ECOLOGY OF SMOOTH-COATED OTTER (*Lutrogale perspicillata*) IN THE LOWER KINABATANGAN WILDLIFE SANCTUARY, SABAH, MALAYSIA

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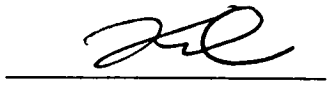

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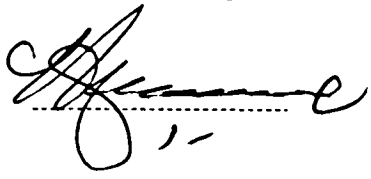

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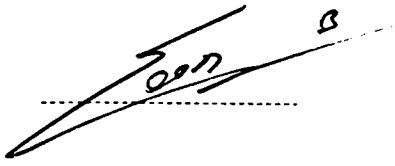

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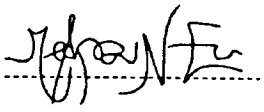

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ABSTRACT

Despite increasing levels of habitat loss and disturbance, and conversion of natural forest habitats to agricultural plantations in wetland areas in Borneo, very little is known about the Bornean otter species within these threatened wetland habitats in the island of Borneo. The aim of the present study was to gather baseline data on the population and habitat relations of otters and identify management issues affecting otter survival in the wild, which in turn may be useful for monitoring and managing this species with a view to conserve them. Set mainly in the lower reaches of the Kinabatangan River floodplain in Sabah, Malaysia, this study sought to (1) determine the presence and absence of otter species, including mapping their distribution across different habitat structures in the secondary lowland fragmented forest along the Kinabatangan River; (2) investigate the activity pattern of Kinabatangan's otters; and (3) discern local villager's perceptions towards otters, specifically to identify human-otter conflict. In addition to direct sightings, the presence of otters within an area is also strongly associated with the presence of their holts, spraints, grooming sites and footprint tracks; therefore, indirect observation techniques i.e., based on otter sign survey were used to detect the presence of otters in this study. A total of 25 sites were surveyed over a 12-month period. Each site was spaced in 1km intervals along the 40 km study area of the Kinabatangan River. Overall, 80 otter signs were detected and all belonged to the smooth-coated otter, *Lutrogale perspicillata*. Based on GLM result, presence of otter is positively correlated with high percentage of bare ground cover, sparse ground vegetation, steep riverbank slope, areas near to oxbow lakes, tributaries and human settlement, as well as grassland areas. However, based on occupancy modelling, otter occupied areas with sparse canopy cover and dense ground vegetation. The contrast in the GLM and occupancy result shows that there was a false absence occurred during the sampling. Areas with close proximity to oxbow lakes has the highest detection of otter sign, while areas with dense vegetation cover has the lowest detection. Four camera traps were deployed in front of two fresh otter holts for 15 non-consecutive months. The result showed that the Kinabatangan's otter mostly active during early morning and late evening, which was influenced by prey abundance and visibility, ambient temperature and human disturbances. A total of 58 respondents were interviewed in Batu Puteh village, Kinabatangan and most of the respondents (56.9%) were fishermen. Based on the interviews, 57% of the respondents held positive perceptions of otters and the level of human-otter conflict was relatively low in Batu Puteh village. The results of this study will be important in determining the current conservation status of Bornean otters in the lower Kinabatangan and provide a valuable baseline to assist in future population monitoring efforts.

