Their bill and legs are black in color, feet are yellow to green color and the body covered with completely white plumage (Hancock & Kushlan, 1984). When reaching the breeding season, the breeding plumage is displayed on nape, lower breast and back as nuptial feathers (Kotagama & Ratnavira, 2010). Their habitats include the shallow areas of lakes, lagoons, rivers, streams, marshy lands and paddy fields. Little Egrets feed mainly on fish, but they also depend on amphibians, small reptiles, some mammals, crustaceans, mollusks, insects, spider and worms (Hancock & Kushlan, 1984). In Sri Lanka Little Egrets are found in wetlands all over the country.

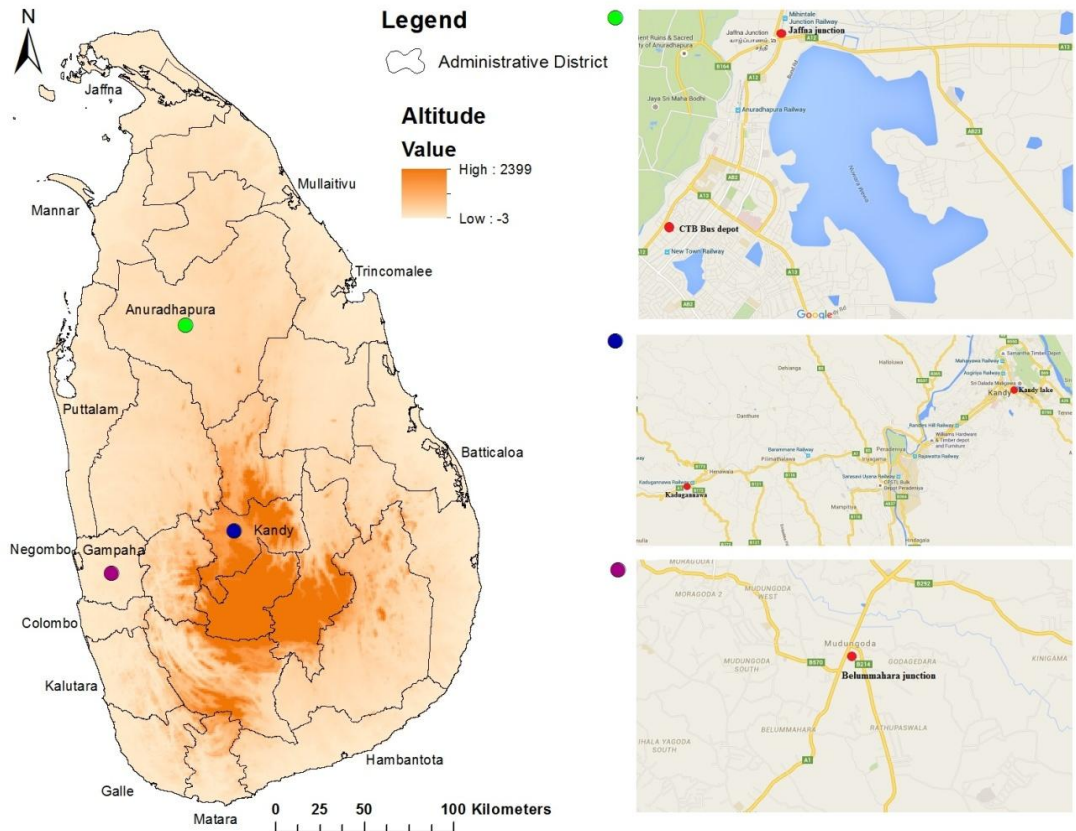


Figure 1. Map showing the study sites.

According to Kotagama and Ratnavira, 2010 they are common in Marshes, paddy-fields, tank edges, mangroves and lagoons all over Sri Lanka. The Harrison and Worfolk, 2011 noted that they are nesting in trees near water during December to May in Sri Lanka.

This study aims at documenting the diet diversity of the Little egrets at five heronries of Sri Lanka. With the recognition of the importance of conservation heronries near to human settlements and their catchment areas of water birds, our assessment of the diet of Little Egrets was undertaken.

