Chapter 2

The study species - Oriental Darter and the study area

Oriental Darter *Anhinga melanogaster* is a waterbird of tropical South and South East Asia and currently considered as a near threatened species (BirdLife International, 2012a, 2014). According to Pande (2004), Darters are mentioned in the ancient Sanskrit texts and are said to represent the ‘Sun God’ mainly due to the silver colour in its wings.

2.1 Taxonomy and nomenclature of Darter

The populations of Old World darters have been in a state of taxonomic flux throughout the later 20th century. According to Schodde *et al.* (2012) *Anhinga* spp. of the Africa, to Australian areas through the Oriental region are considered to form a superspecies separate from *Anhinga anhinga* of the Neotropics. Hence the taxonomy of the Oriental Darter is complex and subject to considerable discussion and revision. As per Alvarenga and Guilherme (2003) and Schodde *et al.* (2012) at present four living species are present in the *Anhinga* genus: i) *Anhinga anhinga* (Linnaeus, 1766) is the smallest and found in Southern and North America through the Neotropical region, ii) *Anhinga melanogaster* (Pennant, 1769) from Asia, iii) *Anhinga rufa* (Daudin, 1802) is from Africa and iv) *Anhinga novaehollandiae* (Gould, 1847) is from Australian region. Del Hoyo *et al.* (1992) put the last three species under a single species, *Anhinga melanogaster* with three subspecies or geographic races. As per Rasmussen and Anderton (2005, 2012) all four species can be often considered conspecific to each other. But according to Olson (1995) the osteological differences between *Anhinga anhinga* and *Anhinga melanogaster* are intense; hence they are not simply allopatric members of a superspecies.

2.2 The study species: Oriental Darter *Anhinga melanogaster* (Pennant, 1769)

According to Ali and Ripley (2001), Darters are black waterbirds, like the cormorant, with longer, slender snake-like neck, narrow head, straight, pointed stiletto shaped bill and fan shaped, stiff and long tail. Oriental Darter *Anhinga melanogaster*
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(Fig. 2.1) belonging to the family Anhingidae is mainly piscivorous, heronry nesting waterbird (Ali and Ripley, 2001; Kumar et al., 2005; BirdLife International, 2012a). As per Ali and Ripley (2001), Oriental Darters are sexually monomorphic, but according to Rasmussen and Anderton (2012), Oriental Darter show sexual dimorphism. ‘Adult has dark crown and neck, prominent white stripe along sides of neck, long lanceolate silver striped black scapulars, and black lower fore neck and under parts and orange bill. Male has black speckles coalescing on white throat, the speckling lacking in females. Juvenile has plain brown head and neck with less defined white face-stripe than adult (wearing to very pale on head, neck, mantle and wing coverts) blackish brown underparts; upperparts plumes are much shorter and less modified, and duller bill and legs’ (Rasmussen and Anderton, 2012).

2.2.1 Status, distribution, habitat etc.

Its global population is roughly about 22000 individuals in total (BirdLife International, 2014). According to Perennou et al. (1994), this species generally uncommon and declining throughout Asia. Kumar et al. (2005) states that, South Asia holds around 4000 individuals of Oriental Darters. As per the IUCN Red List Category, it is classified as a near threatened species (BirdLife International, 2012b, 2014) because its population is suspected to be on decline owing to various factors such as pollution, drainage, hunting and collection of eggs and nestlings (BirdLife International, 2012a). In India, it is a widespread resident species, locally common in Assam, uncommon elsewhere and the current status is poorly known, but shows apparent decline (Kumar et al., 2005; BirdLife International, 2007). Outside India it is found in Pakistan (Indus Valley), Nepal, Sri Lanka, Bangladesh, Myanmar, Thailand, Laos, Vietnam, Cambodia, Malaysia, Singapore, Brunei Darussalam, Sulawesi and Sumbawa in Indonesia and Timor-Leste (Fig. 2.2) (BirdLife International, 2012a; Schodde et al., 2012). It occurs singly or in pairs or small flocks, rarely in large flocks and inhabits shallow inland wetlands including lakes, rivers, swamps, village ponds, and reservoirs, as well as estuaries, tidal inlets, mangroves and coastal lagoons (Ali and Ripley, 2001; Kumar et al., 2005; BirdLife International, 2007). Rahmani (2005) stated that Darters need unpolluted, medium and large sized, deeper water bodies. Being a waterbird they are mainly piscivorous and at certain times they used to eat some too large ones for the bird’s slender
bill and gullet (Ali and Ripley, 2001). Darters are heronry nesting species and its nests are found close to other heronry nesting waterbirds and they show local movements depending on the water conditions (Daniels, 1998; Ali and Ripley, 2001; Kumar et al., 2005).

