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The Asian Palm Civet: Fundamental Baseline Findings in Ecology, Captive Husbandry and Effects of Trade in Civet Coffee

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i. ABSTRACT

Global wildlife population trends are being depleted due to wildlife trade, habitat loss, anthropogenic activities and climate change and only a few of the treats to named species reach global awareness. In respect to mammalian carnivores these tend to be the large charismatic species such as wolves, lions, pandas and tigers for example, small carnivores are far less known, even though threats to populations are as great. One such underrepresented small carnivore is the Asian palm civet of Asia and their threats, conspecific guild interactions and conservation. Asian palm civet (*Paradoxurus musangus*) are small, nocturnal, arboreal, generalist, omnivorous wild viverrids (Mammalia: Carnivora), known as a pest, pet, food and producer of civet coffee (kopi luwak) primarily in Indonesia. Kopi luwak is produced by civets consuming coffee berries and then defecate fermented coffee beans, these beans are washed, roasted and brewed into this highly prized gourmet coffee variety.

Research was carried out to investigate the conspecifics present in the same habitat with Asian palm civets and indicate behavioural ecology and niche. To identify the threats to populations of civets and other carnivores from the exotic pet and kopi luwak trades and make both observations and recommendations related to captive civet husbandry and welfare in ownership. Data were collected by camera trapping wild civets, visits to markets and kopi luwak plantations, and social media and online surveys. To identify what interactions and niches occur between mesocarnivores in the wild, camera traps were used and 11,146 camera trap nights yielded 4,525 images identifying nine species of wild mesocarnivores from Viverridae, Mustelidae, Herpestidae and Felidae groups with 44.4% of images showing Asian palm civets using forest floor, trees, chayote frames and waterlines. Other carnivores were only recorded locomotive behaviour terrestrially. Scent marking behaviour was recorded in six species of mesocarnivore (*Paradoxurus musangus*, *Prionailurus bengalensis, Melogale orientalis*, *Martes flavigula, Herpestes javanicus* and *Canis familiaris*) and showed mutualism for scent site yet no mesocarnivore used the sites at the same time as another species, so whilst they communicated through scent they appeared to otherwise occur at different times. Asian palm civets and Javan ferret badger were nocturnal, yellow throated marten and leopard cat were crepuscular with the leopard cat also showing regular nocturnal activity. The Javan mongoose and domestic dog were diurnal with indications of cathemeral activity.

In Indonesia, the pet animal trade in cities is well known and evident in markets but less known or evident via online sources. Trade incorporates domesticated pet species and many wild exotic pets also. Civets are among many wild species now kept as pets and pages called “Musang Lovers” are being created on social media platforms such as Facebook to connect owners of civets across the country. This thesis assessed the membership of 235 Musang Lovers pages on Facebook, these

rose from 768,603 to 947,280 in just one year (489.5 people per day increase) with a mean of 4,031 members per club. Musang Lovers sites were used by members for advice, to socialise, to coordinate meetings, to display and sell animals and their accessories. Survey results showed civet owners as male (71.1%), Indonesian (89.6%), 25 years old and first-time owners (53.0%), kept two civets as their only pets (84.1%). Asian palm civets were most common (52%-72.3%) but six other Viverridae were also recorded. Sources included; wild (11.7%) and animal markets (16.4%), and numbers traded hugely exceeded the 250-300 annual trade quota legally permitted. Captive breeding increased from 22.2% to 53.9% (average: 35.8%). 45.6% of civets were under one year old (average: 5 months of age, some sold unweaned under two weeks old). Civets appeared mostly healthy (79.0%) though 8.6% were underweight and 9.1% were overweight. Injuries recorded were self-inflicted to body, limbs, tail or head in captive civets.

