# Fishing Practices in Prehistoric Sri Lanka

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## Abstract

A considerable amount of information on prehistoric culture has been gathered from various areas in Sri Lanka. Batadomba Lena Cave in Kuruwita and Bundala in the southern Sri Lanka are two prehistoric sites which are as old as 40,000 years and 125,000 years respectively. Several caves in the wet, dry and intermediate zones were excavated during the last 70 years and a large amount of evidence has been discovered from these sites, which could be used to explain the prehistoric culture in Sri Lanka. Archaeo-faunal evidence helped to describe the prehistoric man not only as a hunter gatherer but also as a fisherman in the floodplains, rivers and streams. The simplest form of fishing tools made out of bones were discovered from many prehistoric settlements in Sri Lanka, indicating that there existed a gradual development of fishing technique and related activities. In this synthesis, an attempt is made to discuss the probable fishing techniques practised in the prehistoric times in habitats such as flood plains, rivers and streams. In this regard, information on, 1) traditional fishing practices of native Sri Lankans; 2) fish guilds that are popular in the dietary habits of Sri Lankans; 3) remains of fishes discovered from the prehistoric settlements; and 4) ecology of freshwater fishes was evaluated. Thirteen food-fish guilds were recognized in the dietary culture of Sri Lanka and were ranked considering the relative importance in the human diet. The archaeologists have discovered nine fish species and two genera from the excavations so far conducted in prehistoric sites. All those species belong to the food-fish guilds of contemporary Sri Lankans.

Key words: archaeo-fauna, floodplains, ethno-ichthyology, prehistoric deposits

## Introduction

Prehistoric man had lived in Sri Lanka 40,000 years before present as per the C14 dating received for Batadomba Lena Cave in Kuruwita, from where many artefacts also were discovered. Bundala in Southern Sri Lanka is the oldest known prehistoric site which dates back to 125,000 years (as confirmed by C14 and Thermo-luminescence dating). Deraniyagala (1996) reported that there were inhabitants on this land even 500,000 years ago. Extensive excavations have been conducted in several caves in Sri Lanka including Alu Lena Cave in Kegalla, Alawala Pothgul Lena Cave in Attanagalla, Aligala Lena Cave in Sigiriya, Batadomba Lena Cave in Kuruwita, Beli Lena Cave in Kitulgala, Dorawaka Lena Cave in Kegalla, Fa-hien Lena Cave in Bulathsinghala and Potana Lena Cave in Sigiriya to understand the behavioural aspect of the pre historic man (Deraniyagala 1992, Ranasinghe 2009, Weliange 2010). These

archaeological excavations carried out in wet, dry and intermediate-zones of Sri Lanka have revealed that the prehistoric man was a hunter-gatherer (Deraniyagala 1992, Ranasinghe 2009).

Excavations in Batadomba Lena Cave in Kuruwita and Udupiyan Galge Cave in Rathnapura have exposed fish remains indicating that the man had been consuming fish for the last 40,000 years or more. The first evidence of fish remains was discovered in Batadomba Lena Cave. The species was identified as Mahseer; *Tor longispinis* (synonymous *T. khudree*) and that evidence has helped conclude that the Neolithic man was a fisherman in certain parts of Sri Lanka (Deraniyagala 1939). Some scholars tend to argue that 40,000 years before present may not be Neolithic but Mesolithic (Somadewa & Manamendra-Archchi, pers. comm.) and therefore it might be safe to mention that the Mesolithic man was a fisherman cum hunter-gatherer.

Evidence about snakeheads, catfish and eels were found in a prehistoric site at Wilpattu in Sri Lanka (Deraniyagala 1952). Excavations conducted in the southern coastal Kirindagodana prehistoric site unearthed six fish species and one of them was a freshwater catfish and rest were marine species (Somadewa 2006). Taxonomical analysis of the fish remains of Batadomba Lena Cave indicated that the remains were *Channa striata, Wallago attu, Ompok bimaculatus, Anabas testudineus* and *Anguilla* spp (Kelum Manamendra-Arachchi & Jude Perera, pers. comm.). In Alawala Pothgul Lena Cave, remains of *Clarias brachysoma, Heteropneustes fossilis, Mystus* spp, *Puntius sarana, P. singhala* and *Tor khudree* were found (Algiriya *et al*., 2009; Manamendra-Arachchi *et al*., 2009). Altogether the remains of 9 species and two genera (*Anguilla* spp *& Mystus* spp) have been discovered from prehistoric deposits in Sri Lanka.

Prehistoric mounds elsewhere in the world have disclosed sufficient evidence of fishing but literature on fish remains in Sri Lanka is scanty. Rau (1885) described about the prehistoric fishing in Europe and North America based on archaeological evidence and the simplest bone tools which are known as fishing gorges. According to Salls (2000) fishing has been a distinguishable subsystem within an overall hunting and gathering system prevailed during the prehistoric time. In China, analyses of collagen extracted from the lower mandible of the 40,000-year-old human skull proved that the person had been a regular consumer of fish (Yaowu *et al*., 2009). Fishing in the Senegal River during the Iron Age has been described by Van Neer (2008) and mentioned that traps and nets were important tools used for fishing in rivers and streams. Use of plant ichthyo-toxins was also a very old practice in the history of mankind (Badola & Singh 1977; Samant & Pangety 1995; Srivastava *et al*., 2002). Some of the traditional Sri Lankan fishing practices have been described by Knox (1681), who was living in the Kanydan Kingdom in Sri Lanka as a captive of the king in the 17$^{th}$ century.