Keywords: *Lutrogale perspicillata,* activity pattern, occupancy, human-otter conflict, Kinabatangan

ABSTRAK

EKOLOGI MEMERANG LICIN (Lutrogale perspicillata) DI SANKTUARI HIDUPAN LIAR HILIR KINABATANGAN, SABAH, MALAYSIA

Sangat sedikit diketahui mengenai spesis memerang di Borneo dan kajian juga sangat kurang di rantau yang kaya dengan biodiversiti ini. Maklamat utama kajian ini adalah untuk mengumpulkan data populasi dan habitat memerang dan mengenal pasti isu yang mungkin memberi kesan kepada memerang liar, dimana kajian ini menjadi sangat berguna untuk memantau dan mengurus spesis ini. Bertempat di Sungai Kinabatangan, Sabah, Malaysia, objektif-objektif kajian ini adalah untuk (1) menentukan kehadiran dan ketiadaan dan juga taburan spesis memerang di pelbagai struktur dan jenis habitat di hutan tanah rendah jenis sekunder; (2) menentukan corak aktiviti memerang; dan (3) mengenalpasti dan memahami konflik manusia-memerang dan persepsi penduduk terhadap memerang. Kehadiran memerang berkait rapat dengan kehadiran tanda memerang seperti lubang, tahi, kawasan berehat dan tapak kaki, oleh itu, pencarian tanda memerang telah dijalankan selama 12 bulan di sepanjang 40km di Sanktuari Hidupan Liar Hilir Kinabatangan. Terdapat 25 kawasan kajian dan setiap satu mempunyai selang 1km. Sejumlah 80 tanda memerang dijumpai dan semua dimiliki oleh spesis memerang Lutrogale perspicillata. *Dalam kajian ini, analisis GLM menerangkan bahawa kehadiran tanda memerang dikaitkan dengan tanah lapang, peratusan tumbuhan tanah yang rendah, tebing sungai yang curam, kawasan berdekatan dengan lembah tasik, anak sungai dan kediaman manusia, dan juga kawasan padang rumput. Manakala model penghunian pula mendapati bahawa memerang menghuni di kawasan yang mempunyai litupan kanopi yang jarang dan peratusan tumbuhan tanah yang tinggi. Perbezaan antara analisis GLM dan model penghunian ini menunjukkan bahawa terdapat ketiadaan palsu semasa persampelan. Empat perangkap kamera telah dipasang selama 15 bulan yang tidak berturut-turut, di depan dua lubang memerang yang aktif. Hasil kajian menunjukkan bahawa memerang aktif pada waktu awal pagi dan lewat petang dan aktiviti memerang dipengaruhi oleh kelimpahan dan kenampakan mangsa, suhu persekitaran dan gangguan manusia. Sejumlah 58 penduduk di kampung Batu Puteh, Kinabatangan telah diwawancara dan sejumlah besar daripada responden tersebut adalah nelayan kerana mereka adalah fokus utama kajian ini. Berdasarkan daripada respon responden, lebih separuh daripada responden mempunyai persepsi positif terhadap memerang dan tahap konflik manusia-memerang adalah agak rendah di kampung Batu Puteh. Hasil kajian ini adalah penting untuk menentukan status memerang Borneo dan memaklumkan tindakan pemuliharaan di masa akan datang.*

Kata kunci: Lutrogale perspicillata, *corak aktiviti, penghunian, konflik manusia-memerang, Kinabatangan*

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ha	hectare
cm	centimetre
m	metre
km	kilometre
am	morning
pm	evening
h	hours
et al.	and others
i.e.	in other words
n	total number
%	percentage
=	equal
>	more than

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Research background

Globally, there are 13 species of otters and four species can be found on the Southeast Asian island of Borneo; *Lutra sumatrana* (hairy-nosed otter), *Lutrogale perspicillata* (smooth otter), *Aonyx cinereus* (Asian small-clawed otter) and *Lutra lutra* (Eurasian otter). Otters (Order: Carnivora; Family: Mustelidae; Sub-family: Lutrinae) are grouped together with martens, weasels and badgers, however, otter demonstrate very unique morphology and behaviours that differentiate them from other mustelids (Payne and Francis, 2007). They have a broad muzzle and partially-webbed feet, which makes their footprint tracks distinguishable from other mammals (Payne and Francis, 2007).