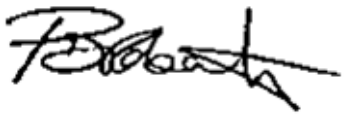
An additional trade occurs to exploit civets for the production of civet coffee (kopi luwak) produced by tourist targeted cafeterias within small agricultural plantations (Agro Wisata). Agro Wisata were visited (n=40), counting 156 Asian palm civets, with 96.2% locally wild caught. Indonesian Law no.37 (2015), legislated kopi luwak production standardising; the five animal's needs, housing, diet, production methods and ownership duration. No plantation met all legal requirements. Cage sizes were below legal sizes (95%), with incorrect substrate (50%), lack of hygiene (35.3%), little or no enrichment (67.6%) and poor construction (58.8%). All shelters were below the statutory 2 metres above ground, 11.8% with either no shelter or one on the cage floor. All enclosures had a roof exceeding legislative requirements. Civets were awake during daytime (73.5%) and some showed distress and stereotypic behaviours. 94.2% of animals were condition scored at 3 with just 3.2% overweight and 1.9% showing injuries. Unlike the pet trade, kopi luwak plantations have kept civets up to 15 years despite illegal after 5 years. Average civet age was 3 years (range 4 weeks to 15 years). Plantation tour guides stated that civets were "*vegetarian*" on 38.3% of visits. Indonesian laws relating kopi luwak, animal welfare and wildlife trade are not enforced, leading to severe infractions of the five animal needs. Civet husbandry needs significant urgent improvements to promote welfare, natural behaviour and health covering overall housing construction, hygiene, feeding, enrichment and drainage. Urgent improvements are needed towards training, education programmes and materials for pet owners and kopi luwak plantations.

On the outset of research, the Asian palm civet was believed to be primarily threatened by the kopi luwak trade in Indonesia and that the pet trade in the species was secondary to this. The two trades are now believed to be even more extensive than originally supposed and is still increasing. Claims about Kopi luwak's production restriction and wild provenance are false and misleading to customers. Kopi luwak may lose its novelty value eventually though the trade in civets as pets will remain as a threat with greater longevity and greater capacity for destroying wild populations of civets with currently unknown detrimental effects on ecology and biodiversity.

ii. PREFACE

The research described in this thesis was conducted at the Department of Social Sciences at the Oxford Brookes University under the supervision of Professor Vincent Nijman and Professor K. Anne-Isola Nekaris.

This study represents original work by the author and has not otherwise been submitted in any form for any degree or diploma to any other University. Where use has been made of the work of others, it has duly been acknowledged in the text.

Signed 

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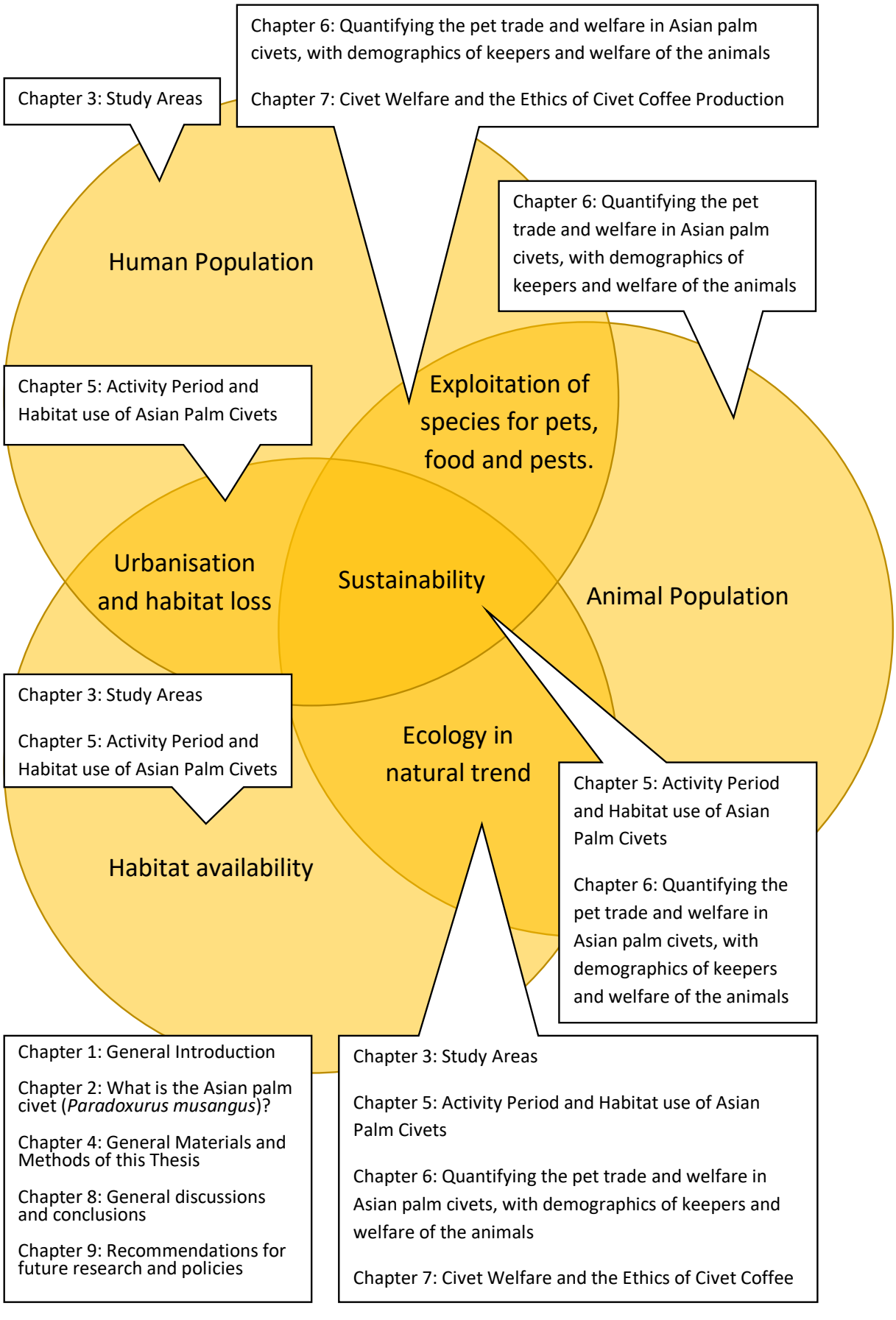
iv. CONTENTS

