

Food preference of pygmy hippopotamus (*Choeropsis liberiensis* Morton, 1849) in the Tiwai Island edge communities, South-Eastern Sierra Leone

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Accepted on November 22, 2022.

Abstract

The pygmy hippopotamus (*Choeropsis liberiensis*) is smaller than the common hippopotamus (*Hippopotamus amphibius*), weighing 180–270 kg and standing 70–80 cm tall at the shoulders. It is less aquatic than the common hippo and retains some terrestrial locomotion patterns. The populations of the *C. liberiensis* are faced with severe hunting pressure and increased habitat fragmentation; sequel to these, the species is listed as “Endangered” on the IUCN Red List of Threatened Species. Thus, it demands very high conservation attention. A study on *C. liberiensis* food preferences will help increase the prospects of safeguarding these endemic and highly threatened species in West Africa. However, there is a paucity of information on the food preference of *Choeropsis liberiensis*. Therefore, this study aimed to assess food items consumed by *C. liberiensis*, as well as the availability of these food items at Tiwai Island edge communities in South-Eastern Sierra Leone. Seven communities: Mapoma, Segbema, Geima, Kabama, Jenneh, Nyanahun, and Booma, on both sides of the island were purposively sampled based on the study’s objectives. The data were collected using a structured questionnaire, oral interview, and reconnaissance surveys. The data were summarized using descriptive statistics, and a one-way ANOVA was used to determine the differences in the two seasons at $P < 0.01$. Ten plant species (*Ipomoea malba*, *Ipomoea batatas*, *Theobroma cacao*, *Pteridium aquilinum*, *Cucurbita pepo*, *Urena* sp., *Digitaria eriantha*, *Hibiscus esculentus*, *Corchorus oltoruis* and *Geophila obvallata*) were consumed by the animal species. The plants eaten by Hippos are mostly herbaceous plants reliant on either anthropogenic or natural breaks in the forest canopy, except for cacao plants. Most of the wild plants mentioned as being consumed are available all year. Krain-karin, sweet potato, and okra are grown in gardens all year. Hippos eat mostly slimy plants. Most species have gone extinct, which is attributed to several anthropogenic factors. Therefore, conservation education programmes focusing on *C. liberiensis* and other notable wildlife species should be executed in communities surrounding Tiwai Island to protect these animal species.

Keywords: *Choeropsis liberiensis*, Food preference, Tiwai Island, Wildlife conservation.

Introduction

The pygmy hippopotamus (*Choeropsis liberiensis*) is one of the rarest wildlife species to be found in and around Tiwai, Sierra Leone. The species is considerably smaller than the common hippopotamus (*Hippopotamus amphibius*), weighing 180–270 kg and with a shoulder height of 70–80 cm. It has proportionately longer limbs and neck and a smaller head (Eltringham, 1999).

The species is less aquatic than the common hippo and has maintained some terrestrial patterns of locomotion (Eltringham, 1999; Fisher *et al.*, 2007). The *C. liberiensis* has a forward-sloping body and only moderately webbed toes, which are advantageous for moving through the dense vegetation of swamps, forests, and watersides (Robinson, 1970). A 1979 survey report on the population of *C. liberiensis* concluded that ‘there are approximately hundreds of the animals in the country (Teleki and Baldwin, 1981). The estimate from the ‘International Pygmy Hippo Conservation Strategy Planning Workshop’ in Liberia in 2010 was approximately 150 individuals in the Gola Forest and the Moa river islands, including Tiwai (Mallon *et al.*, 2011). *C. liberiensis* is listed as endangered on the IUCN Red List of Threatened Species (www.iucnredlist.org 2012). The wild *C. liberiensis* has a restricted range in the Upper Guinea forest region of West Africa, where it is found in only four countries - Liberia, Côte d’Ivoire, Guinea, and Sierra Leone, as shown in Figure 1 (Collen *et al.*, 2011). In Sierra Leone, its presence is confirmed in the Gola Rainforest National Park, Tiwai Island Wildlife Sanctuary, the base of Loma Mountain National Park, and along the Moa River almost 50 km from Tolubu in the north to Tossor in the south on islands with unconfirmed reports as far south as Mambo village only 20 km from the coast. A recent report of *C. liberiensis* along the Seli River close to Kafogo on the road to Kabala, an unprotected area, offers some hope that there may be other small populations elsewhere in the country (Mallon *et al.*, 2010). Largely elusive and nocturnal, it is one of only two extant species in the Family Hippopotamidae. The other is a larger species of hippo, the common Hippopotamus; a distinct subspecies *Choeropsis liberiensis heslopi*, is assumed to be already extinct (Mallon *et al.*, 2011).