Wild-caught fish is still an important dietary component in Sri Lanka. Fishing was an important activity among the aboriginal people of Sri Lanka known as Veddah since early 20$^{th}$ century according to the literature. Fishing in village ponds was very common among Veddah and drought stricken ponds were thrashed with slender sticks until the fish were actually struck and became immovable in order to capture them (Lewis 1915). Fishing with ichthyo-toxic plants was also an important activity among them during the early 20$^{th}$ century (Parker 1909; Seligmann & Seligmann 1911; Spittel 1924, 1961). It has been reported that Veddah have consumed freshwater eels,

snakeheads, catfish and about 19 other smaller varieties (Spittel 1924 & Hill 1941) but they have never used traps for fishing (Seligmann & Seligmann 1911). Deraniyagala (1952) reported that 10-20 kg of *T. khudree* were stupefied by *Acasia acaesia* (Hingurala in native language) and *Derris uliginosa* (Kalawel in Native language) in April and October- December periods. The flesh of fishes caught using ichthyo-toxins was detoxified by skinning, smearing with ash and cooking after five hours.

Sri Lanka (6-10˚ N, 80-82˚E) although small in extent (65,621 $km^2$) is an ecologically diverse tropical island in the Indo-pacific region. Sri Lanka has wide array of freshwater habitats including alluvial systems, flood plains and marshy lands. Sri Lanka has 103 rivers, which occupy 6.4% of the total land area (Somasekaram 1997) and river basins cover over 90% of the island. Most of these rivers originate from the central mountain region and flow through low altitude, coastal areas and finally to the sea. Major river basins and associated aquatic habitats in Sri Lanka accommodate 82 fish species and large number of freshwater shrimps and crabs. Rivers in Sri Lanka are very dynamic habitats and trophic investigations have shown that Eels, Snakeheads and Catfishes are top predators in the aquatic habitats (Weliange 2007).

Although there are more than 12,000 man-made water bodies in Sri Lanka which cover about 135,000-175,774 ha (Mendis 1977; De Silva 1988; Amarasinghe and Weerakoon 2009) of the total land area none was existed during the prehistoric times but perhaps this is a good indication about the land area which could have acted as flood plains before the construction of reservoirs.

**The survey and sources of data**

A survey was done in Veddah home-land in Dambana of the Eastern province of Sri Lanka in 2009. Information was collected about the use of ichthyo-toxic plants in fishing, seasonality of fishing and the composition of the fish harvest. Information about traditional fishing practices and ethno-ichthyology were also collected from various parts of the country since 1998. Archaeological literature which described the fish remains found in prehistoric sites in Sri Lanka was also reviewed.

The fish hooks of contemporary shapes have not been found from prehistoric deposits in Sri Lanka so far, but bone gorges have been discovered from many prehistoric sites including Alavala Pothgul Lena Cave and Batadomba Lena cave (Weliange, in prep).

**Traditional fishing methods and types of fish caught**

The traditional fishing is practised in following three seasons in Sri Lanka; 1) just after the heavy rain as floodwaters gradually receding; 2) post monsoon receding water level in the floodplains; and 3) pre monsoon drying up period where flowing and stagnant water bodies are shrinking to pools.

Ethno-ichthyological studies demonstrated that Veddah live in Dambana and coastal areas use different plant varieties for stupefying fish, and the fishing season generally depends on monsoon.

Various traditional fishing practices are being used in the country including using ichthyo-toxic plants, hand picking in drying up pools, spearing and chopping by long knives. In addition, cane baskets and nets made out of various natural materials are also used for the purpose.

The catches of traditional fishing composed of fish of higher trophic levels and larger body sizes. Small fish species are not considered as a food, although some of them occupy higher trophic levels. Fishes of higher trophic levels ranging from 3.0 to about 4.5 are carnivores (Froese & Pauly 2000). The trophic level of a species is simply the integral count of the number of consumption steps between the primary producers and the end consumer species, generally this is determined by the number of energy-transfer steps that involved in the food chain.

Freshwater carnivorous fish in Sri Lanka are relatively large and having an edible size ranging from about 20 cm up to 100 cm in length. Some carnivorous varieties such as snakeheads, catfishes and eels are considered as "blood-rich fish" by the natives and feed the pregnant women and feeding mothers to provide them with nutritive food. There is a belief amongst the folk in certain areas consuming "blood-rich fish" would enhance the volume of the blood in the body. It is also reported that there is a greater demand and higher market value for "blood-rich fish" varieties.

**Food-fish guilds**

Ranking is an important consideration in folk biological classification as well as in ethno- taxonomy (Berlin 1976, Paz & Begossi 1996). In Sri Lanka food-fish guilds are ranked and consists 13 groups (Figure 1, Table 1). According to the present study this ranking system has a relationship with trophic level, size of the fish, quality of the meat and the abundance of the species (Figure 2). Present study also reveals that this ranking order has existed throughout the country for a long time and its origin is unknown. This ranking order is always used by people when they talk about freshwater fish and fishing.

First in the ranking system goes to the largest snakeheads in Sri Lanka (*Channa striata* and *C. ara*) and generally known as Loola (Murrel) by natives (Table 1). The second in the ranking system goes to smaller snakeheads known as "Kanaya" among natives who comprise *C. gachua, C. orientals* and *C. punctata.* "Magura" in native language refers to *Clarias brachysoma* which ranks third. Fourth place goes to eels (*Anguilla bicolor* and *A. nebulosa*) and referred as "Aandha" in native language. Fifth in the ranking system is held by "Hunga" and includes *Heteropneustes fossilis* (Stinging catfish). Sixth in the ranking system goes to "Walaya" and include *Wallago attu* and *Ompok bimaculatus.* Seventh place goes to *Anabas testudineus* (Climbing perch) and known as Kaawaiya by natives. Rank eight goes to bagrid catfishes (*Mystes cavasius, M. gulio, M. ankutta* and *M. vittatus*) and known as Ankutta by natives. The ninth in the ranking is identified as Theliya by the natives and includes both spiny eels (*Mastacembelus armatus* and *Macrognathus pentophthalmos*). Ranks 10, 11 and 12 go to Cyprinids such as Dandi, Pethiya and Lehella respectively. Dandi include nine fish species; *Esomus thermoicos, Rasbora carverii, R. daniconius, R. wilpita, Rasboroides atukorali, Ra. vaterifloris, Devario aequipinnatus, D. malabaricus* and *D. pathirana.* Dandi is the only fish group that does not have a common English name. Pethiya refers to medium size barbs and further classified into Mas-pethiya (*Puntius sarana),* Katu-pethiya *(P. kelumi* and *P. dorsalis*) and Dankola

Pethiya (*P. singhala*). The largest cyprinid in Sri Lanka is *T. khudree* holds the twelfth position in the ranking system, and known as Lehella or "Horapolaya" by natives. The two native Cichlids; *Etroplus maculatus* and *E. suratensis* are referred to as Korali in native language and rank in the thirteenth position of the order. According to the ethno-ichthyology *Belontia signata* is also included into the guild called Korali in some parts of the country.