v. INDEX TO FIGURES

vi. INDEX TO TABLES

vii. THESIS ROADMAP



GENERAL INTRODUCTION

1. GENERAL INTRODUCTION

1.1. Overview of threats to biodiversity and population

Habitat destruction, anthropogenic changes, wildlife trade and climate change are leading to detrimental effects on worldwide biodiversity. This is trending towards an increased global extinction rate of plant and animal species of up to 10,000 times higher than naturally derived trends (De Vos, *et al.,* 2014). The IUCN red list classifies 85% of all listed species as under threat from habitat loss as well as from invasive species and trade (IUCN, 2015). Humans are changing habitats to resource timber for building, to expand urban areas, to clear habitats for growing crops and grazing livestock (Yurike, *et al.,* 2018). Biodiversity notably under threat from irreversible habitat degradation by humans occur in rainforest, grasslands, freshwater habitats, coastal regions and tundra (Bevanger, 2019). Since 1990, 94 million hectares of global forest has been lost, mainly for conversion to agricultural land resulting in the loss of up to 50% of the entire worlds biodiversity particularly from tropical forests (Sivashanmugam, 2007; Simonsen, 2018). According to Greenpeace, Indonesia is one of the worst performers for sustainability and maintaining biodiversity as for example the country has lost 74 million hectares of forest within half a century (around 72% of the whole) (Greenpeace, 2019).

Indonesia is sited in the southern hemisphere at 6.1750°S, 106.8283°E within the tropical biome. Historically the islands would have been densely clothed with highly biodiverse rainforests (containing 10-15% of all global plant and animal species) yet has lost significant amounts of forests due to agricultural expansion (Greenpeace, 2019). A process set to increase as the cultivation of plantations of such as palm oil crops continues to rise, demand for this crop is projected to double to 240 million tonnes by 2050 (Corley, 2009), a demand that will increase the 15 million hectares of land already used for palm oil production currently (Greenpeace, 2019). The increasing demand due to around 50% of typical supermarket brands now contain palm oil whether food products, cleaners or cosmetics (Turner, 2018) yet as palm oil plants vegetable oil production is greater than any other alternative, more land is lost than would be if alternative plants were used (Hinrichsen, 2016). Further problems arise from this habitat change, the draining and loss of peat forest in Borneo for timber and palm oil for example probably contributed to the fires that ravaged the island in 1997 resulting in loss of 32% of forests, and a release of carbon equivalent to up to 40% of all emissions since the 1950s (Page, *et al.,* 2002). Extensive fires have also occurred most recently up to the end of 2015, further preventing recovery and destroying more primary habitat (Mang, 2017). It is predicted that fires will ravage the island's forests again in the future. In Indonesia the annual loss of forest due to conversion to arable and livestock farming, housing, fuel and forest fires are up to 2.5 million hectares per year (Budiman, *et al.,* 2018). Undoubtly having an affect on the endemic species assemblages, biomass, biodiversity and functionality of ecosystems.