The *C. liberiensis* displays many terrestrial adaptations; however, similar to the larger species of hippo, it is semi-aquatic and relies on proximity to water to keep its skin moisturized and its body temperature cool. Behaviours, including mating and giving birth, may occur in water or on land with one calf, rarely twins. Mothers give birth in shallow water pools and visit their offspring only a few times daily for suckling. The *C. liberiensis* is herbivorous, although there are previous records of them eating fish from traps in Sierra Leone. In the wild, *C. liberiensis* feed on ferns, leaves, grasses, herbs, stems, and fallen fruits and crops, such as cassava and young rice shoots (Robinson, 1970; Eltringham, 1999). *C. liberiensis* usually feed between mid-afternoon and midnight (Robinson, 1981, Eltringham, 1999). The behavior of the *C. liberiensis* differs from that of the common hippopotamus in many ways. While the common hippopotamus is gregarious, *C. liberiensis* live either alone or in small groups, typically a mated pair or a mother and calf. *C. liberiensis* tend to ignore each other rather than fight when they meet. Field studies have estimated that the male *C. liberiensis* range from 1.85 square kilometers (460 acres), while the female is from 0.4 to 0.6 square kilometers (99–150 acres) (Kingdon, 1997).

A rare, elusive, and nocturnal forest creature, the *C. liberiensis* is a difficult animal to study in the wild. The *C. liberiensis* were unknown outside West Africa until the 19th century (Mallon *et al.*, 2011). Introduced to zoos in the early 20th century, they breed well in captivity, and the vast majority of research is derived from zoo specimens. The survival of the species in captivity is more assured than in the wild; the IUCN estimates that there are fewer than 3,000 *C. liberiensis* remaining in the wild (IUCN Hippo Specialist Group, 2008). *C. liberiensis* are primarily threatened by loss of habitat, as forests are fragmented and converted to farmland, and are also vulnerable to poaching and hunting. A study on the *C. Liberiensis* food preference at Tiwai Island Sanctuary will help increase the prospects for safeguarding this endemic and endangered species in West Africa and establish a robust baseline for future conservation efforts. Studying the season in which *C. liberiensis* food is available is also necessary because foods for its survival are symbolic of the overall conservation dilemma in the Upper Guinea

ecosystem. However, there is a dearth of information on the food preference of *Choeropsis liberiensis*. Therefore, this study aimed to assess the foods consumed by *C. liberiensis*, the areas, and the seasons these foods are available.

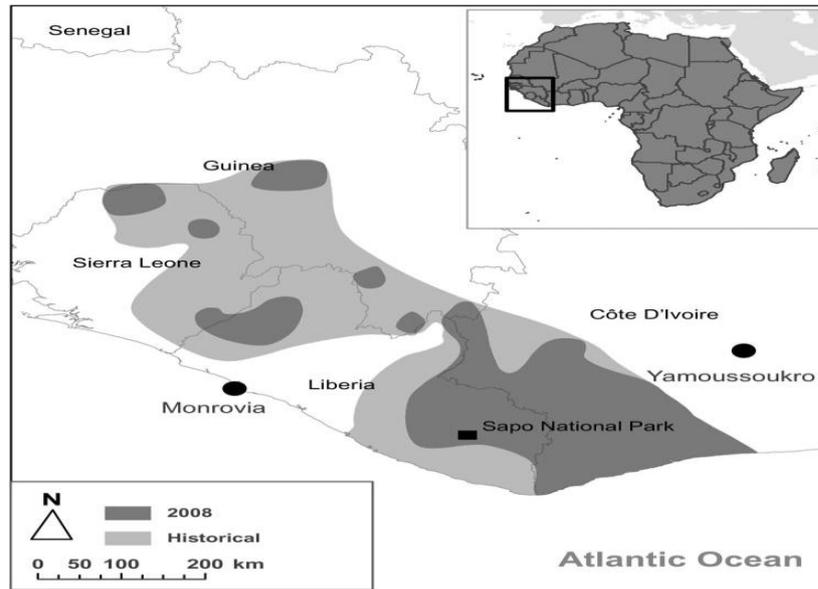


Figure 1. Map showing Distribution of Pygmy Hippopotamus in West Africa
Adapted from Collen et al., 2011