Holts (otter dens), spraint (otter faeces), grooming sites and footprint tracks are strong indicators of the presence of otters within a riverine region (Anoop and Hussain, 2004). Holts are usually found nearby water bodies that would provide otters an easy access to food resources and adequate protection. Their holts can be found in thick, laced tree roots, loose cracks between rocks or any man-built structure (Quadros and Monteiro-Filho, 2002). Otters are a very territorial species and exhibit their territorial behaviour by sprainting along the boundaries of their home range (Kruuk 1992). Grooming site are often located in areas with a high percentage of sand and direct exposure to sunlight (Anoop and Hussain, 2014). In order to maintain the insulating ability of their fur, grooming activity is essential for otters and they spend a large amount of their time grooming as they forage food under water (Hussain, 2013; Kruuk, 2006).

In addition to their unique semi-aquatic and social behaviours, otters play crucial parts in preserving the ecosystem health through their many ecological roles. Otters are one of the top predators in the aquatic ecosystem (Hussain, 2013), and

they control the populations of the species they prey on (Estes *et al.*, 1998; Stewart and Konar, 2012). Otters can also act as ecosystem stabilizers (Hussain, 2013); sea otters (*Enhydra lutris*) indirectly help in maintaining the growth of kelp forests by preying on sea urchins. The predation upon the urchins helps facilitate kelp forest growth- which in turn becomes valuable habitat and food foraging sites for several species of larval fishes and other species in the aquatic community (Estes *et al.*, 1998; Roemer *et al.*, 2009; Stewart and Konar, 2012). Otters also have the potential to distribute aquatic nutrients to terrestrial ecosystem by depositing their spraint on ground (Ben-David *et al.*, 2005; Roemer *et al.*, 2009). By studying the otter population in a given watershed, the health of the ecosystem can be estimated, as given their high tropic position, otters can be good indicators of a functioning ecosystem (Hussain, 2013).

Despite their many ecological importances, otter populations are declining all over the world due to illegal hunting of otter for pet trade and fur, human-otter conflict, water pollution caused by the usage of pesticide in wetland ecosystem, overfishing, habitat loss, and deforestation along river margins (Bedford, 2009; Khan *et al.*, 2010; Lovett *et al.*, 1997; Quadros and Monteiro-Filho, 2002; Gomez and Bouhuys, 2018). Based on the IUCN Red List, the population trend of all 13 otter species are declining. Five otter species are identified as Endangered (sea otter, marine otter, southern river otter, hairy-nosed otter and giant otter); five species (Eurasian otter, African clawless otter, Congo clawless otter, Neotropical otter and spotted-necked otter) are listed as Near Threatened; and two species (Asian small-clawed otter and smooth-coated otter) are listed as Vulnerable (IUCN, 2016). In addition to direct threats, a significant threat to otter populations is a lack of basic status and ecological information at hand, most notably the Bornean otter species. Therefore, intensive research on the ecology of otters needs to be carried out to establish informed and effective conservation management plans for protecting otter populations.

1.2 Research justification

This research was conducted to provide baseline data on the population and habitat relations of otters and identify management issues affecting otter survival in the wild that may be useful for monitoring and managing this species with a view to conserve them. Information on otter species in Sabah is currently scarce and there is a dearth in knowledge on this semi-aquatic species in Lower Kinabatangan Wildlife Sanctuary (LKWS), despite the area being one of the most important protected wetlands in Sabah. In the LKWS, *Lutrogale perspicillata* and *Aonyx cinereus* are commonly seen, however, their population status and distribution are unknown and so far, no scientific studies have been conducted on otters in LKWS. The *Lutra sumatrana* was rediscovered in Sabah in 2010 and the *Lutra lutra* was considered extinct in Borneo during the Borneo Carnivore Symposium in 2011. In 2015, however, *L. lutra* was rediscovered and photographed. The knowledge on the population status of otters in Borneo remains patchy due to lack of scientific surveys and research. Despite their global population declines and playing important ecological roles in both wetland and terrestrial ecosystem, otters are often being neglected and appeared to be given less priority in terms of conservation. Given the rapid and extensive conversions of wetland ecosystem to agriculture, in particular oil palm (*Elaeis guineensis*) in the surrounding areas of the LKWS, information about otters persisting- in degraded habitats is crucially needed. With this information established, it can be used to develop future monitoring and conservation management plans for Bornean otters. This study aimed to determine the presence of otter species, their distribution range, habitat relations and activity patterns in fragmented and degraded habitats and in oil palm plantations, as well as to discern the local community's perception towards otter conservation and identify human-otter conflicts that might occur in LKWS.