Materials and Methods

Study sites

Five heronries representing different climatic zones in the country (Wet, intermediate and dry) were selected from three districts, Gampaha, Kandy and Anuradhapura in Sri Lanka. (Figure1). The sampling heronries were considered. Preliminary survey was justified that the mean foraging area of Little Egrets which was 3-4 km radius from each heronry. Base of this finding five sites were selected which have diversified catchment area within 3-4 km.

Of the selected five sites, the site at Belummahara is at a latitude 7°66'06''N and longitude 80°12'13''E at elevation of 21 m above sea level. Paddy fields, marshy lands and tributaries of two streams (Uruwal oya and Attanagalu oya) are the foraging areas of the heronry. Two sites were selected from Anuradhapura district. These two heronries were the CTB depot site and Jaffna junction site. The CTB depot site is at a latitude 8°32'35''N and longitude 80°39'71'' E at 100 m above mean sea level. The Paddy fields and Malwathu oya are common foraging areas of two sites in Anuradhapura while adults in Jaffna Junction were also foraged in canals of Nuwara wewa. Two other sites were selected from Kandy districts, namely Kandy Lake and Kadugannawa. The Kandy Lake site is at a latitude 7°17'47''N and longitude 80°38'16''E is at 539 m above sea level. It is an ancient tank built in 1807. The main foraging area of egrets was the tank itself with occasional visits to paddy fields within the 3-4 km catchment area. The Kadugannawa heronry was situated at the Yatinuwara depot of Ceylon Tourist Board; it is at a latitude 7°26'N and longitude 80°53' E is at 551 m

above sea level. The Nanu oya and some of paddy fields were the foraging area of Little Egrets.

Sample collection and identification

The study was conducted during the breeding seasons from May 2014 to September 2015. Ten fledglings of Little Egrets were randomly caught representing each breeding heronries and the regurgitated materials were collected. The fledglings regurgitated their last meal when handling (Hanebrink & Denton, 1969). In each year these birds were captured for a toxicology study, for collecting feathers, blood and regurgitated materials. Immediately the collected materials were stored in a cool box with ice cubes and brought to the laboratory. Before preparation of regurgitated materials for metal analysis, they were sorted out as insects, mollusks, fish, amphibians, snakes, lizards, frogs etc. The materials that were easy to identify were only selected as a species and the body parts of insects and crabs, otolith of fishes etc were avoided. By using a field guides of Freshwater Fishes of Sri Lanka (Pethiyagoda, 1991),

Amphibians of Sri Lanka (Dutta & Manamendra-Arachchi, 1996) and Lizards of Sri Lanka (Somaweera & Somaweera, 2009). They were identified as species levels.

Statistical analysis

The relative abundance of species was determined by using Shannon Diversity Index (H') (Shannon & Weaver, 1949) and Species richness was determined by using Margalef's Diversity Index (Magurran, 1988).

Results and Discussion

Species diversity in regurgitated materials

A total of 25 faunal species belonging to 5 classes were recorded (Table 1). Of them 18 species in year 2014 and 7 new species in 2015 were recorded. Class Pisces had the highest number of species both in year 2014 (13 Nos) & 2015 (11 Nos). Figure 2 and 3 show the Class-wise representation of the faunal species recorded in regurgitated materials at five sites.

Table 1. Faunal species in regurgitated materials of Little Egrets observed in the field survey in the five heronries. (JJ- Jaffna Junction, CTB- CTB depot Anuradhapura, BM- Belummahara, KL- Kandy Lake, KDU- Kadugannawa), ° Endemic species,