Materials and Methods

The study was conducted at Tiwai Island, located in the Upper Guinea Tropical Rainforest in south-eastern Sierra Leone, approximately 300 km from the capital city, Freetown, 15 km from Potoru, and 30 km from the Liberian border. Tiwai Island is an inland rainforest island in the Moa River, approximately 12 km² (1,200 hectares) in size, located between latitude 7° 30' and 7° 34' N and longitude 11° 20' and 11° 21' W (see figure 2: Office of Tourism and Cultural Affairs, Sierra Leone, 2012). Tiwai, in the Mende language, means big island. It is located on the edge of the Eastern Province, approximately a town from the sanctuary. In the late 1970s, the island was recognized as a unique biosphere for wildlife conservation, and ecological research began on Tiwai island in the early 1980s (Oates, 1999). It is nationally the first community conservation program. Tiwai is managed by the Tiwai Island Administrative Committee (TIAC), representing communities, government, universities, and conservation organizations. The Guinean Forests Biodiversity Hotspot, designated by Conservation International (CI), is home to approximately 9,000 vascular plant species, 785 bird species, 320 mammal species, 425 herptiles, and 510 freshwater fish. Of these species, substantial percentages are endemic, ranging from 20% of plants to 35% of freshwater fishes (Oates, 1999). Tiwai is a humid tropical lowland ecosystem where rainfall can exceed 4,000 mm yearly in some places. It is an inland island in the Moa River, which flows from the highlands of Guinea southwest into the Southern Province of Sierra Leone (Oates, 1999).



Figure 2. Map of Sierra Leone showing the Study Area. Adapted from Collen et al, (2011).

A purposive sampling technique was employed to select seven communities (Mapoma, Segbema, Geima, Kabama, Jenneh, Nyanahun, and Booma) on both sides of the island based on the objectives of the study. The data were collected using a structured questionnaire, oral interview, and reconnaissance surveys. The methodology was adapted from that developed by Zoological Society of London (2010) for surveys of hippos in Loma to consider the emphasis on food requirements and preferences, which was the focus of this study. Structured questionnaires (see Appendix 1) based on the study's objectives were distributed in seven communities on both sides of the island (see figure 3). Three of the communities; Mapoma, Segbema, and Geima, are in Baoma-Koya chiefdom in Kenema District, Eastern Province of the country, and four of the communities; Kabama, Jenneh, Nyanahun, and Booma, in Barrie Chiefdom, Pujehun District, Southern Province of Sierra Leone. In each community, respondents were randomly selected, making a total of 50 completed interviewees. The interviewees were comprised of farmers, fishermen, and past hunters. The village's name, Global Positioning System (GPS) location, date, and time of administering the questionnaires were recorded at each village. Reconnaissance surveys were also conducted along suspected *C. liberiensis* trails, rivers, and streams, assessing and recording *C. liberiensis* signs, including dung, footprints, and feeding sites. Additionally, any plant observed to be fed on by *C. liberiensis* was photographed, identified, and GPS coordinates were taken. In cases where it was impossible to identify the correct name of the plant specimens, they were collected and taken to the National Herbarium at Njala Campus for later identification. The data were pooled and summarized using descriptive statistics, and a One- way ANOVA was used to determine the differences in the two seasons at $P < 0.01$.

Results and Discussion

Overall, 50 respondents in seven communities around Tiwai Island were randomly interviewed using a structured questionnaire. In total, 50 questionnaires were completed during this study from April to May 2017. One-way ANOVA shows no statistically significant difference between the communities regarding the number of positive and negative responses ($f = 0.255$, $df = 13$, $P > 0.05$). Eleven respondents in four communities (Kambama, Nyanahun Booma, and Geima) stated that they had seen at least once a *C. liberiensis* with a calf. In contrast, none of

the respondents in Jenneh Mapoma and Segbema indicated that they had seen a *C. liberiensis* accompanied by a calf.



Figure 3. Map Showing Locations of Respondents.