1.3 Research objectives

The specific research objectives for this study were:

1. To determine the presence and absence of otter species, and their distribution across different habitat structures in LKWS
2. To investigate the activity patterns of otter in LKWS
3. To identify and better understand human-otter conflict and local people's perceptions towards otters

CHAPTER 2

LITERATURE REVIEW

2.1 Otter ecology and behaviour

According to Kruuks (2006), there are 13 otter species distributed around the world; *Lutra lutra* (Eurasian otter), *Lontra canadensis* (river otter), *Lontra longicaudis* (Neotropical otter), *Enhydra lutra* (sea otter), *Pteronura brasiliensis* (giant otter), *Lontra provocax* (Southern river otter), *Lontra felina* (marine otter), *Lutra sumatrana* (hairy-nosed otter), *Lutrogale perspicillata* (smooth-coated otter), *Aonyx cinereus* (Asian small-clawed otter), *Aonyx capensis* (Cape clawless otter), *Aonyx congicus* (Congo clawless otter) and *Lutra maculicollis* (spotted-necked otter). Of this number, four otter species can be found in Borneo; *Lutrogale perspicillata, Aonyx cinereus, Lutra lutra* and *Lutra sumatrana* (Payne and Francis, 2007). All 13 otter species differ in terms of morphology, however, all of them share several common behaviours that make them unique among other mammal species.

Sprainting is important to otters for communication and marking their territory and can act as signals concerning the spatial utilization of resources, as otters are territorial species (Kruuk, 1992; Shenoy *et al.*, 2006; White *et al.*, 2003). According to Kruuk (2006), spraint is defined as the faeces or waste of an otter. Spraints are the best sign indicating the presence of otter within an area, as all otter species scent-mark this way (Anoop and Hussain, 2004; Kruuk, 2006;). According to Kruuk (2006), otter's spraint emits a strong odour that is detectable by human nose from several metres away, especially when it is fresh. Spraint consists mostly of their food remains, for example fish bones, fish scales and mollusc shells. As sprainting acts as a form of intraspecific communication, it is important for the otter to select a suitable sprainting site and they often spraint on prominent places such as on top of rocks, under bridges, near trees or at the junction of tributaries (Kruuk, 2006; Shenoy *et al.*, 2006). They also spraint in or near the entrances of holts, except near natal holts with newly born cubs.

Holts are usually located close to the water and can be found among tree roots by the riverbank, under fallen logs, cavities among rocks or man-built structure such as drainage ducts (Anoop and Hussain, 2004; Quadros and Monteiro-Filho, 2002). Otters will build their holts in a strategic location to provide protection from predators, close to food resources and easy access to a water sources (Anoop and Hussain, 2004). Holts usually have several exits as part of their anti-predation strategies. Otter will actively spraint mark their holts by defecating around their holts, to mark their territory and to inform other otter group that the area is being utilized by a group of otter (Anoop and Hussain, 2004; Kruuk, 2006). Holts do not only function as resting sites, but also provide a site for the birthing of cubs. Natal holts, however, are used only when the female is giving birth and are usually hard to find as natal holt does not have a discreet entrance, and no visibly apparent signs are located around the holt, to avoid otter male cannibalisms to the new born cubs (Kruuk, 2006).