Figure 2.1 Oriental Darter *Anhinga melanogaster*
2.2.2 Status and distribution in Kerala

They are resident, breeding waterbird of Kerala. According to Sashikumar et al. (2011a) they are common in the wetlands of central and Southern Kerala, but uncommon in the north’. Neelakantan (1991) stated that Darters were very common during 1970’s at Periyar Lake, but after the appearance of Great Cormorants, its number has been reduced greatly. Sashikumar et al. (2011a) states that, in Kerala they are frequent found in fresh and brackish water wetlands, reservoirs and backwaters. According to Zacharias and Gaston (2004), their number is decreasing in Kerala. Based on the available information, Kerala state could have more than 500 individuals of Oriental Darter (Sashikumar et al., 2011a).

![Image of Oriental Darter Range](Image courtesy: www.wikipedia.org)

**Figure 2.2** Range of Oriental Darter *Anhinga melanogaster*

2.3 The study area

Kuttanad is a highly complex, dynamic and unique rice growing wetland ecosystem of the state and is the “Rice Bowl of Kerala”, contributing nearly 20% of the total rice production of the state and covers an area of 53639 hectares distributed among 1086 units where rice is cultivated (Sudhikumar and Sebastian, 2005). Kuttanadan paddy fields along with the Vembanad estuary and the Kole lands of Thrissur and Malappuram districts together declared as ‘Ramsar Site’ by Wetlands International on 19th August.
2002. Vembanad region of the Kuttanad wetland has also been declared as an ‘Important Bird Area’ (Islam and Rahmani, 2004).

2.3.1 Myths and history related to Kuttanad

There are certain legends connected with Kuttanad. As per one belief based on the epic ‘Mahabharatha’, the entire Kuttanad area was once covered with dense forest, the legendary ‘Khandavavana’ (Khandava forest), which caught fire and got engulfed by the sea during the succeeding time periods. Years later, the sea receded, exposing the land in which mud set in gradually and gave rise to the fields existing at present. As such, it is said that this place was originally known as “Chuttanadu” (meaning ‘burnt land’), which later on became ‘Kuttanadu’. Logs of burnt and charred wood are still seen in the Karinilams of Vaikom, Thuravoor, Thakazhy, Purakkad etc. According to another one belief, once Buddhist religion widely practiced in this area and hence the name Kuttanad is derived from the name ‘Buddhanadu’ which means ‘Land of Buddhist people’. But a few often connect the name with ‘Karumadikutten’ a stone carved statue of ‘Lord Budha’ situated at Karumadi, as the ‘land of Kuttan’ became Kuttanad. Early ‘Cheras’ had their home in Kuttanad and they were called as “Kuttuvans” named after this place. Apart from this, there are also certain legends connected with Kuttanad. In ancient days, the term, ‘Kuttanad’ referred to a much larger area extending from Karunagappally to Aluva.

2.3.2 Origin and geology

There are two major hypotheses on the origin of Kuttanad wetland ecosystem. According to the widely agreed hypothesis, millions of years ago this region was forest and during a geological event, the Arabian Sea advanced up to the foot of Western Ghats in many places, submerging these areas (Anon, 2007). Years later, there were upliftment and recession of sea, during which the trees of the entire forest that was under submergence got uprooted and buried ‘in situ’ under varying levels of silt to give rise to the low lying marshy saline lands of Kuttanad (Anon, 2007). Soils of these areas have vast organic deposits, fossils of timber and shellfish in varying depths (Anon, 2007; MSSRF, 2007).

According to geologists, Kuttanad is a ‘recent sedimentary formation’. It has been established that Arabian Sea once extended up to the eastern border of Kuttanad region.
With the upliftment of the ‘Warkalay Laterite Formation’, the tract of the recent formation got elevated forming an extensive bay. The west flowing rivers Periyar, Muvattupuzha, Meenachil, Manimala, Pampa and Achankovil were discharged into the bay. The silt carried by these rivers was deposited at the mouth of the rivers and this gave rise to the present sea coast, converting the shallow bay into an extensive backwater tract. The lagoon gradually silted up and gave rise to the shallow wet paddy lands, which now characterize the Kuttanad (Sylas, 2010). Hence, Kuttanad is a deltaic formation of four rivers viz., Achankovil, Pampa, Manimala, and Meenachil and partly contributed Muvattupuzha River at the northern part i.e., Vaikom. The deeper portions of the lagoon formed the present ‘Kayal’ (backwater).