A one-way ANOVA shows that although respondents were twice as likely to see an animal without a calf, the difference was not statistically significant ($F = 4.22$, $P = 0.062$, $df = 13$). The number of sightings in the morning was significantly greater than that in the evening (one-way ANOVA $P < 0.01$, $F = 17.3$, Total $df = 13$). Out of the 50 respondents interviewed in seven communities around Tiwai Island, 24 of them stated that *C. liberiensis* are likely to be seen in the early morning hours. In contrast, nine stated that *C. liberiensis* is likely to be seen at night. Seventeen (17) respondents randomly interviewed in the seven communities stated that they had no idea about the *C. liberiensis*. Despite difficult access in the wet season, the number of observations was not significantly different between the two seasons (One-way ANOVA, $P > 0.05$, $F = 0.842$, Total $df = 13$). Fourteen respondents of the targeted communities indicated that *C. liberiensis* are seen in the wet season, except in Kambama, where all respondents interviewed stated that they have not seen hippos in the wet season. Nineteen randomly interviewed respondents in all study areas stated that they were more likely to be seen in the dry season, and 17 of the respondents stated that they had no idea when they would be seen. One-way ANOVA shows no statistically significant difference indicating that those that believe that hippos are destructive are matched by those who do not believe they are destructive. Seventeen respondents contacted in the study area during this study stated that *C. liberiensis* were destroying their crops except for Segbema, where respondents registered no evidence of destruction of their crops. Sixteen respondents across the study areas indicated that Hippos are destructive to their crops. Moreover, 17 respondents stated that they have no idea about the destructiveness of *C. liberiensis*.

Table 1: Plants Reported as being Eaten by *C. liberiensis*

S/N	Mende Name	English/Krio Name	Scientific Name	Cultivated Wild	or Edible to people
1	Ndogboyolaa	Moonflower	<i>Ipomoea alba</i>	Wild	No
2	Njolaa	Sweet potato	<i>Ipomoea batatas</i>	Cultivated	Yes
3	Cacaowii	Cocoa	<i>Theobroma cacao</i>	Cultivated	Yes
4	Gbuhuin	Bracken	<i>Pteridium aquilinum</i>	Wild	Yes
5	Towae	Pumpkin	<i>Cucurbita pepo</i>	Cultivated	Yes
6	Kpɔlorhun	Caesar weed	<i>Urena sp.</i>	Wild	Yes
7	Kpetee	Pangola grass	<i>Digitaria eriantha</i>	Wild	No
8	Bondea	Okra	<i>Hibiscus esculentus</i>	Cultivated	Yes
9	Ngegee	Krainkrain	<i>Corchorus olitorius</i>	Cultivated	Yes
10	Kwaawolie	Monkey –tail	<i>Geophila obvallata</i>	Wild	No

During this study, 10 different plant species were reported to be frequently consumed by *C. liberiensis* in this area. Two of these plants, *Ipomoea alba* and *Ipomoea batatas*, belong to the Family Convolvulaceae. The remaining eight species (*Theobroma cacao*, *Pteridium aquilinum*, *Cucurbita pepo*, *Urena sp.*, *Digitaria eriantha*, *Hibiscus esculentus*, *Corchorusolitorius*, and *Geophilaobvallata*) belong to different families. Five of these plants are cultivated plants (*Corchorusolitorius*, *Hibiscus esculentus*, *Cucurbita pepo*, *Ipomoea batatas*, and *Theobroma cacao*). Simultaneously, the other five are wildy grown (*Geophila obvallata*, *Pteridium aquilinum*, *Urena sp.*, *Digitaria eriantha*, and *Ipomoea alba*) (Table 1).

Characteristics of Plant Species Preferred by *C. liberiensis*

Scientific Name: *Ipomoea alba*

Description: Sometimes called the tropical white morning glory or moonflower in English/Krio (but not to be confused with the other species also called moonflower). The Mende name Ndogboyolaa translates approximately as ‘‘potato leaf in the bush’’ (see Figure 4).

Growth Form: Perennial, herbaceous liana growing to a height of 5–30 m tall with twining stems.

Leaf: Entire or three-lobed, 5–15 cm long, with a 5–20-cm long stem.

Flowers: fragrant, white, or pink, and large, 8–14 cm in diameter. The flowers are larger than the more common sweet potato and, unlike sweet potatoes, open in the evening and last through the night.

Fruit: inconspicuous.

Habitat: river banks and wet areas.

Origin: introduced - native range: tropical and subtropical America



Figure 4: *Ipomoea alba*
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Scientific Name: *Ipomoea batatas*

Description: It is called in English ‘‘Sweet Potato’’ and in Krio ‘‘peteteh leaf’’ the Mende name is njolaa (see Figure 5).

Growth Form: a short-lived creeping ‘‘vine’’ (known locally as ‘‘rope’’). Always propagated from ‘‘slips’’ (20–30 cm long lengths of the stem).

Leaf: very varied in shape from simple ‘‘heart shape’’ to deeply incised palmate.

The leaves are less bitter than most greens and form one of the most common dishes in Sierra Leone. Some cultivars are grown just for the leaves (for sale), but most are for dual purposes of the tubers and leaves

Flowers: white to the mauve trumpet shape.

Fruit: No fruit.