Grooming is an essential behaviour for otters as grooming helps in the survival of an otter (Anoop and Hussain, 2004; Hussain, 2013; Kruuk, 2006). The body temperature of an otter is around 38°C, and they need to maintain this temperature as they travel under cold water, which uses a large amount of energy (Kruuk, 2006). Otters usually lick and blow their fur, and air bubble are trapped in between their fur, which then gives their fur the thermo-insulation ability while underwater (Hussian, 2013; Kruuk, 2006). In order to maintain the insulating ability of their fur, otters spend 6-30% (1-7 hours) of their daily activity budgets grooming (Hussain, 2013; Kruuk, 2006). Grooming activities includes otters rolling their body on sandy, soil or grass substrate, rubbing their body on tree stump or rocks and licking or scratching their fur (Anoop and Hussain, 2004). There is a strong relationship between the depth of diving and longevity of grooming sessions, whereby the deeper the diving, the longer the grooming duration (Kruuk, 2006). Basking is usually done after grooming, where the otter will rest in the sunlight, presumable to increase its body temperature and facilitate in the drying process (Anoop and Hussain, 2004). Grooming sites are thus usually located in areas with direct hit of sunlight, high percentage of sand coverage, and also close to water (Anoop and Hussain, 2004).

2.2 Morphology, distribution range and biology of Bornean otters

2.2.1 *Aonyx cinereus* (Asian small-clawed otter)

Asian small-clawed otter or scientifically known as *Aonyx cinereus* (Figure 2.1), is widely distributed abundantly across Asia and its distribution ranges from India to South Asia; including the islands of Palawan, Borneo, Java and Bali (Hussain *et al.*, 2011; Phillips and Phillips, 2016). They occur in various type of habitats such as lower montane evergreen forests, peat swamp forests, freshwater wetlands, freshwater swamp forests, coastal wetlands, mangrove, marshes, rice fields, larger rivers, small streams in the hills, ponds and lakes (Foster-Turley, 1992; Lariviere, 2003; Payne and Francis, 2007; Roberton, 2007). They can also be found in habitats such as the coast, large rivers, small streams in the hills, ponds and lakes (Payne and Francis, 2007).

Being the smallest of the four species, *A. cinereus* head-body length ranges from 36 - 65 cm and their weight ranges from 2.5 - 4.7 kg (Hussain *et al.*, 2011; Payne and Francis, 2007; Phillips and Phillips, 2016;). Their feet are smaller in size compared to other otter species and claws are not exceeding beyond their digital pads, therefore their footprint tracks appear "clawless" (Hussain *et al.*, 2011). Their toes are also closer together and have a narrower web in between toes (Hussain *et al.*, 2011; Payne and Francis., 2007). *A. cinereus* has a rounder head compared to the other Bornean species, and their upperparts appear as dark brown or greyish brown with slightly paler on the underparts (Payne and Francis, 2007; Phillips and Phillips, 2016). In addition, their neck area appears to be buffy (Payne and Francis, 2007; Phillips and Phillips, 2016). They have a smooth rhinarium (nose pad), similar to *L. perspicillata*'s rhinarium but it appears smaller in size and often lighter in colour (Hussain *et al.*, 2011; Phillips and Phillips, 2016).

This species is widely nocturnal (active during the night) and can also be a crepuscular (active during dawn and dusk) mammal (Foster-Turley, 1992). Their diet consists mainly of crabs, shrimps, smaller fishes, other crustacean and molluscs (Foster-Turley, 1992; Hussain *et al.*, 2011; Payne and Francis, 2007). They are very social animal and live in groups ranging in size from 2-12 individuals, which are often family groups (Hussain *et al.*, 2011). Adult mates will normally pair for life and will

rear their cubs equally until the cubs become independently capable (Hussain *et al.*, 2011; Payne and Francis, 2007).