Class	Species	Number of individuals in study sites										Total Individuals (2014 & 2015)	
		Year-2014					Year-2015						
		JJ	CTB	BM	KL	KDU	JJ	CTB	BM	KL	KDU		
Pisces	<i>Amblypharyngodon melatinnus</i> *	22	42	-	-	-	23	-	-	-	-	-	87
	<i>Anabas testudineus</i> *	-	4	-	-	-	-	-	-	-	-	-	4
	<i>Channa striata</i> *	-	1	3	-	1	2	2	-	4	-	-	13
	<i>Channa punctata</i> *	-	-	7	-	-	-	-	-	-	-	-	7
	<i>Devario malabaricus</i> *	-	-	-	-	29	-	-	-	8	-	-	37
	<i>Esomus thermoicos</i> *	-	-	-	14	-	-	-	-	-	-	-	14
	<i>Glossogobius giuris</i> *	-	-	-	-	-	2	5	-	2	-	-	9
	<i>Lepidocephalichthys thermalis</i> *	-	-	-	-	-	-	-	-	3	-	-	3
	<i>Mystus vittatus</i> *	-	-	5	-	5	-	-	-	4	2	-	16
	<i>Ompok bimaculatus</i> *	-	-	1	-	-	-	-	-	-	-	-	1
	<i>Oriochromis niloticus</i> *	-	-	-	-	-	-	3	-	3	4	-	10
	<i>Puntius dorsalis</i> *	8	14	-	12	2	-	-	-	2	-	-	38
	<i>Dawkinsia singhala</i> *	-	-	-	13	-	-	-	-	5	-	-	18
	<i>Puntius vittatus</i> *	-	-	17	-	-	-	-	-	-	-	-	17
<i>Rasbora dandia</i> *	10	11	-	-	9	5	16	7	3	8	-	69	
<i>Trichropodalism pectoralis</i> *	20	11	2	8	-	3	-	3	2	-	-	49	
Amphibia	<i>Hoplobatrachus spp</i> *	-	-	-	-	-	4	3	-	4	3	-	10
	<i>Zakerana spp</i> *	-	-	-	-	-	-	2	-	-	-	-	2
	<i>Euphyctis hexadactylus</i> *	-	1	-	-	1	-	-	3	3	3	-	11
Insecta	Grasshoppers*	-	-	10	-	8	-	-	3	3	-	-	24
	<i>Gryllotalpa spp</i> *	-	-	-	-	-	-	-	3	11	-	-	14
	Rat tailed maggots*	-	-	-	-	-	-	38	-	-	-	-	38
Crustacea	Freshwater crab*	-	-	4	-	-	-	2	3	2	2	-	13
	Freshwater shrimp*	-	-	-	-	-	23	-	-	-	-	-	23
Reptilia	<i>Lankascincus fallax</i> *°	-	-	-	-	4	-	-	-	-	-	-	4

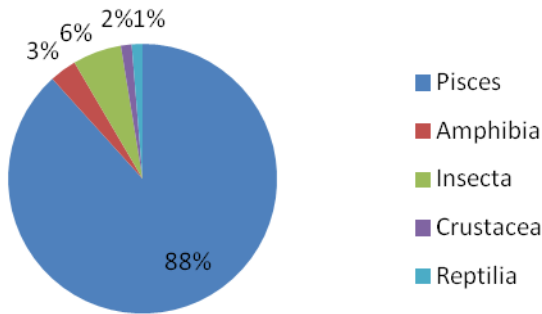


Figure 2. Classes-wise representation of species richness of regurgitated materials in all heronries-2014

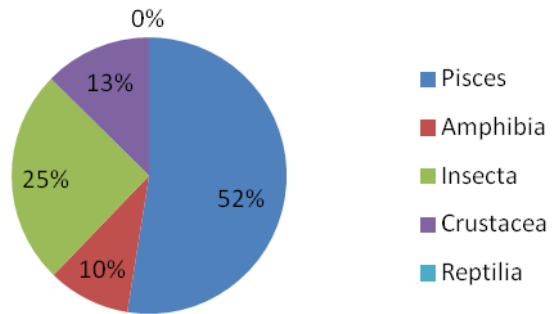


Figure 3. Classes-wise representation of species richness of regurgitated materials in all heronries -2015