Remains of 10 out of the 13 food-fish guilds have been discovered from two prehistoric sites. Three guilds; Theliya, Dandi and Korali are not yet found. Alavala Pothgul Lena Cave unearthed remains of five species and one genus including *C. brachysoma, H. fossilis, P. sarana, P. singhala, T. khudree* and *Mystus* spp (Algiriya *et al.,* 2009; Manamendra-Archchi *et al*., 2009) which belongs to native guilds of Magura, Hunga, Mas-pethiya, Dankola-pethiya, Lehella and Ankutta respectively. The remains of five species and one genus including *T. khudree* (Deraniyagala 1939), C. *striata, W. attu, O. bimaculatus, A. testudineus* and *Anguilla* spp (Manamendra – Arachchi & Jude Perera, pers. comm.) were unearthed at the Batadombalena Cave which belongs to food-fish guilds of Lehella, Loola, Walaya, Kaawaiya and Aandha respectively.

**Optimum Foraging Theory**

Some taxonomic groups of fishes such as Eleotridae, Gobiidae, Belonidae, Aplocheilidae, Oryziidae, Cobitidae, Balitoridae and some Cyprinidae are not included in the ranking system as they are smaller in size. Dandi are the smallest guilds included in the ranking system and fishes smaller than Dandi are not considered as food-fishes in the dietary culture.

The legendary comedian of the Royals of the ancient Sri Lanka have mentioned about "Titteya melluma" in his yarns, which is a dish made of small sized *Puntius* species such as *P. titteya* and *P. ticto* etc. "Titteya" could be another guild which is occasionally eaten by peoples particularly during scarcity other larger species.

Of the 48 Cyprinid species, only 16 are included in the food-fish guild, 32 are omitted due to small size. Although the indigenous *Labeo* species are larger in size but had restricted distributions in some river basins in the north central province they are not considered as a separate food-fish guild. It is also likely that they are included in the guild of Lehella.

Fishing is often directed towards the procurement of one or more primary species, with other fish comprising only the incidental and opportunistic component of the catch (Salls 2000). Smaller species are caught during the fishing activities as incidental catches particularly when using ichthyo-toxic plants. The decision of consuming the by catch would have subjected to the circumstances.