2.2.2 *Lutra sumatrana* (hairy-nosed otter)

One of the least known otter species, *L. sumatrana* (Figure 2.1) is known to occur on the Malaysian Peninsula, bordering southern parts of Thailand, Borneo, Java, Cambodia, Vietnam, Borneo and Java (Kruuk, 2006). It has been many decades since a direct sighting of *L. sumatrana* has been recorded and it was rarely seen in the past, sometimes with the only evidence of its occurrence in a region determined from a roadkill carcass (Indonesia [Lubis,2005]; Selangor, Malaysia [Tan, 2015]). Due to a lack of regular scientific detection, *L. sumatrana* was once thought to be extinct in Asia; recently, however, the species has been rediscovered in many new regions such as Cambodia in 1998 (Long, 2000), direct sightings in Sumatra in 2013 (Latifiana and Pickles, 2013), Vietnam in 2000 (Dang *et al.*,2011) and camera trap photo in Sabah in 2010 (Wilting *et al.*, 2010). It is believed that their preferred habitat consists of swamps, swamp forest, rivers, streams, lakes, and coastal environment (Kruuk, 2006; Payne and Francis, 2007). Despite these new localities, the species s still considered Endangered by the IUCN (IUCN, 2016).

One of the most distinctive features of *L. sumatrana* compared to other Bornean otter species is their hair-covered rhinarium (Kruuk, 2006; Wright et al., 2008). They also have a dark brown coat and distinct white fur on the lips, chin and upper throat, with coat texture described as short but rough (Kruuk, 2006; Payne and Francis, 2007; Wright *et al.*, 2008). Their feet are fully webbed and claws are conspicuous (Payne and Francis, 2007). Their head-body length ranges from 50 - 60 cm and their weight ranges from 7 – 8 kg (Payne and Francis, 2007; Wright *et al.*, 2008).

This species is considered nocturnal and is usually found solitary, rarely in groups (Kruuk, 2006; Payne and Francis, 2007). Their diet consists mainly of small fish, and also some snakes, frog, crabs, insects and few small mammals (Kanchanasaka, 2001; Kruuk, 2006). Their spraint is usually in a cylindrical shape does not emit a detectably strong fishy smell (Kanchanasaka, 2001). Sprainting sites

are usually found at the base of a large tree or on a log or tree trunk (Kanchanasaka, 2001).

2.2.3 *Lutrogale perspicillata* (smooth-coated otter)

The smooth-coated otter or scientifically known as *L. perspicillata* (Figure 2.1) is commonly seen and distributed abundantly across Asia, with distribution ranging from India to Sumatra. *L. perspicillata* is well-adapted to many aquatic habitat types and can be found in lowlands, mangroves, freshwater wetlands, small and large rivers, lakes, rice fields and including nearby human settlements (Khan *et al.*, 2010; Sivasothi *et al.*, 1994).

Being the largest among these four otter species, *L. perspicillata* head-body length ranges from 1-1.2 m, while the weight ranges from 5-8 kg (Phillips and Phillips, 2016). They have a somewhat flattened head, thick muscular tail, thick fur that appears "velvety" and noticeably large paws (Khan *et al.*, 2010; Kruuk, 2006). The shape of rhinarium is similar to *A. cinereus* but larger in size and they have hairless rhinarium (Payne and Francis, 2007). Coat colour varies from dark to reddish-brown and often has a creamy colour on the underpart of their neck (Payne and Francis, 2007; Sotheary, 2011).

They are a largely piscivorous animal, with a diet dominated by fish, although they also eat other prey such as frogs, rats, insects, and snakes (Foster-Turley, 1992; Kruuk, 2006). Their spraints are usually seen in a large pile, which consist mainly of fish scales and strongly smells of rotten fish (Kruuk, 2006). According to Khan *et al.* (2010) and Hussain (2013), they are mainly diurnal animals, although elevated human disturbance levels within their habitats might result in more nocturnal behaviours. They are very social mammals, with group sizes ranging from 5-20 individuals, which comprises of parents with cubs and sub-adult (Khan *et al.*, 2010; Kruuk, 2006). Moreover, *L. perspicillata* have been observed demonstrating cooperative group hunting behaviours (Khan *et al.*, 2010).