A contributing driver to the threats to habitat loss and biodiversity deterioration is the growing human population in Indonesia. Indonesia's human population stands at 262 million people according to the 2017 census (Setiyono and Chalmers, 2018). Bali and Java for example are two of 17,000 plus islands (17,508 according to Inlingua, 2015) within the Indonesian archipelago (Dahuri & Dutton, 2000) (further details of the economy and ethnities of Java and Bali can be found in Appendix One, Chapter 11.1). The islands of Java and Bali are particularly densely populated with over 130 million people residing on Java and 4.225 million people residing on Bali, rising by 2.1% per year (UNEP, 1998; Ardli & Wolff, 2009). Java's population in 1980 was 91 million (UNEP, 1998), therefore the likely pressure on native habitats and species is increasing. Indonesia consists of 18,115.7km^2 of which 51.4% is forest, 31.2% is agricultural land and 17.4% is unaccounted for habitat types (World Bank Group, 2015a, World Bank Group, 2015b). Java is ranked 13th in the world's largest islands with an area of 138,794km^2. Bali is much smaller at 5,416km^2 and is ranked 108th in the world. The forests in Indonesia were once more extensive and becoming fragmented by conversion from native forest to agricultural land to feed the growing population and for export around the world. Sitorus & Pravitasari (2017) states that 25% of Indonesia's total land area as suffered severe degradation due to agriculture causing loss of soil, loss of vegetative cover and loss of productivity. That puts great pressure on remaining native flora and fauna as 46% of Indonesia's human population lives in rural areas (Van der Schaar Investments, 2017).

Agriculture seems to be quite seasonally volatile for Indonesia, characteristically low productivity in the first quarter of the year, markedly improving during the middle half before declining again in the 4th quarter (Trading Economics, 2018). This could leave farmers in need of diversification of their trade and sale of goods that includes harvesting timber, bamboo and wildlife species from their land and surrounding areas. For those animals that survive the changes in habitat, there is the added pressures of the non-native plant and animal introductions, hunting for bushmeat, wildlife trade for exotic pets and eradication of species deemed as pests (Nijman, 2010). Cookson (2019) and Vaughan (2019) report that a mean of 18% of all 31,745 land-based vertebrate taxa are commodities of wildlife trade (27% of mammals alone) and that this is upto double the quantity of previous estimates of the extent. Wildlife trade in mammals in Indonesia ranks the country within the top 5% of contributing nations, with maps indicate that Sumatra and West Java are particular hotspots (Cookson, 2019; Vaughan, 2019) (more details on Indonesian wildlife trade can be found in Chapter 6).

Such endemic mammal species likely affected by trade and deforestation are Sumatra's two orangutan species (*Pongo abelii* and *P. tapanuliensis*) and Borneo's own (*Pongo pygmaeus*) (Ancrenaz, *et al.,* 2016; Singleton, *et al.,* 2017). Borneo, Sumatra and Java also have further endemism for their respected critically endangered Javan and Sumatran rhinoceros species (*Rhinoceros sondaicus* and *Dicerorhinus sumatrensis*) (Van Strien, Manullang, *et al.,* 2008; Van Strien, Steinmetz, *et al.,* 2008), Slow Lorises (*Nycticebus* spp.) (Nekaris & Jaffe, 2007), the pangolin (*Manis* spp.) (Shepherd, 2009) and the remaining

tiger species, the Sumatran tiger (*P. t. sumatrae*) (Goodrich, *et al.,* 2015) and these all of these species despite being named after specific islands formally had a wider distribution (Nijman, pers comm). Asia is also resident to Asian elephants (*Elephas maximus*) with populations in Sumatra, Borneo and India and several other countries (Choudhury, *et al.,* 2008). These are under threat from habitat loss due to burning and palm oil and trade in such as Asian traditional medicines, ivory and rhino horn (Sodhi, *et al.,* 2010a; Sodhi, *et al.,* 2010b). It is noted that the reason for the extinction of the Javan tiger (*Panthera tigris sondaica*) likely in the 1980s (declared extinct in 2003) was due to hunting for medicinal uses and compounded by habitat loss and reduced prey populations (Panko, 2017). The threats posed to mesocarnivores are not well known and this includes civets and their relatives.