Habitat: primarily seen in cultivation, grown in the uplands in the wet season and swamps (on heaps) in the dry season.

Origin: now naturalized (introduced many hundreds of years ago).



Figure 5: *Ipomoea batatas*
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Scientific Name: *Theobroma cocoa*

Description: it is one of the most important tropical export crops and one of the few export crops grown in Sierra Leone. It is only economic in regions with high rainfall (short dry season) (see Figure 6).

Growth Form: a small evergreen tree approximately 8 m tall.

Leaf: approximately 20 cm long, oblong-obovate with drip tip (acuminate). Leaf edge (margin) entire, without teeth or lobes.

Flowers: borne in clusters on branches and trunk (cauliferous), pinkish-white in color, small (1-cm diameter), petals slender and pointed, curving back over the flower structure.



Figure 6: *Theobroma cocoa*
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Fruit: pods up to 30 cm long, yellow, brown, and even purple, usually with 10 ribs. Hippos eat this part of the plant. Seeds embedded in slimy (mucilaginous) pulp.

Habitat: usually grown in plantations under shade trees, sometimes mixed with coffee and other tree crops.

Origin: native to the deep tropical native regions of Central and South America

Scientific Name: *Pteridium aquilinum*

Description: usually known in English as bracken and in Mende as *gbuhuin*. It is deemed a troublesome weed in rice farms (see Figure 7).

Growth Form: a large fern 1–3 m (3–10 ft) tall; the main stem is approximately 1 cm (0.4 in) in diameter at the base.

Leaf: fronds are roughly triangular, and young leaves emerge as straight stems with a curled top that unfolds as the leaf grows.

Flowers: a non-flowering plant

Fruit: none.

Habitat: mainly grows along forest clearings and swamp edges.

Origin: common in temperate and tropical countries, pan-global tropical and sub-tropical regions.



Figure 7: *Pteridium aquilinum*
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Scientific Name: *Cucurbita pepo* (= *Cucurbita moschata*)

Description: known in English and Krio as “Pumpkin” (note in “American” English, it would be more normal to term it a “squash”), and it is known in Mende as “*Towae*.” The pumpkins in Sierra Leone may belong, botanically, to *Cucurbita moschata* (see Figure 8).

Growth Form: pumpkin plants are creeping herbs approximately 10 m. in length. Stems are hairy, grooved, and hollow inside. Stems may produce roots where they touch the bare ground.

Leaf: are cordate lobed. Otherwise, they are broad and round.

Flowers: pumpkins have separate male and female flowers, with the male flowers appearing first. One or 2 weeks after they appear, the female flowers form and begin to open. The color appears light yellow or creamy.

Fruit: Mature Pumpkin fruits vary in shape and color according to the different varieties and sometimes can weigh up to 30 kg; however, fruit in Sierra Leone is usually less than 5 kg. Colour varies from grey/pale yellow to dark green; sometimes, striped, orange-coloured fruits are rarely seen. Mature fruits are smooth and slightly ribbed skin and vary in shape from flattened spheres through the round to elongated, occasionally seen with a distinct “neck.” In Sierra Leone, mature fruits are prepared as sauces and served with rice. A very useful “hungry season” crop and a good source of Vitamin A; there is considerable research on using pumpkin seed oil as a medicine. There is often conflict between farmers and hippos that frequently damage the rice crop while they are hunting for pumpkins.

Habitat: mostly on warm, fertile soils, up to land.

Origin: native to North America



Figure 8: *Cucurbita pepo* (= *Cucurbita moschata*)
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Scientific Name: *Urena* spp.

Description: Usually called caesar weed in English, in Mende named *kpolorhun* (see Figure 9).

Growth Form: grows up to 10 ft in height, it is single stalked, with free-branching stems that comprise a bushy appearance. Considered an invasive weed in some other countries (e.g., Florida).

Leaf: are palmately lobed, pubescent with stellate hairs, and about 4–8 cm long. Some leaves are smooth on the surface and are eaten by some tribes in Sierra Leone, particularly the Mendes; the raw leaves are pounded and cooked as a source that appears slippery and is eaten with rice, and foofoo.

Flowers: borne in axillary clusters, pinkish-violet, approximately 1 cm across.

Fruit: pubescent with hooked bristles or barbs that cling to clothing or fur;

Habitat: found on low moist lands, mostly swamp and forest edges.

Origin: native to India and tropical Asia



Figure 9: *Urena* spp
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Scientific Name: *Digitaria eriantha*

Description: it is a grass that is sometimes very tough, which makes it resistant to any weather type or condition (see Figure 10).