2.2.4 *Lutra lutra* (Eurasian otter)

Eurasian otter or *L. lutra* (Figure 2.1) has the widest distribution range of all other otter species and they are found in Europe, North Africa, Russia, India, Pakistan

Mainland Asia, Sri Lanka, Taiwan, Japan, Sumatra and Java (Payne and Francis., 2007; Ullah *et al.*, 2012). In this past several decades, it has extinct in few regions due to anthropogenic activities (Ullah *et al.*, 2012). With no definite records in Borneo, *L. lutra* was thought to live in mountainous areas around Borneo based on the records found, which was skin pelt (Payne and Francis, 2007). However, the condition of the pelt made it difficult to confirm the species identification. Meanwhile, in Peninsular Malaysia, the only record of *L. lutra* was from Pulau Langkawi (Sivasothi and Nor, 1994). However, recently there have been several purported sightings of *L. lutra* around Borneo (Phillips and Phillips, 2016), although this is yet to be confirmed by genetic evidence.

The head-body length of *L. lutra* ranges from 1 m - 1.5 m and weight ranges from 7 - 10 kg (Kruuk, 2006; Payne and Francis, 2007). They have a dark brown fur with paler chin and upper throat as well as a grizzled fur appearance (Kruuk, 2006; Payne and Francis, 2007). Their feet are fully webbed and claws, although they are not as prominent as *L. perspicillata*, their claws can still be seen on their tracks (Kruuk, 2006). Their daily activity patterns depend on their habitat, as they have been recorded as both nocturnal and diurnal (Kruuk, 2006). They are social mammals and often seen in groups that normally consists of a mother with sub-adult cubs (Kruuk, 2006). Males and females are only together during mating (Kruuk, 2006). *L. lutra* consumes mostly fish, crustaceans and other small vertebrate (Kruuk, 2006; Payne and Francis, 2007).