There is however a disproportionate media coverage on the plight of species' threats and conservation efforts depending on how charismatic and well known the species is to the general public (Kontoleon & Swanson, 2003). Species such as: orangutans (*P. abelii, P. pygmaeus* and *P. tapanuliensis*, giant pandas (*Ailuropoda melanoleuca*), rhinos (*R. sondaicus* and *D. sumatrensis*), elephants (*E. maximus*) and tigers (*Panthera tigris*) can be advocate flagship and poster species to help raise awareness of wider issues (Walpole & Leader-Williams, 2002). Among the carnivore communities around the world, media covers such as: Lions (*Panthera leo*), tigers (*P. tigris*), leopards (*P. pardus*), wolves (*Canis lupus*), bears (*Ursus* spp.) and African wild dogs (*Lycaon pictus*) for example, yet does not generally tell the stories of small carnivores (excluding meerkats *Suricata suricatta*), members of the weasel family (Mustelidae), small canine (Canidae), small cat (Felidae), mongoose (Herpestidae) and especially the members of the civet family (Viverridae)[1].

The research *in scripta* is derived from Indonesia in South East Asia and investigated the Asian palm civet (*Paradoxurus musangus*) (introduced in Chapter 2), their conspecific mesocarnivores and identified threats to their densities, niches and welfare. As noted previously mesocarnivores are less known and less studied but are vital components of the ecosystem, though difficult to study due to a mix of cryptic behaviour, socially solitary and use of habitats too challenging for people to utilise. The species are seldom believed a threat to human or livestock lives. Indonesian carnivores are seldom known in the western world so they could be under threat unseen due to demand for crops such as palm oil and coffee for example. This study is one of many needed to understand the ecology and conservation requirements of mesocarnivores in Indonesia and to raise awareness of the threats to the species. Business ventures could potentially threaten biodiversity and populations specifically on the islands of Java and Bali by investigating the pet trade in civets and other carnivores, exploring the scale of the trade and animal welfare (Chapter 6). Finally

[1] The author of this thesis has studied both civets and Genets. Most people have never heard of Genets and of those that have heard of civets only know civet coffee, sometimes not realising that the coffee is part digested by an animal.

analysed the welfare of civets used in the production of animal produced coffee varieties namely civet coffee (in Indonesian known as kopi luwak – also referred to in this *in scripta* by this name) (Chapter 7). Before this, clarity needs to be given in to what actually an Asian palm civet is as the classification and affliations of the species have been reassessed on a number of occasions (in the thesis appendices in Chapter 11.2).

1.2. Perceived threats to civet and other small carnivore populations in Indonesia

As well as the pressures from increasing human population and the anthropogenic changes of habitat to agriculture there are a number of additional business ventures that could be major threats to populations of wild civets and other carnivore species throughout the Indonesia's islands. By 2050, it is projected that 67% of Indonesia's population will live in urban areas (Van der Schaar Investments, 2017). To accommodate population growth, the urban areas must encroach outward to anthropogenically change peripheral native habitats in to housing and farmland. In this thesis, wild civet data is collected from Cipaganti village near Garut in West Java as a model for biodiversity and threats wider Indonesia (see Chapter 3). The village has a small but expanding human community encroaching on native fragmented habitats typical across Indonesia. There is no formal waste disposal infrastructure and litter is abundant in the streets, sports field and in the watercourses that poses a threat to wildlife in the form of entanglement, injury, disease vectoring or toxicity.

Native trees and bamboo are under threat continually as they are major building materials, for fuel and to remove borders to fields to make fields larger for more crops (Figures 7 and 11). These clearances leave no natural corridors of endemic vegetation for wild species to migrate between remaining fragments. Fragmentation is likely to reduce biodiversity and carrying capacity, requiring animals to travel further seeking suitable habitats for resources, conspecifics, rest sites and sites to sleep to avoid predation (Nakashima, *et al.,* 2013; Wanlop, *et al.,* 2015). Greater ranging habits could also lead to increased chances of death on roads as a result of collisions (Colón, 2002). Whilst Asian palm civet may well be adaptable to live in antropogenically changed habitats and feed from some of these crop plants (Bartels, 1964; Rabinowitz, 1991; Joshi, *et al.,* 1995; Jothish, 2011; Nakabayashi, *et al.,* 2016). Heydon & Bulloh (1996) recorded civets persisting in logged and unlogged habitats and determined that the carrying capacity of the altered habitat was around 20% of the primary forest. Parikesit, Withaningsih & Prastiwi, 2019 too also recorded lower civet densities in disturbed habitats. As a juxtaposition however in fields of crops, small carnivores like civets may assist in preventing crop loss by hunting rodents and invertebrates that cause crop damage (Pin & Tiong, 2008; Zaki, 2018) and promoting seed dispersal (Rabinowitz, 1991; Nakashima, *et al.,* 2010; Jothish, 2011; Nakabayashi, *et al.,* 2012; Fung, 2016). It is unknown if the Asian palm civet and other carnivores in Cipaganti are adapting or adapted to the changed habitats.