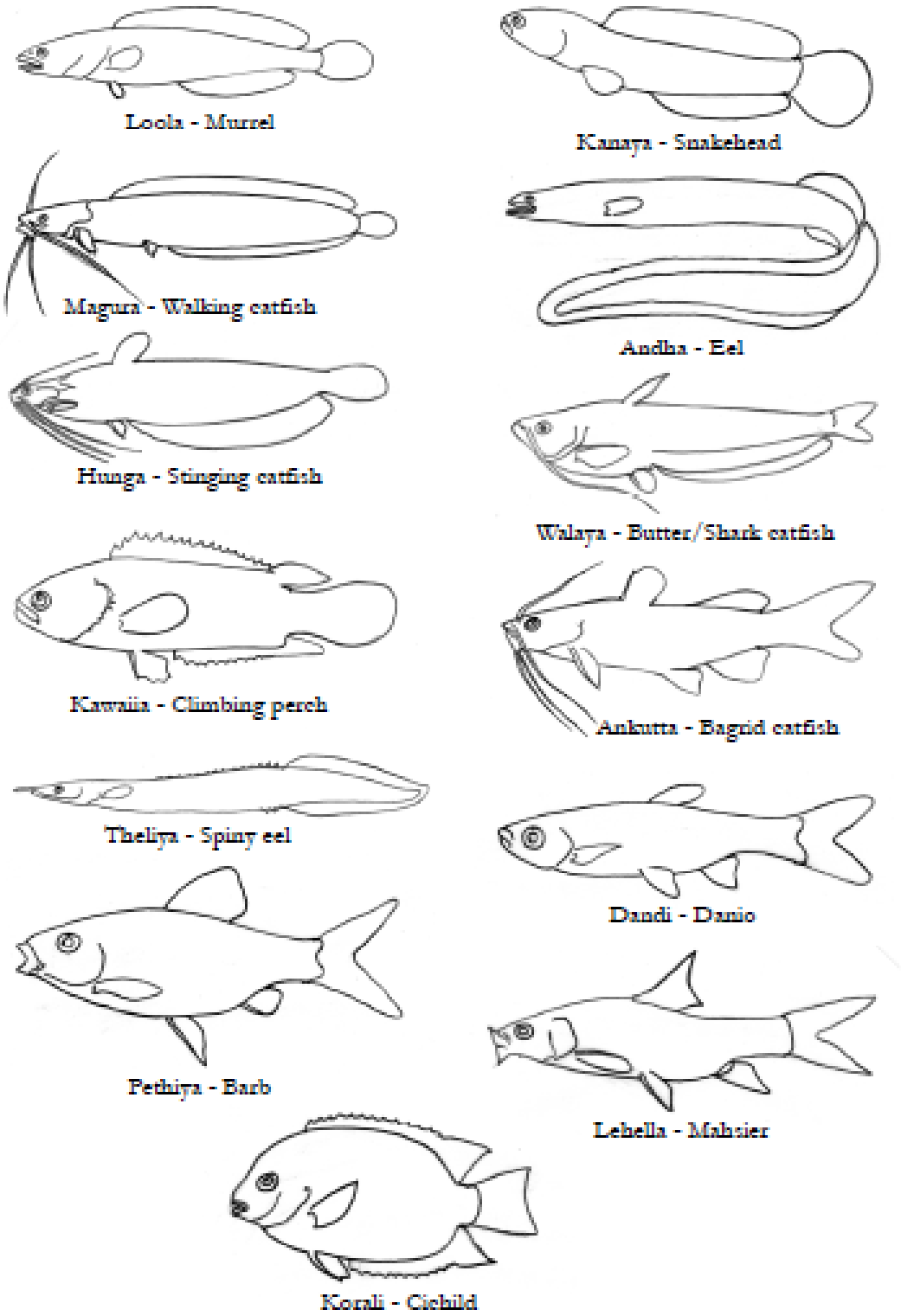


**Figure 1.** Thirteen food fish guilds of the Sri Lankan dietary culture

**Table 1.** Order of ranking based on the relative importance of freshwater fish in the human diet, native name given for ranking, family to which natives ranks belongs to, species belongs to each rank and the English common name given for each species. Fish / species found in the prehistoric deposits in Sri Lanka are shown with a star ( * ).

| Rank | Food-fish guild | Family | Species name | Common name (English) | Native name |
|---|---|---|---|---|---|
| 1 | Loola* | Channidae | *Channa striata* | Murrel | Loola |
| | | | *Channa ara* | Giant snakehead | Gan Ara |
| 2 | Kanaya* | | *Channa gachua* | Brown snakehead | Paradel Kanaya |
| | | | *Channa orientalis* | Smooth-breasted snakehead | Kola / Gas Kanaya |
| | | | *Channa punctata* | Spotted snakehead | Mada Kanaya |
| 3 | Magura* | Claridae | *Clarias brachysoma* | Walking catfish | Magura |
| 4 | Aandha* | Anguillidae | *Anguilla bicolor* | Level finned eel | Kalu or Madha Aandha |
| | | | *Anguilla nebulosa* | Long finned eel | Polmal Aandha |
| 5 | Hunga* | Heteropneustidae | *Heteropneustes fossilis* | Stinging catfish | Hunga |
| 6 | Walaya* | Siluridae | *Wallago attu* | Shark catfish | Walaya |
| | | | *Ompok bimaculates* | Butter catfish | Walapoththa / Kokessa |
| 7 | Kaawaiya* | Anabantidae | *Anabas testudineus* | Climbing perch | Kawaiia |
| 8 | Ankutta* | Bagridae | *Mystus cavasius* | Gangetic mystus | na |
| | | | *Mystus gulio* | Long-whiskered catfish | Mana Ankutta |
| | | | *Mystus ankutta* | Yellow catfish | Path Ankutta |
| | | | *Mystus vittatus* | Striped dwarf catfish | Iri Ankutta |
| 9 | Theliya | Mastacembelidae | *Mastacembelus armatus* | Marbled spiny eel | Gan / Oya Thelia |
| | | | *Macrognathus pentophthalmos* | Sri Lankan spiny eel | Bata Kola Theliya |
| 10 | Dandi | Cyprinidae | *Devario aequipinnatus* | Knuckles Danio | Dumbara or Dankola Salaya |
| | | | *D.malabaricus* | Giant Danio | Damkola or Rat kailaya |
| | | | *D.pathirana* | Barred Danio | Pathirana salaya |
| | | | *Esomus thermoicos* | Flying barb | Rewul Dandiya |
| | | | *Rasbora carverii* | Carverii Rasbora | Caveri Dandiya |
| | | | *R.daniconius* | Common Rasbora | Kiri / Kehel Danidiya |
| | | | *R.wilpita* | Wilpita Rasbora | Wilpita Dandiya |
| | | | *Rasboroides atukorali* | Horadandiya | Hora Dandiya |
| | | | *Ra.vaterifloris* | Golden Rasbora | Hal Mal Dandiya |
| 11 | Pethiya * | | *Puntius sarana* | Olive barb | Mas Pethiya* |
| | | | *P.dorsalis* | Long snouted barb | Katu Pethiya |
| | | | *P.kelumi* | Kelums barb | - |
| | | | *P.singhala* | Filamented barb | Dankola Pethiya* |
| 12 | Lehella/ Horapolaya* | | *Tor khudree* | Mahseer | Lehella / Horapolaya |
| 13 | Korali | Cichlidae | *Etroplus maculates* | Orange chromid | Ralliya |
| | | | *E.suratensis* | Pearl spot | Koraliya |