Growth Form: this grass grows a dense tussock with extended stolons, which are covered with hair or without hair. Each grass, erect or ascending, is between 35 and 180 cm tall.

Leaf: the leaves are densely hairy, and very few appear smooth. The leaves are blade-like in structure and are typically 5–60 cm long and 2–14 mm wide. *C. liberiensis* appreciate this grass, especially during the plant's vegetative stage, when the leaves appear fresh and palatable. Domesticated animals also feed on this grass as forage.

Fruit: this grass thrives in warm, moist environments where it will generally proliferate; therefore, it is seen in many humid subtropical and tropical countries.

Habitat: native to Africa.

Origin: native to Africa



Figure 10: *Digitaria eriantha*
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Scientific Name: *Hibiscus esculentus*

Description: usually called “Bondea” in Mende, and Okra or “Ladies finger” in English (see Figure11).

Growth Form: traditional varieties grow on a sparsely branching stem to 2 or 3 meters, recently short duration varieties (“40-day Okra”) have been introduced that only grow to 1 m.

Leaf: leaves are 10–20 cm (3.9–7.9 in) long and broad. The leaves and fruits are popular sources in Sierra Leone, prepared and served with rice and foofoo (traditional food made from cassava).

Flowers: 4–8 cm (1.6–3.1 in) in diameter, with five white to yellow petals, often with a red or purple spot at the base of each petal.

Fruit: a capsule-like structure up to 18 cm (7.1 in) long and contains numerous seeds when opening. Some fruits are green while others are red; however, they remain green and slimy when cooked. *C. liberiensis* disturb the farmers by eating the young fruits and leaves of the crop.

Habitat: mostly well-drained loam soils, and found in temperate climates\countries.

Origin: it is disputed, with supporters of West Africa, Ethiopian, and South Asia, but now cultivated, in tropical, subtropical, and warm temperate regions around the world



Figure 11: *Hibiscus esculentus*
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Scientific Name: *Corchorus olitorui*

Description: usually known in English as Krain Krain or “Crain Crain” and in Mende it is *Ngegee* (see Figure 12).

Growth Form: usually an annual herb, it is harvested when 30 or 40 cm tall but can reach up to 2 or even 4 m if left.

Leaf: alternate approximately 5–15 cm long with an acuminate tip and a lobed margin. Leaves are consumed in various countries worldwide. In Sierra Leone, it is cooked as a stew or source and is slimy, and is usually eaten with rice or fofofo (traditional food made from cassava).

Flowers: are small (2–3 cm diameter) and yellow.

Fruit: a many-seeded capsule-like structure.

Habitat: mostly grown on well-drained, moist soils.

Origin: common in temperate and tropical countries. Native to tropical and sub-tropical regions throughout the world.



Figure 12: *Corchorus olitorui*
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Scientific Name: *Geophila obvallata*

Description: usually called “*Kwaawolie*” in Mende, but the plant has no common English name (see Figure 13).

Growth Form: carpet forming, creeping herb, rooting at the nodes. Stems, up to 60 cm long, sometimes underground.

Leaf: up to 4 × 6 cm, broadly ovate to kidney-shaped, dark green to blue-green, primarily hairless except for occasional hairs on the midrib below. Humans collect green leaves of the plant for medicinal purposes, while food for *C. liberiensis*; **Flowers:** clustered and white.

Fruit: berry-like structure and approximately 7–8 mm in diameter, purple, blue, or black when ripe, crowned with the remains of the calyx lobes.

Habitat: found on sandy soils in evergreen forest and moist woodland, growing on the forest floor.

Origin: native to West African tropical forest countries.



Figure 13: *Geophila obvallata*
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The 10 plants presented above were identified by respondents as being consumed by hippos. No other species were identified in reconnaissance walks, although there may be many other plant species that are consumed in areas not readily accessible to humans. There was no reference to the *C. liberiensis* consuming any cereal crop (rice, maize, millet, or sorghum), and only one wild grass was noted as being consumed. None of the species consumed have either strong chemical or strong physical defenses. Most species are edible, including those that are not cultivated. Most of the species are mucilaginous (slimy) but whether this is a coincidence or a requirement of the hippo is unknown; the local explanation is that hippos eat “mud” and require the slime to help them digest it. It is possible that “eating mud” is a behaviour associated with “salt licks” and minerals. Except for cocoa, the plants eaten are herbaceous, reliant on anthropogenic or natural breaks in the forest canopy. Many plants are found on the river banks or in swamps where there is a year-round supply of water and light (presumably soils that are enriched by regular flooding). Most of the wild plants noted as being consumed are available throughout the year. Of the cultivated plants, krin-krin, sweet potato, and okra are cultivated year-round in gardens (although they are most abundant in the wet season).