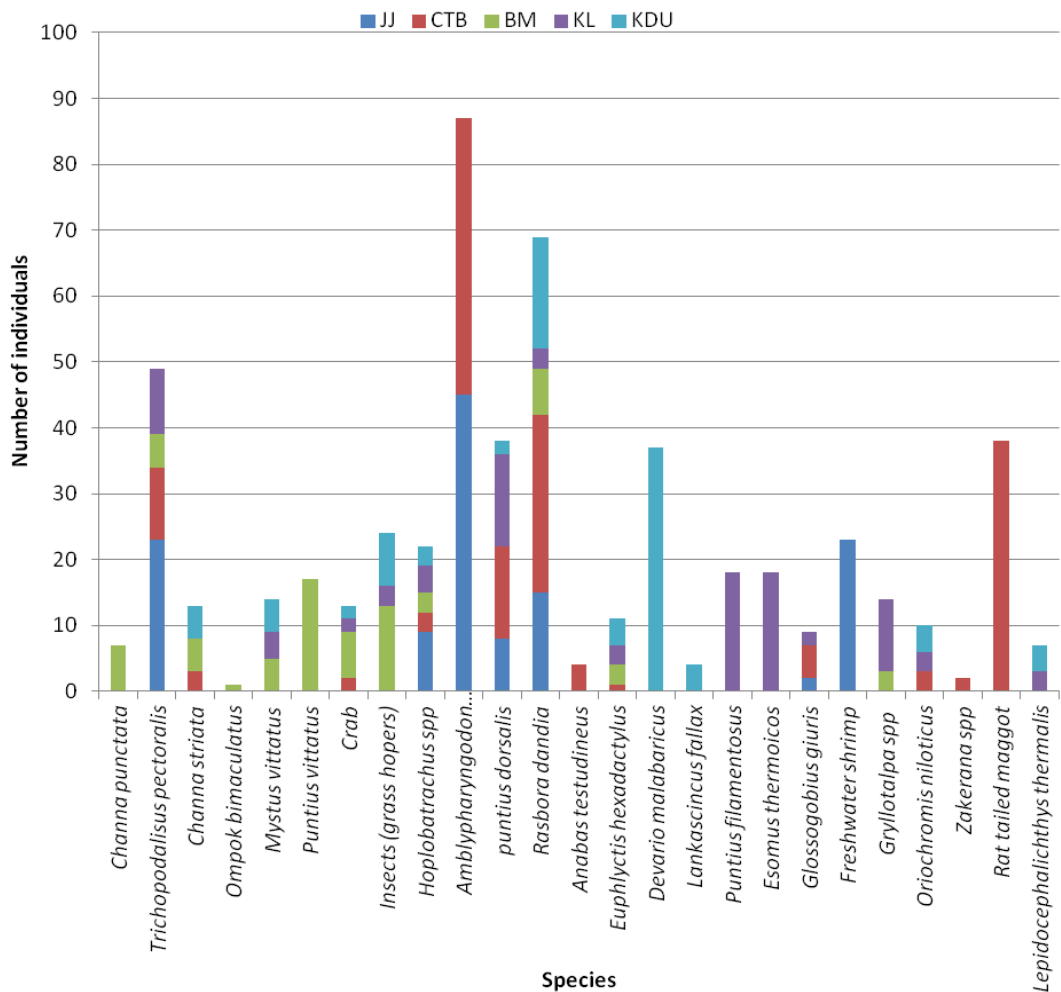


Figure 4: Relative abundance faunal species in regurgitated materials of Little Egrets in year 2014/2015.

Figure 4 shows the relative abundance of faunal species in regurgitated materials of Little egrets in year 2014 & 2015. These data revealed that the regurgitated materials of Little egrets in Kandy Lake

site celebrates the highest species richness (14 Nos). Regurgitated materials of Little egrets in Jaffna Junction site is the poorest in species composition (07 Nos) whereas the regurgitated materials of CTB site

in Anuradhapura, Kadugannawa and Belummahara sites also show high number of faunal species (13, 13 and 12 Nos respectively).

Table 2 shows that the Shannon-Weiner Diversity Index is highest in regurgitated materials of Little Egrets who's nested in Kandy Lake. This was observed both in years 2014 and 2015 which justifies the fact that the overall diversity which includes species richness and relative abundance is highest in the regurgitated materials of egrets in Kandy Lake. Although the Margalef's Index in year 2014 (Table 3) is highest in regurgitated materials of egrets in Belummahara site, the overall Margalef's Index of 2014 & 2015 highest in regurgitated materials of egrets in Kandy Lake. Both diversity indexes showed that the poorest faunal diversity was observed in regurgitated materials of Little Egrets in Jaffna Junction site.