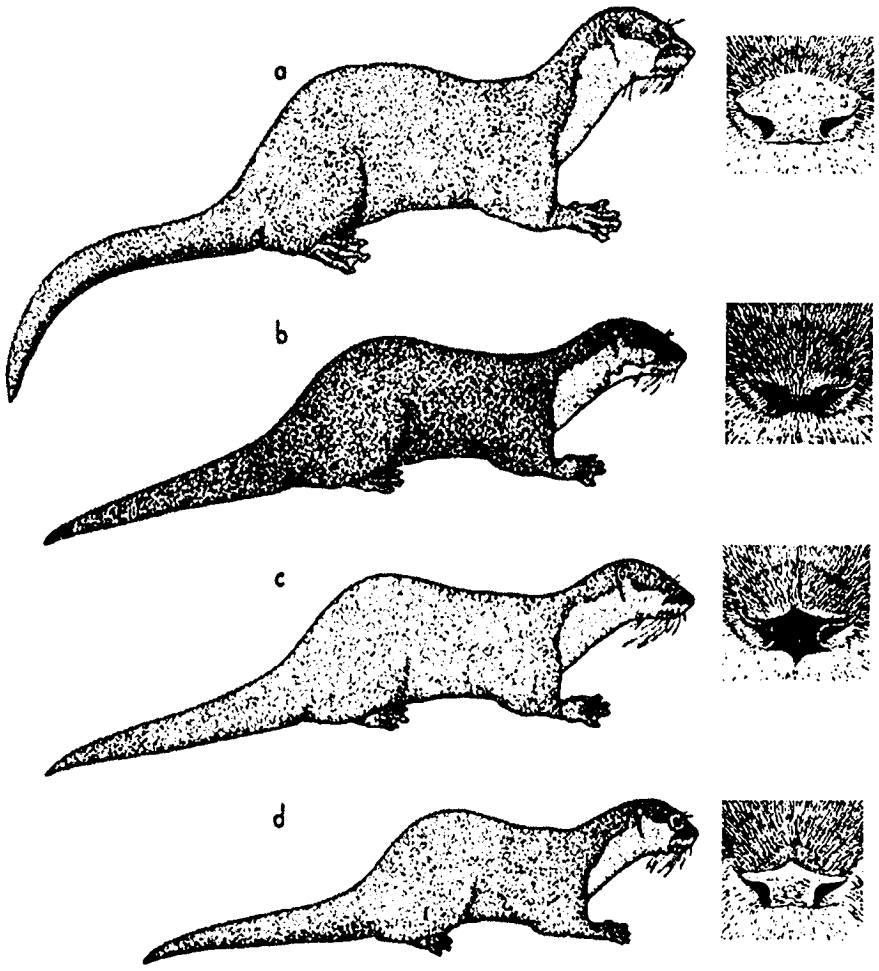

Figure 2.1: Body size and rhinarium comparison of all four Bornean otter species;

(a) *Lutrogale perspicillata* (smooth-coated otter)

(b) *Lutra sumatrana* (hairy-nosed otter)

(c) *Lutra lutra* (Eurasian otter)

(d) *Aonyx cinereus* (Asian small-clawed otter)

Source : Foster-Turley *et al.* (1990), Sivasothi and Nor (1994)

2.3 Otter habitat selection

Otter inhabits in any aquatic environment, where there are sufficient food sources, although, certain otter species have some specific habitat preferences depending on their specific needs and adaptation towards the environment surrounding them (Kruuk, 2006). Food availability and accessibility, as well as adequate shelter influence the habitat selection by otters (Anoop and Hussain, 2004; Kruuk, 2006). Generally, otters prefer shallow, well-vegetated banks (Kruuk, 2006) to enable them to hunt with minimum energy expenditure (Anoop and Hussain, 2004). River bank vegetation is also known to be selected for as it provides protection to their holt especially when they are rearing cubs (Shenoy *et al.*, 2006). Low canopy covers also preferred by otters as they need the sunlight to dry their fur after their hunting activities (Shenoy *et al.*, 2006).

The smooth-coated otter, *L. perspicillata,* is a strongly adaptable species that can adapt even to a severely disturbed environments such as urban areas (Theng and Sivasothi, 2016). In Singapore, the otters have been documented using completely bare and vertical wall, which indicates that they are adapting to the harsh environment in order to survive (Theng and Sivasothi, 2016). Although they can survive in a heavily disturbed environment, this type of habitat is not natural nor optimal for them and may hinder their natural behaviours and affect them physiologically. In their natural habitat, *L. perspicillata* are mainly found in large river, lakes and rice paddies field (Foster-Turley, 1992; Kruuk, 2006; Sivasothi and Nor, 1994). Dense vegetation with many trees on the river bank are preferred when digging their holts as a part of their anti-predation strategies (Anoop and Hussain, 2004; Shenoy *et al.*, 2006). In terms of their grooming sites, this species has been documented selecting areas that contains a high percentage of sand, sparse vegetation and low canopy covers (Anoop and Hussain, 2004; Shenoy *et al.*, 2006).

Similar to *L. perspicillata*, *A. cinereus* is also very adaptable species and has been documented in rice paddies, small streams, narrow mountain creeks, natural pools and slow-flowing and wide rivers (Hussain *et al.*, 2011; Kruuk, 2006). Their habitat selection is influenced by their food preferences, which is mainly crabs (Kruuk, 2006; Hussain *et al.*, 2011). *A. cinereus* has been documented as preferring well-vegetated areas for the purposes of protection (Hussain *et al.*, 2011). In

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