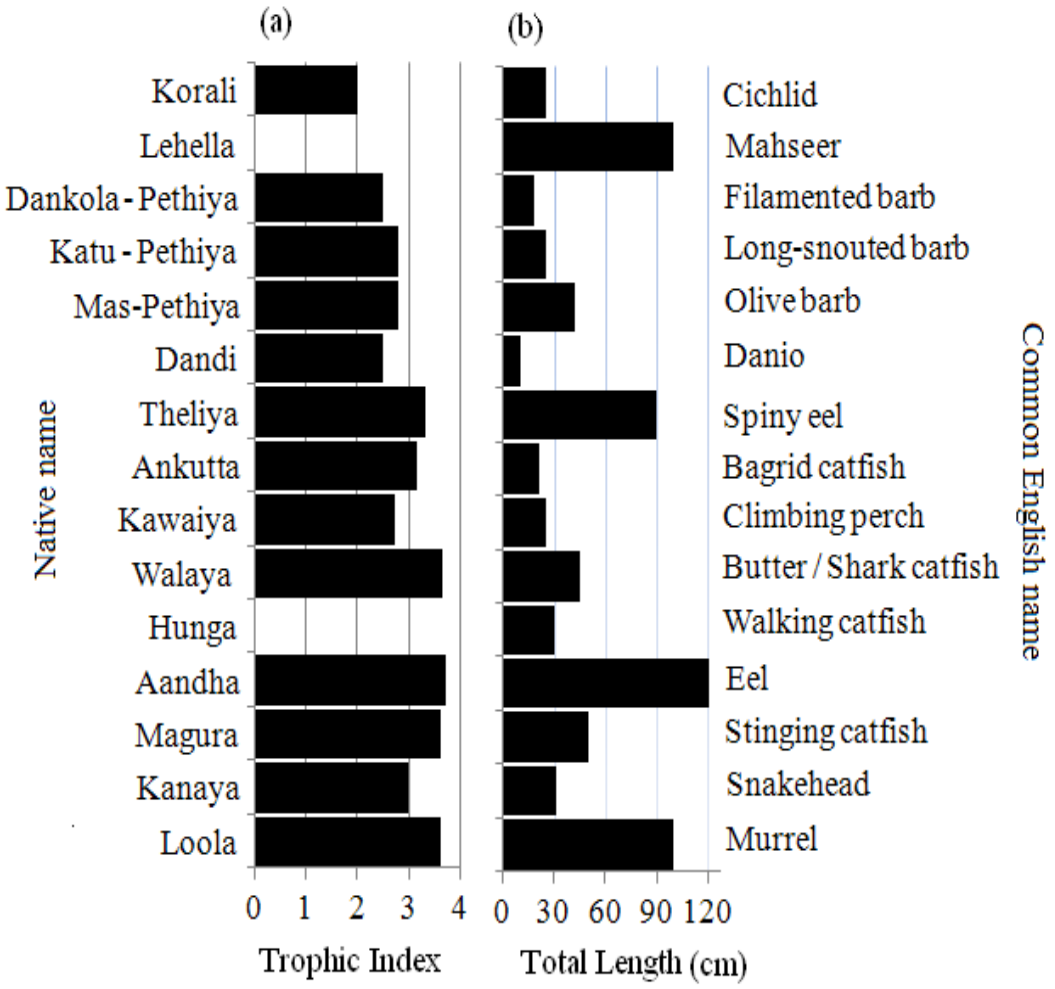


**Figure 2.** Food-fish guilds in Sri Lanka, arranged according to the ranking order from bottom to top, trophic index and the total length of each guild. When guilds are represented by more than one species trophic index valued was averaged and the total length is given of the smallest species (See text for the references).

Optimum Foraging Theory (OFT) helps to explain the effectiveness of energy balance involved in foraging. Optimum Foraging theory (MacArthur & Pianka 1966) in its simplest form states that organisms forage in such a way to find, capture and consume food containing the most calories while expending the least amount of time possible in doing so. Catching smaller fishes is time consuming and provides only negligible amount of calories.

According to the present study the fishes that could be held on the palm of a human adult or larger than the index finger of the same are generally defined as the edible size in Sri Lanka.

**Food-fish guilds and fish behaviour**

Prehistoric man lived in the natural shelters near the alluvial systems and migrated annually to the floodplains associated aquatic habitats for many reasons. Fishing would have been an important activity of the prehistoric man other than the collecting of aquatic snails, crabs and shrimps. Long association with the aquatic habitats would have provided him a thorough knowledge about the ecology and biodiversity of the aquatic habitats. As a result of this association the behavioural aspects of fish such as migration patterns, spawning, distribution and abundance related to the weather patterns would have been known to the prehistoric man. This particular knowledge would have been the foundation for the evolution and development of artisanal fishing methods. This ecological knowledge would have granted him opportunities for optimal harvesting. In the following paragraphs ecological perspectives of the fish species found in the prehistoric deposits in Sri Lanka and the possible catching methods employed by them would be discussed.

Traditional ranking system has a very close relationship with the trophic level of the fish and their size. Trophic level is directly related to the nutritive quality of flesh. Except for Pethiya, Lehella and Korali all the others are predators therefore they have a higher trophic index meaning rich in nutrition. Pethiya, Lehella and Korali are omnivorous hence their trophic level is generally low. But these three guilds grow to a comparatively large size to be considered suitable for edibility. Therefore consuming them was meaningful on the principles of the Optimum Foraging Theory.

**Loola or Murrel**

Loola or Murrel is a carnivorous, belongs to family Channidae. This food-fish guild consist of two species; *C. striata* and *C. ara,* but only the former is been discovered at prehistoric deposits in Sri Lanka. *C. striata* has a trophic level of 3.65 (Talde *et al*., 2004), grows up to about 100 cm standard length (Davidson 1975). It is the most abundant snakehead in Sri Lanka according to present Ethno-ichthyological survey. It can survive in the dry season by burrowing in mud as long as skin and air-breathing apparatus remains moist (Davidson 1975) and subsists on the stored fat (Rahman 1989), which is also confirmed by the present study. It migrates laterally from the mainstream to floodplain during the rainy season and returns to the permanent water bodies at the onset of the dry season (Sokheng *et al*., 1999). In the floodplain they use submerged plant material to construct circular nests ranging from 50 cm to 100 cm in diameter for laying eggs according to the present Ethno-ichthyological information. They stay in the nests during spawning and after hatching one of the parents guards the young at a time while the other goes for feeding.

*C. ara* is the largest in the family that grows up to 120-122 cm (Talwar & Jhingran 1991). According to the ethnographic records *C. ara* is less abundant and rarely caught. This could be the reason why *C. ara* is not considered as a separate food-fish guild, but pooled into Murrel or Loola. This is a good indication to accept that the abundance is an important parameter in ranking of fish in Sri Lanka.

**Kanaya or snakehead**

Food-fish guild defined as Kanaya refers to three C*hanna* species inhabited in freshwater and brackish-waters such as *C. gachua, C. orientals* and *C. punctata. C. orientalis* grows to a maximum of 33 cm (Menon 1999). In general 8 cm long individual have a trophic level ranging from 2 - 3 (Weliange 2007). *C. punctata* grows

up to 31 cm in total length and is a carnivorous (Pethiyagoda 1991). *C. gachua* reaches 20 cm (Baird *et al*., 1999) and it is found that 14 cm individuals have a trophic level of 2 (Weliange 2007).