According to the Table 1, it can be conclude that *Channa punctata*, *Ompok bimaculatus* and *Puntius vittatus* were detected only from regurgitated materials from Belummahara site. However *Anabas testudineus* and rat tailed maggots were confined to regurgitated materials of egrets in CTB depot site in Anuradhapura. When consider *Daverio malabaricus*, it was only detected from Kadugannawa site. Further Kandy Lake was populated with *Puntius filamentosus* and *Esomus thermoicos*. The freshwater shrimp that own to class – Crustacea was only detected in regurgitated materials of Little Egrets that collected from Jaffna Junction site Anuradhapura. In the case of *Amblypharyngodon melattinus*, it was only detected in regurgitated materials that were collected from Little Egrets in heronries of Anuradhapura. According to the Mann-Whitney test there were no significant variation of the relative abundance of other (16) species between sites ($p>0.05$).

Table 2. Shannon-Weiner Diversity indices in regurgitated materials that collected from all five sites.

Site	Shannon-Weiner Diversity Index		
	Year-2014	Year-2015	Year-2014&2015
Jaffna Junction, Anuradhapura (JJ)	1.47	1.38	1.67
CTB depot, Anuradhapura	1.42	1.45	2.02
Belummahara, Gampaha	1.90	1.91	2.27
Kandy Lake	1.97	2.41	2.35
Kadugannawa	1.71	1.94	1.95

$H' = - \sum p_i \ln p_i$, H' = Shannon Weiner Diversity Index, P_i = Proportion of i^{th} species in the sample

Table 3. Margalef's indices in regurgitated materials that collected from all five sites

Site	Margalef's Index		
	Year-2014	Year-2015	Year-2014&2015
Jaffna Junction, Anuradhapura (JJ)	2.20	3.41	2.86
CTB depot, Anuradhapura	3.11	4.35	5.47
Belummahara, Gampaha	4.66	5.47	5.84
Kandy Lake	1.79	8.00	6.58
Kadugannawa	3.95	5.41	5.64

$D = (s - 1) / \log_e N$, D = Margalef's Index, S = Number of species found in each habitat, N = Total number

Pollution in the foraging areas of the heronries

The site Belummahara is located at highly urbanised area, which close to the Colombo Kandy main road. From industries, human settlements, vehicle service stations, hotels and other commercial buildings, the pollutants are released to the catchment area of the heronry. The marshy land and paddy fields are fertile with water from tributaries of Uruwal oya and Aththanagalalu oya. Surface runoff water from Colombo Kandy road was added to these tributaries. During the south west monsoon, these marshy lands were flooded and lot of sediments is deposited. Invading marshy areas due to the land filling for development purpose is one of a major threat to the aquatic and semi aquatic fauna in Belummahara. CTB depot site was an urbanized area. It is so closed to the A5 Anuradhapura Puttalam highway. The most of birds are foraging in paddy fields, Malwathu oya and its tributaries. Pollutants enter these wetlands form human settlements, vehicle service stations, hotels and also from the surface runoff from highways. Jaffna Junction also an urbanised area like CTB depot. This site was so closed to the Anuradhapura Jaffna highway. Surrounding paddy fields, Malwathu oya and canals of Nuwara wewa are the foraging areas of egrets. Due to the anthropogenic activities pollutants enter these foraging areas. Kadugannawa is also an urbanised area and the heronry was situated at the Yatinuwara depot of Ceylon tourist board. The Nanuoya and some of paddy fields are the foraging areas of egrets. Pollutants enter these areas through hotels, service stations and other human settlements. Lot of pollutants enters to the Kandy Lake from small scale and large scale hotels which are around the lake. Waste water directly added to the tank from these hotels and other human settlements through municipal canals. Several agricultural practices are noted in the immediate vicinity of all sites. According to the observations, agro chemicals are generally used in the paddy fields within catchment areas of all