The Abundance of *C. liberiensis* around Tiwai

C. liberiensis were observed by some members of all seven communities (Mapoma, Segbema, Geima, Kambama, Jenneh, Konobaia, Nyanahun, and Booma) that surround Tiwai. There were no obvious areas where they were more common, although it is assumed that Tiwai is about the upstream limit of hippos on this river. *C. liberiensis* are not commonly seen and have a well-deserved reputation for being elusive and secretive. They were most often seen early in the morning by people going fishing; they were more rarely seen in the evening. The *C. liberiensis* is a rare species and has very limited distribution. However, it was recorded sparsely but

widely in the study area. Direct evidence (feeding sites and footprint) of the species were seen in all habitats, most notably in gallery forests, swamp edges, farm bush, and thickets (old farm bush). This indicates that *C. liberiensis* are widely distributed in all habitats around Tiwai Island and its surroundings; however, they are most common in the gallery forests, swamps, and plantation edges. A similar situation was observed elsewhere in Sierra Leone (Teleki and Baldwin, 1981; Conway, 2013), Cote d'Ivoire (Roth *et al.*, 2004), and Liberia (Anstey, 1991; Robinson, 1970). Generally, it was observed that during the dry season, there is limited food as most of their preferred foods are dried up or withered. In the past, hippos were hunted, but the activities of various conservation programs and the long-term presence of April Conway seem to have sensitized the communities about their importance. Respondents in four communities of Kambama, Nyanahum, Geima, and Booma mentioned that calves were occasionally caught by chance by both men and women with their fishing gear while fishing in streams and the Moa River during the dry season. Half the respondents considered the hippos to be an agricultural pest, but no specific deterrents were mentioned.

The Density of *C. liberiensis* in the Study Area

C. liberiensis were confirmed to occur in the study area. Although population density estimate abundance was not calculated for this study, *C. liberiensis* populations were generally observed to be appreciable in the study area, with regard to its footprints and feeding sites noticed, particularly in communities in the Barri chiefdom, Pujehun district. They are sparsely but widely distributed in all habitats on and around the island. However, most commonly in the gallery forests, plantations, river catchments, and swamp edge habitat loss or habitat disturbances through farming, large mining, and fishing activities in the dry season when the river is dried and left in segments is probably the main factor that determines *C. liberiensis* scarcity, especially communities (Mapoma, Geima, and Seigbema) in the Boamakoya chiefdom, Kenema district is a major threat to the population living on, the sub-Island and the general surroundings.

Human–hippo conflicts

C. liberiensis raid farms searching for food; therefore, there are some opportunities for conflict. However, the hippos are very shy, and there are no reports of hippos attacking people on land or water. They are timid and easily disturbed by people. *C. liberiensis* are destructive to food crops in the study area. Five food crops, *Hibiscus esculentus*, *Ipomoea batatas*, *Cucurbita pepo*, *Theobroma cacao*, and *Corchorus olitorius*, were recorded to be consumed by *C. liberiensis*. They, therefore, interact much with the study area's local community. However, the local community's usage of *C. liberiensis* habitats, particularly for agricultural purposes, should be a cause for concern.

Conservation Implications

Despite formal protection since 1933, *C. liberiensis* have declined drastically (Kingdon, 1997; Mallon *et al.*, 2010). Conservation of the species is hampered by a lack of basic biological knowledge, including details of food preferences. Observational records of the species are scanty because of its cryptic nature. However, the most acute period of range decline (inferred from habitat loss) has occurred over the past three decades (Lewison and Oliver, 2008). The largest fragment of the species' former range is the contiguous Upper Guinea forest in Liberia and Cote d'Ivoire, and this area probably harbours the most remaining population (IUCN Hippo Specialist Group, 2008). Priorities for conserving the *C. liberiensis* include establishing a reliable method for assessing the sizes of the various populations and monitoring the species in protected areas using census techniques (Lewison and Oliver, 2008). The main threats to the species include habitat fragmentation, land conversion, and hunting (Roth *et al.*, 2004). Its