**Magura or walking catfish**

Four guilds of catfishes are known and popular in the indigenous dietary culture in Sri Lanka. Walking catfish (*C. brachysoma)* or Clarids ranks first among them and third in the overall list. Adults of *C. brachysoma* grow to a total length of about 50 cm and weight of 3.6 kg (Pethiyagoda 1991). Bruton (1979) has reported that Clarid catfish were among the first species to migrate to floodplains. They are captured in large quantities in channels leading towards the floodplain, later on in the marginal areas of the floodplain where they spawn in shallow waters. Males guard the nests and young ones until they reach about 1 cm in length (Pethiyagoda 1991). When the water levels decrease, the larger specimens migrate first towards the main river through channels where fish could be caught again. Spawning occurs in makeshift nests among weeds in very shallow water. According to Reizer (1988) Clarids are one of the major fish species landed from the wetlands.

**Aandha or eels**

This guild consists of *A. bicolor* and *A. nebulosa* belonging to family Anguillidae. They are catadromus and descend to the sea to spawn (Riede 2004), live in estuaries and shallow seas as young (Rainboth 1996) and return to the mountainous streams while growing to adulthood. They grow up to 121 cm total length and weight of 7 kg (Pethiyagoda 1991), are carnivorous and have a higher trophic level of 3.75 (Froese & Pauly 2000).

**Hunga or stinging catfish**

Hunga or stinging catfish (*H. fossilis*) ranks second among the catfishes and 4$^{th}$ in the total ranking system. *H. fossilis* feeds mainly on animals (Arunachalam *et al.,* 2000), has a trophic level of 3.68 (Weliange & Amarasinghe 2007b), and grows up to the maximum size of 30 cm total length (Pethiyagoda 1991).

**Walaya or butter catfish and shark catfish**

*O. bimaculatus* (butter catfish) and *W. attu* (shark catfish) belong to family Siluridae and known collectively as Walaya in ethno-ichthyology.

*W. attu* is the largest among the predatory fishes in Sri Lanka which reaches about 240 cm in total length (Pethiyagoda 1991). It thrives in heels with grassy margin (Pethiyagoda 1991); hides under holes in river banks and canals (Arunachalam *et al*., 2000). Juveniles are insectivorous and adults feed on smaller fish, crustaceans, and molluscs. It is abundant during the warm season; a pre-monsoon summer breeder, migrate to smaller streams or to floodplain during the flood season (Sokheng *et al*., 1999).

*O.bimaculatus* is carnivorous, has a trophic level of 3.61 (Weliange & Amarasinghe 2007b), attain the size of 45 cm in total length (Talwar & Jhingran 1991) and spawn in the floodplain (Rainboth 1996).

**Kawaiya or climbing perch**

Climbing perch (*A. testudineus*) receives an important place due to its hardiness, tastier flesh and its ability to move on land (Herre 1935). It migrates from permanent water bodies to floodplain during the monsoon and return at the outset of the dry season (Sokheng *et al*., 1999). During the dry season, it stays in pools associated with submerged woods and shrubs (Sokheng *et al*., 1999), possesses an accessory air-breathing organ (Allen 1991) and survives for weeks out of water if the air breathing organs can be kept moist (Rahman 1989). Climbing perch grows up to a total length of 25 cm (Talwar & Jhingran 1991) and has a trophic level of 2.73 (Talde *et al*., 2004).

**Ankutta or bagrid catfishes**

This guild is represented by four species. *M. ankutta* (also known as *M. keletius*) and *M. vittatus* have trophic level of 3.27 and 3.12 respectively (Weliange & Amarasinghe 2007b). *M. keletius* and *M. vittatus* grow up to 18 (Pethiyagoda 1991) and 21 cm (Talwar & Jhingran 1991) total length respectively. *M. gulio* is the largest in the family and grows up to 46 cm total length (Menon 1999).

**Theliya or spiny eels**

This guild consists of two species; *M. armatus* and *M. pentophthalmos.* Anatomically both look similar and share the same niche. *M. armatus* occurs in areas with rocky bottoms in rivers and streams during the dry season and enters into the floodplains during the monsoon (Sokheng *et al.,* 1999). Trophic index of *M. armatus* is 3.34 indicating its higher place in the food web (Weliange & Amarasinghe 2007b).

**Dandi**

Dandi includes fish species belongs to family Cyprinidae such as *E. thermoicos, R. carverii, R. daniconius, R. wilpita, Ra. atukorali, Ra. vaterifloris, D. aequipinnatus, D. malabaricus* and *D. pathirana.* These are the smallest freshwater edible-sized fish found in Sri Lankan culinary culture. According to the ethno-ichthyology, fishes smaller than these guilds are not considered as important for consuming. All fish species considered as Dandi inhabit in the water column in pools or slow flowing waters, are insectivorous and their trophic level is around 2.5 (Weliange & Amarasinghe 2007b). it is also known during the present investigation that the this group of fishes makes quick turns in the water and shows a peculiar jumping behaviour during the dawn and dusk.

**Pethiya or barbs**

Pethiya are larger than Dandi and consist of four major species such as *P. sarana* (Mas-pethiya), *P. dorsalis* (Katu-pethiya), *P. kelumi* and *P. singhala* (Dankola-pethiya). Remnants of *P. sarana* and *P. singhala* have been discovered at prehistoric deposits in Sri Lanka.

**Mas-pethiya or olive barb**

*P. sarana* is the fleshiest among the medium sized cyprinids, hence known as Mas-pethiya in ethno-ichthyology implying "fleshy barb". It feeds on aquatic insects, fish, algae and shrimps and has a tophic level of 2.6-3.0 (Weliange & Amarasinghe 2007b) and grows up to the maximum size of 42 cm total length (Rahman 1989). It spawns in running waters among submerged boulders and vegetation (Talwar & Jhingran 1991).