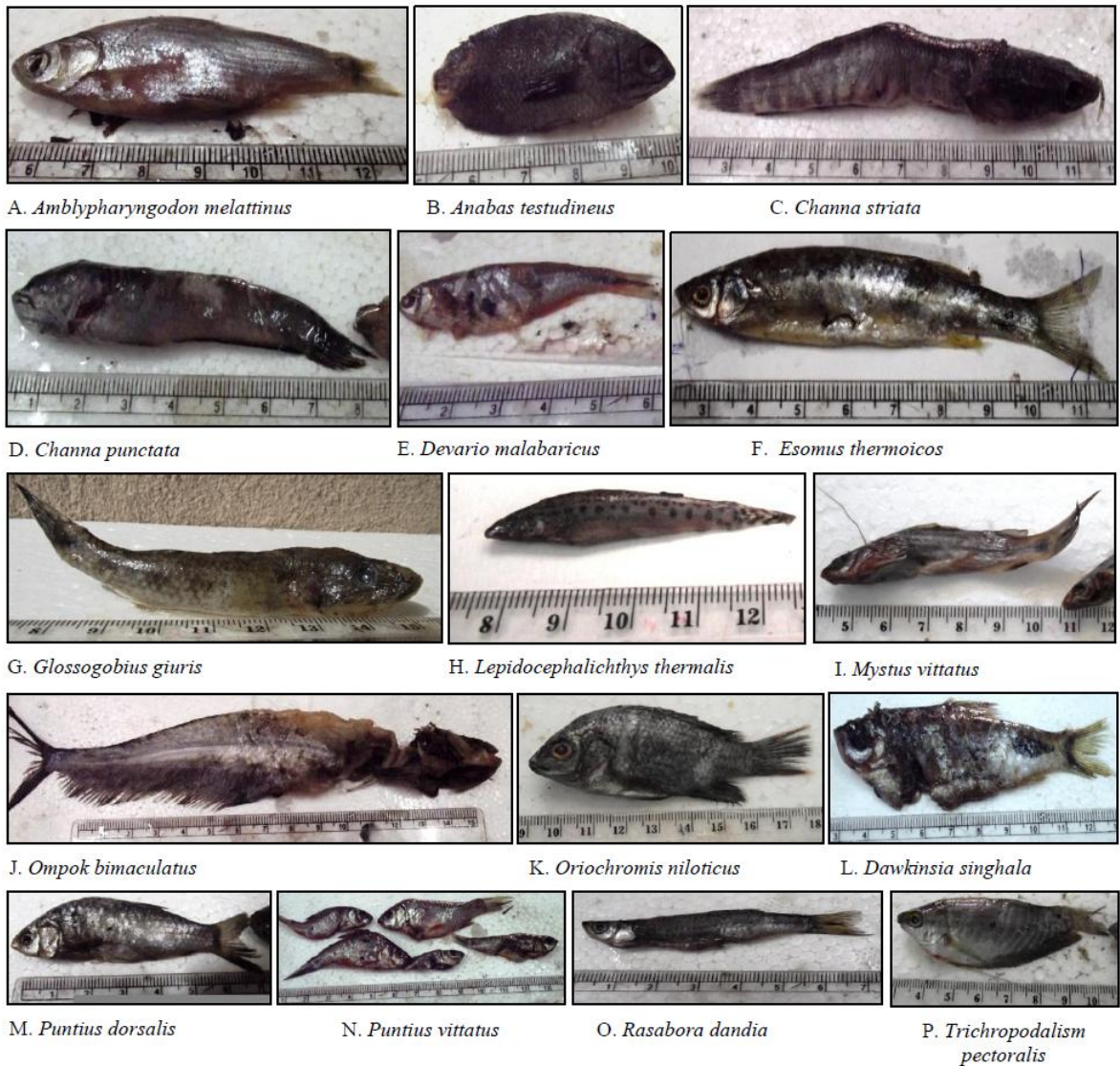


Figure 5. Faunal species (Fish) in regurgitated materials of Little Egrets.

sites. Although these five sites are in different climatic zones, the sources of pollution are much as same.