threatened status, long independent evolutionary heritage, and ongoing threats make the *C. liberiensis* a candidate for priority conservation attention (Isaac *et al.*, 2007). Several *C. liberiensis* and conservation-related initiatives have been adopted to address this concern. A Regional Conservation Strategy Workshop in 2009 was attended by representatives of several NGOs involved in *C. liberiensis* conservation, including the Zoological Society of London (ZSL), Fauna and Flora International (FFI), Institute for Breeding of Rare and Endangered African Mammals (IBREAM), IUCN, and the Royal Society for the Protection of Birds (RSPB) resulted in the establishment of the *C. liberiensis* Sub-group of the IUCN SSC Pigs, Peccaries, and Hippos Specialist Group., with Monique Paris (IBREAM) and Chris Ransom (ZSL) as its Co-chairs. The workshop aimed to bring together all stakeholders to review current knowledge, create a collaborative network and develop a government-endorsed, regional conservation strategy to guide conservation, education, and research across the entire range of the *C. liberiensis*. Some other notable conservation initiatives include the Liberia-Sierra Leone transboundary *C. liberiensis* conservation project, the University of Georgia Pygmy Hippo Project on Tiwai Island, Njala University-Zoological Society of London Pygmy Hippo Conservation Project in Loma Mountain National Park, the ZSL-FFI-FDA Pygmy Hippo Project in Sapo National Park and the Tai Hippo Project in Cote d'Ivoire (Mallon *et al.*, 2010). Captive breeding programs are also being undertaken to conserve captive *C. liberiensis* populations. Until 2009, there were 332 (133 males, 196 females, and 3 individuals of unknown sex) *C. liberiensis* in 134 public zoos and private collections (Mallon *et al.*, 2010).

Conclusion and Recommendations

This study has identified about ten plant species consumed by *C. liberiensis*, as well as their characteristics and season of availability. Wildlife nutrition is essential for the growth and development of animal species. Therefore, a great need for conservation and management practices to protect these vulnerable wildlife species and their habitats is needed. Based on the findings of this study, the following recommendations are essential:

- i. Farmers should avoid intercropping foods that hippos prefer with rice (such as pumpkin or okra), particularly in fields less than 500 m from the river.
- ii. Conservation education programmes regarding *C. liberiensis* and other notable wildlife species should be implemented in Tiwai Island communities.
- iii. Plants, such as *Ipoma alba* and *Pteridium aquilinum*, and trees, including *Acacia* sp., should be planted during restoration in mined-out regions, particularly in artisanal mining areas.
- iv. A long-term study of *C. liberiensis* on Tiwai Island and its sub-islands is needed to create a quantitative baseline and fully understand their population dynamics, as well as whether the availability of sufficient food is a limiting factor.
- v. A camera trapping technique combined with reconnaissance surveys should be developed for more information on population trends in the research area.
- vi. Consolidated biodiversity maintenance and protection agreement among community stakeholders (BaomaKoya and Barri chiefdoms), EFA, and other conservation organizations.
- vii. Community farmers' minds should be diverted away from clearing water catchment areas, forests, plantations, and swamp edges, as these are areas where plants of Hippo food preferences grow wildly.

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Appendix 1: Questionnaire

C. liberiensis CONSERVATION VILLAGE QUESTIONNAIRE

Date:

Village: GPS: Location:

1. Name
2. Do you have a phone number you can give?
3. Have you ever seen a pygmy hippo? Yes; No:
4. If yes, where did you see it?
5. How many did see?
6. Did they have young with them? Yes: No:
7. Have ever seen signs of pygmy hippo? Yes: No:
8. What were you doing when you saw the hippo? (eg. Looking for wide foods, farming, fishing, gathering medicines or NTFP)

.....
9. What signs did you see? Describe them to me

- a. Foot prints
- b. Actual sighting
- c. Dung
- d. Carcass
- e. Hard one

10. Can you take me to the place where you saw it? (If agreed record)

- a. GPS location
- b. Way point

11. Apart from the island where else can we find hippos?

12. What time of the day do you see them?

13. What time of the year do you see them?

14. Where do pygmy hippos spend most of their time?

15. Have you any knowledge about food pygmy hippos eat? Yes No

16. If yes, what kind of food do eat?

.....
.....
.....
17. Where do hippos feed?

18. Can we visit places where they feed?

19. Are pygmy hippos destructive to food crops you grow? Yes No

20. If yes, how are they destructive and which type of crop?

.....
.....
21. In your opinion, have the number of pygmy hippos in the last 5 years

- a. Gone up
- b. Gone down
- c. Stayed the same

22. Why do you think this is so?

23. Do you think other communities (not this one) are hunting hippos?

24. If yes, what are the hunted for?

25. Are you aware of regulations and by-laws concerning the conservation of hippos?