**Katu-pethiya or long snouted barb**

Katu-pethiya guild has less flesh hence they are called "bony barb". One species belongs to this guild; *P. dorsalis* has a trophic index ranges from 2.7-3.0 (Weliange & Amarasinghe 2003, 2007b) and attains to 25 cm in total length (Pethiyagoda 1991).

**Dankola-pethiya or filamented barb**

*P. singhala* (synonym *P. filamentosus*) has purplish dorsal and caudle fins when matured. Hence it is identified as Dankola-pethiya meaning "purplish barb" in ethno-ichthyology. Its trophic level ranges from 2.3-2.9 (Weliange & Amarasinghe 2003, 2007b) and grows up to 18 cm (Menon 1999).

**Lehella or Mahseer**

*T. khudree* (Lehella) is the largest cyprinid in Sri Lanka and grows over 50cm Pethiyagoda 1991). According to Menon (1999) they grow up to about one metre and weighs 45 kg. It feeds on aquatic insects, fish, algae and shrimps (Talwar 1991). It inhabits in pools or slow moving parts of rocky streams and rivers, moves upstream to spawn among submerged boulders and vegetation (Talwar 1991).

**Korali or native cichlids**

Native Cichlids are the last in the ranking order because it is the least importance in native dietary culture due to very low abundance. Native cichlids are represented by two species *E. maculatus* and *E. suratensis*, the latter is reported to be translocated from the brackish-water to inland water bodies during latter part of 19$^{th}$ century (Wiley 1910). Food habits of *E. suratensis* is described as herbivorous (De Silva *et al.,* 1984) and having a trophic level of 2.00 (Weliange *et al.,* 2006).

*E. maculatus* is found in riverine habitats in dry and wet zones of the country (Weliange 2007). *E. maculatus* is smaller and has a trophic level of 2.73 (Weliange & Amarasinghe 2007b).

**River and floodplain fishery**

Five million tonnes of fish for human consumption come from rivers and floodplains, most of which comes from major floodplains (Welcomme 2008). Average floodplain production has been estimated to be 40-60 kg/ha/year which includes the production from lightly exploited floodplain-river systems (Welcomme 1979, 1985). A considerable amount of protein would have been obtained from the floodplains and rivers during the prehistoric times too, although physical evidence is relatively poor compared to that of mammals. Fish would have been an important resource for prehistoric people due to the reason that catching fish was much easier than the hunting land animals. Therefore fishing would have been an important activity during the prehistoric times in Sri Lanka.

One hundred and three major rivers in Sri Lanka and two monsoons create a large area of floodplains during the rainy season. Floodplains provide important spawning and feeding grounds for a large number of freshwater fish (Welcomme 1979; Payne 1986; de Graff *et al.,* 1999). The floodplains inundated during the monsoon are nutrient rich and play a significant role for four to five months of the year. Larvae, juveniles and adults of fishes grow in this habitat, after which they

migrate back to rivers or depressions at the end of the monsoon (Welcomme 1985; Bayley 1988; Junk *et al.,* 1989). Traditional fishing practices in Sri Lanka are developed basically for the floodplains as the floodplains are generally shallow, and have fewer obstacles than in the rivers making fishing easier (De Silva 1988b). Fishing in floodplains during the monsoon is an important economic activity of the people living adjacent to the floodplains (Payne 1997, de Graaf *et al.,* 1994).

Unlike land animals, fish that migrate into floodplains become naturally trapped as evaporation takes place and congregation occurs. Time of congregation is determined by the evaporation and flow rate of the water. Also De Silva (1983) has reported that fish become more vulnerable to predation during the spawning that occurs in monsoon period. This particular time period is the most important for fishing nowadays and probably during the prehistoric times too. The migration pattern and the migration route are also important for floodplain fisheries today and during the prehistoric times too.

In the north-central part of Bangladesh highest catch is obtained during the receding of floodwaters (October to December) and the lowest during the pre-monsoon (April to June) (Ahmed *et al.,* 2005), which also indicate that there are two main seasons for fishing.

Freshwater food fishes of present day are exactly similar to those of the prehistoric times. It should be noted that catch composition in Bangladesh floodplains are very similar to the food-fish guilds of Sri Lanka. In Bangladesh, floodplain catches include catfishes (*Heteropneustes, Clarias, Ompock, Mystus* and *Wallago),* snakeheads (*Channa*), *Anabas, Mastacembelus,* small indigenous Cyprinids (*Chela, Amblypharyngodon, Esomus, Puntius*) and other less common fish species (Ahmed *et al.,* 2005). This is an indication that the floodplains in the tropical Asia are home for many similar species. Similar species are harvested from similar habitats although they are located in different geographical regions. Further it could be assumed that the same techniques would have been used everywhere in the region.

**Black fish and white fish**

Sri Lankan native fish fauna has a riverine origin but depending on the spawning behaviour they are grouped into two types as black and white fish. Black fish migrate to floodplains while white fish migrate upstream for spawning (Sao-Lean & Dom Saveun 1955).

White fish migrate to the main river channel in the late dry season in order to avoid the unfavourable conditions on the floodplain. At the beginning of the monsoon, with the rising water level, they either spawn upstream in the main channel or spawn in the floodplain. After spawning in the main channel, the eggs and larvae drift passively downstream towards the inundated floodplain (de Graaf *et al.,* 1999). The main species of white fish comprise of Cyprinidae and Schilbeidae form which latter is not found in Sri Lanka. On the basis of this classification, a high percentage of white fish is attained in the floodplain. Accordingly *P. sarana* and *T. khudree* would have been caught using ichthyo-toxins in the rivers and streams, or while migrating back from the floodplain by spearing, or in muddy pools by hand picking. It is evident that *P. sarana* and *T. khudree* are spawning in running waters (Talwar &

Jhingran 1991) and therefore can be considered as white fish (Sao-Lean & Dom Saveun 1955).