Among the five heronries concerned, the regurgitated materials from heronry in Kandy Lake showed highest species diversity. Presence of diversified habitat types such as tank ecosystem, canals, marshy areas and paddy fields within the foraging area of Little egrets in Kandy Lake may be the reason for highest diversity. Also two small perennial brooks (Silva, 2010) with unique micro habitats like runs, riffles and pools support the species diversity of aquatic and semi aquatic fauna.

Class Pisces is the most species-rich class of faunal species in regurgitated materials of all sites. According to the von Blotzheim *et al.* (1966), Ali *et al.* (1987) and Hancock and Kushlan (1984), the main prey item of Little egrets is fish, but amphibians, small reptiles, crustaceans, insects and worms are also eaten. The variation of the prey items in this study is high (5 classes), Kazantzidis and Goutner (1996) reported that the Little egrets have high variation in their diet because they are foraging in diverse feeding habitats. In this study all most all sites were populated with diversify foraging habitats, including wetlands such as streams, tanks, canals, paddy fields and marshy lands.

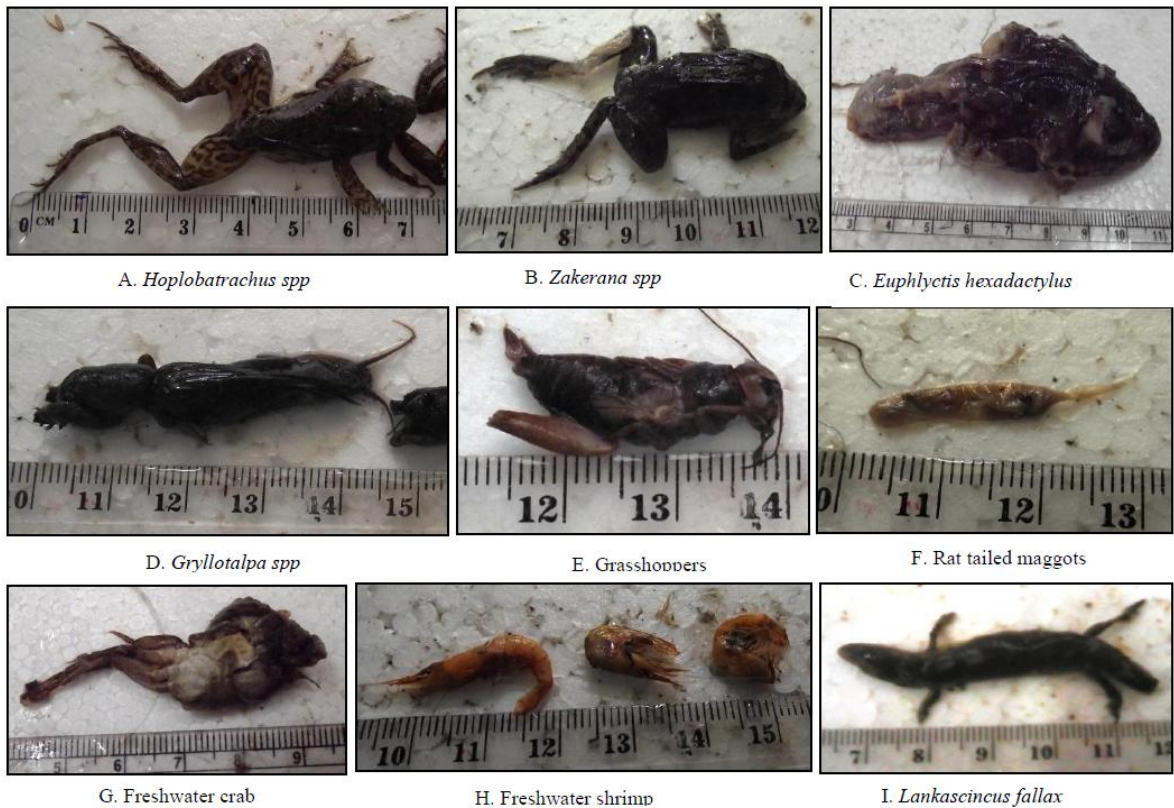


Figure 6. Faunal species (amphibians, insects, crustaceans and reptiles) in regurgitated materials of Little Egrets.