2.3.3 Topography and geographical area

Kuttanad is highly complex and primarily a deltaic formation of five river systems together with the fertile low lying areas in and around Vembanad Lake comprises 54 revenue villages and spread over Kottayam, Alappuzha and Pathanamthitta districts of Kerala. Nearly 57% of the Kuttanad wetland ecosystem falls in Alappuzha district, 30% in Kottayam district and remaining 13% in the Pathanamthitta district (Anon, 2007). More precisely it is formed of two deltaic formations, one at the confluence of the four river systems namely – Achankovil, Pampa and Manimala, and the other by the Meenachil River (Aravindakshan and Joseph, 1990). It is separated from the Arabian Sea by a narrow strip of land. The region extends from North latitudes 9° 17’ to 9° 40’ and East longitudes 76° 19’ to 76° 33’ (Sreejith, 2013). The garden lands are 1m above mean sea level, which is formed by the deposition of alluvium where human population of Kuttanad inhabit and the wetlands 0.5 to 2m below sea level (Babu, 2006). Total geographic area of Kuttanad region is around 110000 ha (1100km$^2$) comprising 28% dry land, 60% wetland and 12% other water bodies such as lakes, rivers channels etc. (Kurup and Ranjeet, 2002). Kuttanad spreads over Cherthala, Ambalappuha, Kuttanad, Mavelikkara and Chengannur Taluks of Alappuzha district, Thiruvalla Taluk of Pathanamthitta district and Vaikom and Changanacherry Taluks of the district Kottayam. Kuttanad is bordered by Kaduthuruthi - Vaikom road in the north, Kaduthuruthi - Kottayam - Mavelikkara railway line in east, Mavelikkara - Harippad - Thottappally road in south and Thottappally - Alappuzha – Thanneermukkom road in the west.
Kuttanad acts as a receptacle to receive the flood waters of the fast flowing river systems viz., Periyar, Muvattupuzha, Meenachil, Pampa and Achankovil, all originating from the Kerala part of Western Ghat mountain ranges which receive two monsoon rains, South West and North East. Muvattupuzha River is in the north, Meenachil in the middle and Manimala, Pamba, Achankovil Rivers located in the southeast part of Kuttanad. Flow of water in the river, the alluvium they carry etc. affect the ecology of Kuttanad. These rivers have great significance in the saltwater intrusion reduction and flood. Major portion of the Vembanad estuary is situated in Kuttanad wetland, which is the biggest estuary in the South West coast of India. It is reported that two-thirds of the total area of Vembanad Lake has been reclaimed or converted into fields for agricultural or fishery activities (Gopalan, 1991). Transformation of paddy cultivation in Kuttanad region to its present form is invariably related to the history of the reclamation of ‘karappadams’ and ‘kayal’ lands and it started in 1834 and by the end of 1995 about 63-76% of the total area was reclaimed for other purposes (Thomas, 2002).

This area is water logged, almost throughout the year, and subjected to continued flood submergence during the monsoon and saline water ingestion during the summer months. Most of the paddy fields of this region are inundated during the non crop season and water has to be pumped out to the canal systems and backwaters before the commencement of the cultivating season (Sashikumar and Palot, 1996). During the monsoon floods, the whole area becomes engulfed under a vast sheet of water as the above rivers branch into many water courses which are connected to one another. The floodwaters move towards the Vembanad Lake to be drained to the Arabian Sea mainly through the Cochin Estuary. The area includes mainly the wet rice fields and dry garden land like sandy areas, un-reclaimed and reclaimed kayal land areas, and other water spread, rivers, canals, channels and waterways. The network of canals and rivers are extensively used for transportation, recreation and livelihood means.

2.3.4 Climate

The climatic feature of Kuttanad is typical of humid tropical features. Climate is warm, humid with fairly uniform temperature throughout the year (Islam and Rahmani, 2004). The average annual rainfall recorded as 3000mm of which 83% received during...
the monsoon, more precisely during the South-West and North-East monsoons (Anon, 2007). The study area is blessed with South-West and North-East monsoon. South-west monsoon prevails on the state from June to August and the later from October to November with the heaviest rainfall in November. Among them, the South-West monsoon has the highest percentage (60%) of rain than the North-West monsoon (30%) (Anon, 2007). This is a warm, humid region and the seasonal variation in the temperature ranges usually between 21 to 38°C (Sudhikumar et al., 2005). February and March are dry months followed by the summer reaching to tropical severity during the months of April and May. The winds have seasonal direction of South West during monsoon and speeds attain 45-55km/hr. The humidity is also showing a seasonal fluctuation (Sudhikumar et al., 2005).

2.3.5 Soil and its types

Sand and clay form the major content in the soil of Kuttanad and it is found in varying proportions at different locations of the study area. In some parts, presence of decayed organic matter including decayed parts of logs of wood has been reported (Ajaykumar et al., 2009) and these woods are locally called as ‘Kandamaram’. In most of the areas, the soil is highly acidic and contains toxic salts like acid sulphates (Indira and Covilakom, et al., 2013). The toxicity adversely affects plant life through capillary action when the fields are dry (Sylas, 2010). The soil in Kuttanad is classified into three major categories.