Black fish has a broad environmental tolerance and can sustain the harsh conditions of the floodplain during the dry season. Many food-fish guilds that belong to the families such as Channidae, Claridae, Heteropneustidae, Siluridae, Anabantidae, Bagridae and Mastacembelidae migrate to floodplains during the monsoon period; hence the adults of these guilds become vulnerable to predation. This particular vulnerable period would have been the most effective time of fishing during the prehistoric times.

**Prehistoric fishing methods**

Hand picking, stirring for deoxygenating, wounding or striking and usage of plant ichthyo-toxics are the basic and simple techniques used for fishing throughout the world, and each method has evolved on the basis of behavioural aspects of the fishes. Traditional fishing methods in Africa include hand picking in shallow waters, use of sticks or other striking gears for wounding or killing fish in marginal waters, constructing barriers and traps in the channel, deoxygenating by stirring up the mud and use of ichthyo-toxic plants in floodplains and in the rivers (Blache & Miton 1962; von Brandt 1984). In the cascading rivers in Philippines, regulation of water flow is an effective way of catching aquatic animals such as fish, crabs and shrimps (Weliange pers. obs.). Ethno-ichthyological studies revealed that all methods mentioned above are used in Sri Lanka too.

Hand picking in the muddy pools, where fish aggregate is the most effective method of fishing during pre-monsoon drying up season and the post monsoon receding water levels which is promoted by stirring for deoxygenation which makes fish surfacing for breathing.

Use of ichthyo-toxic plants for fishing is a very old practice in the history of human kind (Badola & Singh 1977; Samant & Pangety 1995; Badola & Badola 1999; Srivastava *et al.,* 2002) and still in use amongst indigenous tribes in many countries (Van Andel 2000) including Sri Lanka (Weliange in prep). Ichthyo-toxic plants are used (Darty *et al.,* 2007) to catch fish in stagnant or semi-stagnant waters, partly blocked streams, particularly in the morning and in the evening (Negi & Kanwal 2009). This method is done during the pre-monsoon period where fish are aggregated into temporary pools in Garhwal region in India (Negi & Kanwal 2009) and in Sri Lanka (Weliange in prep). During the prehistoric times fishing would have been done by using ichthyo-toxic plants, in the drying up pools or in the large pool areas in the rivers and streams. Fishing with ichthyo-toxic plants during dry seasons would have bagged not only the important fish guilds but also others less important fish guilds. Therefore it could be concluded that the prehistoric by-catch would have composed of crabs, shrimps and less favoured fish as well. Deraniyagala (1939) also reported that the fishing would have been done either by poisoning the pools with roots or berries of certain plants or herbs or by angling.

Hand picking and use of plant ichthyo-toxics would have left no evidence in the prehistoric deposits, but such simple and basic methods would have been the commonly used methods. Bone splinters were discovered from 40,000 years old deposits from Batadomba Lena Cave and from Alawala Portugal Lena Cave

indicating that angling have been in practise since then. Those bone splinters were tight together cross-wise, and attached to a line of sinew or palm fibres for angling (Deraniyagala 1939).

There is no evidence found from prehistoric deposits in Sri Lanka to believe that the nets, baskets and traps were used by the prehistoric man for fishing activities. Using these trapping methods could collect large quantities of fish, but require moderate preparation, continuous repairs and some maintenance as requisites. Spearing, angling, and arrowing are less efficient also require less concentration and preparation (Spencer & Jennings 1965), hand picking and using plant ichthyo-toxins needed no preparation and maintenance.

One or both ends pointed bone tools similar or smaller in length than the index finger of an adult were found from prehistoric deposits in Sri Lanka, the largest among those could have been used in spearing attached to long wooden poles (Weliange in prep).

**Fishing seasons**

Spawning occurs during the monsoon period and fishing is directly related to the hydrological regime and the ecology of the fish. The amount of fish catch varies from season to season. In floodplains of Bangladesh, the largest catch was obtained during the receding of floodwater and the lowest during the pre-monsoon period (Ahmed *et al*., 2005). Present study also revealed that in Sri Lanka post-monsoon receding water level and pre-monsoon drying up periods are equally important for traditional fishing.

All traditional methods except of using plant ichthyo-toxics are effective in shallow and non-flowing water.

With the invention of angling with bone splinters as described by Deraniyagala (1939) deep water fishing was also possible for the prehistoric man, and since then fishing would have been a year around activity.

Spearing would have been practised in the shallow floodplains in the monsoon and post-monsoon periods. Spearing would have been much effective when the water is clear, probably not during the monsoon time.

Hence, it could be argued that during the prehistoric times floodplains would have been a major attraction particularly during the monsoon and the post-monsoon drying up period. As such, the prehistoric man would have either travelled or migrated to floodplains during these periods. Such migration patterns are still available among the coastal fishermen in Sri Lanka to avoid the hazards of the monsoon climate and to improve the catch.

**Conclusion**

Fish remains in prehistoric deposits indicate that same fish species had been consumed by the prehistoric man. Deraniyagala (1939) reported that the days' collection of the prehistoric man would have probably consisted of tree snails, water snails, bivalves, crabs and prawns with an occasional large fish, birds and game. According to this analysis prehistoric man would have caught fish not only occasionally but seasonally and regularly in floodplains and rivers.

Only three guilds; Dandi, Korali (native cichlids) and Theliya (spiny eels) are not found and recorded from prehistoric settlements so far. There could be many possible reasons for the lack of evidence of these species. Dandis would have been eaten with bones as sprats due to their small size. Korali are not abundant in the wet zone mountainous areas due to their body morphology which is only suitable for lateral areas of slow moving waters in higher order rivers as has being described by Weliange & Amarasinghe (2007a). Also other reasons such as sampling errors and misidentifications may be responsible for lack of evidence for the remains in prehistoric deposits.

It could be established from this synthesis that fishing could have been done without any task oriented tools but with simple and basic techniques. Lacking evidence on fishing tools in prehistoric deposits does not mean that fishing was an insignificant activity. The gathered information about prehistoric fishing techniques may throw light on the concept of division of labour, social organization, material and culinary culture, and the migration pattern of the prehistoric man lived in Sri Lanka.

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