Among the 25 faunal species that were detected in this study, 9 were only restricted to a one particular heronry. The *Channa punctata* was only encountered in Belummahara site. According to the Pethiyagoda, (1991) the preferable habitat of this species is marshes, paddy fields and swamps in wet zone Sri Lanka, that is common in foraging areas of Belummahara heronry. *Ompok bimaculatus* was only detected in regurgitated materials from Belummahara, but only one individual in 2014 and not in 2015. However Amarasinghe and Pushpalatha (2012) reported that the *Ompok bimaculatus* is a common fish in Uruwal oya which is one of the foraging stream of egrets in Belummahara heronry. Also *Puntius vittatus* was only detected in regurgitated materials in Little Egrets of Belummahara heronry. According to the Pethiyagoda (1991), the preferable habitat of this species is open water with muddy substrate, that is common in the vicinity of the Belummahara heronry. However according to the distribution map of the *Puntius vittatus*, they should be in other heronries too. When consider the *Amblypharyngodon melattinus*, It was only detected in Jaffna Junction and CTB depot heronries in Anuradhapura district, which was

restricted to the dry zone. This is proved by Pethiyagoda (1991) were he shows that this species most common in dry zone tanks. The fish species, *Devario malabaricus*, *Anabas testudineus* and *Esomus therococ* were only detected from the heronries in Kadugunnawa, CTB depot Anuradhapura and Kandy Lake respectively. But according to the Pethiyagoda (1991), these species are be found in other sites too. However the abundance level of *Devario malabaricus* was very high in regurgitated materials of Kadugannawa site.

Among the other classes detected in regurgitated materials, Rat tailed maggots (Class - Insects) were only in regurgitated materials of Little egrets from CTB depot site in Anuradhapura. According to the observations, the adult egrets are foraging in canals near the CTB depot site. Those canals contain polluted water which is an ideal habitat for Rat tailed maggots (Aguilera *et al.*, 1999). The only reptilian species, (*Lankascincus fallax*) was detected in regurgitated materials of Little egrets in Kadugannawa site. According to Somaweera and Somaweera, 2009, this endemic species is common in all zones from sea level to 1000 m, among leaf litter,

short grass, roots and under large stones. Although the observations show that the adults of Little Egrets forage in paddy fields and Nanu oya stream within the vicinity of Kadugannawa heronry, above findings indicate that they forage in all available habitats within the vicinity of a heronry. Kazantzidis and Goutner (1996) also reported that Little egrets forage in all available feeding habitats.

As only 10 birds were sampled from a site, the probability of all occupied faunal food species being present in the regurgitated materials is low. The birds regurgitate only their last meal while handling (Hanebrink & Denton, 1969), thus limiting the food in the regurgitate. Further, these regurgitated samples represent the random catching effect of the adults Little Egrets, because they are an opportunistic hunters (Kushlan & Hancock, 2005).

Recommendation of conservation actions for the foraging areas of heronries

A total 25 species of food items were present in the regurgitates of all five heronries (16- Fishes, 3- Amphibians, 1-Skink, 2- Crustaceans and 3- Insects species) where one species is endemic. The catchment areas of these heronries are diverse with many wetlands, such as marshy lands, streams, tanks, canals and paddy fields which may harbor a many faunal species that fulfill the diet of nestlings of Little Egrets. However these habitats are getting polluted due to many anthropogenic activities, therefore conservation strategies should be commence with collaboration of government agencies, University researchers, private sectors and local authorities. Further these five heronries are populated with other wetland birds, like Great Egret (*Ardea alba*) and other heron species like Night Heron (*Nycticorax nycticorax*), Purple Heron (*Ardea purpurea*), Pond Heron (*Ardeola grayii*) and Grey Heron (*Ardea cinerea*) and also many cormorant species are nesting in these heronries. Therefore, protection and management of these invaluable ecosystems are a vital activity.

Conclusion

Use of regurgitated materials for the dietary assessments, is a least harmful method, as it does not require to kill birds. It gives a relatively good picture about the food variation of the Little egrets and the abundance of food species within the vicinity of the heronry. According to the finding of this study Little Egrets are foraging in all available habitats within the vicinity of the heronry (3-4 km) during their breeding season for feed their nestlings and fledglings.

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