1. Kayal land: This type is seen in the kayal (lake) lands of Kuttanad, mainly in revenue villages Chennenkari, Kainakari, Pulincunnoo of Kuttanad Taluk and Thiruvarppu and southern regions of Kumarakom of Kottayam Taluk. The area lies 1 to 2m below MSL. Soils are seriously affected by salinity than the other types.

2. Karapadom: They are generally situated along waterways and rivers. They lie in the interior of the villages on the Eastern and Southern periphery of Kuttanad. They are periodically replenished by the silt deposit carried by the rivers during the flood.
3. Kari: These are situated in the Ambalappuzha, Cherthala and Vaikom Taluks. The name Kari is derived from the intense black colour of the soil due to the presence of partially decayed organic matter (peat) and pyrites in high amount. The soil and water itself are highly acidic (pH 2 to 4.3) and saline.

2.3.6 Agro-ecological zones

Based on the agro-ecological and climatic characteristics like the height from the mean sea level, influence of rivers, geomorphology, flood risk, risk of saline water intrusion, soil type and fertility and the cropping pattern, Kuttanad is subdivided into six agro-ecological zones (Fig. 2.3) (Indo-Dutch Mission, 1989). These regions are as follows:

1. Vaikom Kari
2. North Kuttanad
3. Kayal Kuttanad (Kayal land)
4. Lower Kuttanad
5. Upper Kuttanad
6. Purakkad Kari

1. Vaikom Kari: A piece of land situated at the northern part of the Kuttanad, it spreads over 7748 ha falling under Kottayam district located at the north of North Kuttanad and include Vaikom (Anon, 2007). Western part of this land is 0.5m below and eastern part is lying over 6m above from the sea level (Shari and Chithra, 2005). This area is also having acidic soil. Muvattupuzha River drains into this land and the below sea level area faces saltwater intrusion during summer (Shari and Chithra, 2005).

2. North Kuttanad: This tract is formed by the deposition of alluvium carried by the Meenachil River, and it is spreads over 6556 ha (Shari and Chithra, 2005; Anon, 2007). Western part of this zone lies 1.5m below sea level and eastern part is 1m above MSL. This area is also affected by flood and salinity (Shari and Chithra, 2005).
3. **Kayal Kuttanad (Kayal Land)**: It spreads over 9464 ha area at elevations 1 to 2m below MSL with bund levels ranging from 0.6 to 1.1m above MSL (Anon, 2007). This region has the reclaimed land from Vembanad estuary and faces threats from flood and saline water intrusion; hence the paddy cultivation of this area is very challenging (Shari and Chithra, 2005).

4. **Lower Kuttanad**: This is the core area of Kuttanad, situated in between Upper Kuttanad and Kayal Kuttanad and spreads over 16280 ha, much of the area falling in Alappuzha district. Western part of this division (majority of the paddy fields) is lying 1.5m below MSL and eastern part is around 1m above MSL (Anon, 2007). Like Kayal Kuttanad this region also faces severe threats from the floods and salt-water intrusion. Three rivers viz. Pamba, Achankovil and Manimala drains into this area, therefore floods of this region last longer (Shari and Chithra, 2005). Assemblage of human settlements is seen here in the dykes in between the river, canal and paddy fields and in small island like places in paddy fields is a common feature of this land (Shari and Chithra, 2005).

5. **Upper Kuttanad**: It is the South East zone of Kuttanad with elevation from 0.5m below to 6m above MSL (Anon, 2007; Shari and Chithra, 2005). It occupies around 10576 ha. Compared to other parts of Kuttanad, this region does not have that much effect of salinity intrusion and the flood during the monsoon (Shari and Chithra, 2005).

6. **Purakkad Kari** (Shari and Chithra, 2005): This division is situated at the south and lies close to the sea and forms the smallest among the six divisions. This area is strongly acidic because of the presence of high organic biomass present in the soil (Shari and Chithra, 2005). It spreads over 3500 ha land and situated 1.5 to 2m below MSL (Anon, 2007) and affected by severe saltwater intrusion due to the presence of sea.

### 2.3.7 Land use changes in Kuttanad

Centuries back the process of reclamation had begun in Kuttanad. In early reclamations small strips of land were recovered from shallow areas of backwaters and river systems in Upper Kuttanad region. By the middle of the 19th century due to the
increased population pressure on land and the non availability of shallow backwaters suitable for reclamation, people turned toward the Vembanad Lake (see Pillai and Paniker, 1965). Remote sensing studies carried out by Sylas (2010) showed a considerable change in the land use pattern of Kuttanad region, and noted that during 1967 – 2003, 20% of paddy lands have become fallow lands, another 8.3% became permanently water logged. It is not clear how much of built up land have been recovered from paddy and the water bodies (MSSRF, 2007).
Fig. 2.3 Six agro-ecological divisions of Kuttanad