Civets are also traded into exotic pet and Kopi luwak businesses in Indonesia. Wildlife trade is well known and widespread in Indonesia (Nekaris & Jaffe, 2007; Nijman, 2010; Shepherd, 2008; 2012; Shepherd & Shepherd, 2010; Nijman, *et al.,* 2014; Cookson, 2019; Vaughan, 2019; Lewis-Whelan, *et al.,* in prep). Trade includes large quantities of animals are currently being traded legally and illegally in national and international trade in Southern Asia (Nijman, 2005; Nijman, 2010; Nijman, Nekaris, *et al.,* 2011; Cookson, 2019; Vaughan, 2019). Within legal trade there is likely increasing global demand in civet coffee (kopi luwak) that may threaten wild populations of Asian palm civet (Shepherd, 2008; 2012). Cipaganti is a probable source of civets for the trade as traps intended for civet have been discovered in the area (Figure 1). It is unknown whether the anonymous trapper was intending on capturing a civet to sell in to kopi luwak production or as an exotic pet or to eliminate as a pest. It is not expected that the trapper intended the civet captured to become bushmeat as civets are not normally eaten in Indonesia. However, elsewhere in Asia civet derived bushmeat is common, a recent study in India ascertained from DNA that 99% of confiscated processed meat was from Asian palm civets and that once processed other than through DNA would be very difficult to determine species' source (Ghosh, *et al.,* 2019). As live civets have been seen for sale in the market in the town of Garut, it is assumed that markets are the most likely route for any trapped civets in Indonesia would be into the pet trade (Chapter 6) or kopi luwak production (Chapter 7).

1.3. Businesses and ventures keeping and selling civets and other carnivores

The keeping and sale of civets in Indonesia requires supporting and supplying businesses and ventures. These are including but not exclusively (Nekaris & Jaffe, 2007; Nijman, 2010; Shepherd, 2008; 2012; Shepherd & Shepherd, 2010; Carder, *et al.,* 2014; Nijman, *et al.,* 2014; Cookson, 2019; Vaughan, 2019; Lewis-Whelan, *et al.,* in prep):

- Animal Markets selling livestock and accessories directly to customers.
- Breeders supplying markets, pet shops and kopi luwak plantations with animals.
- Farms keeping civets and other animals that are not open to the public for kopi luwak, fur, scent and for meat.
- Kopi luwak Plantations (Agro Wisata) selling kopi luwak to tourists and tours.
- Pet shops selling livestock and foods and accessories directly to customers.
- Private breeders, hobbyists and sellers selling via social media on species and breed specific pages and clubs.
- Trappers supplying markets with wild caught animals.

Markets selling animals and their accessories can be little more than pop-up stalls on the roadside to small shops, the size of a single car garage to medium and large multistore establishments (Figure 2) (Nijman, *et al.,* 2014). Breeders supply animals to the markets but also via online listings on such sites as '*Musang Lovers*' on Facebook. For results and discussion on animal markets and *Musang Lovers*, see Chapter 6.

Figure 1 has been removed from this version of the thesis due to copyright restrictions

Figure 1: First civet trap sighted in Cipaganti, in November 2013 (Reproduced from: Rode-Margono, *et al.,* 2014).

a

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Figure 2: Selection of images from Java and Bali animal markets taken between 2013 and 2018. a) Denpasar, Bali; b) Garut, Java; c) Bandung, Java; d) Pasar Barito, Java; e) Pasar Premuka; Java; f) Pasar Burito, Java (showing a small Indian civet for sale)

The businesses within which the civet is perhaps best known is in the production of civet coffee, in key tourist destinations such as the island of Bali. In these locations (otherwise known as Agro Wisata), there are are allotment-like small holdings consisting of various food plants indicative of Indonesia's wider agricultural productions including tea, coffee, cinnamon, chilli, papaya, jackfruit, banana and durian. Plantations follow similar themes with: a roadside carpark, winding path through crops, civets and other animals in cages, a café to sample coffee and a gift shop selling packets of kopi luwak, herbal teas and confectionary (Figure 3) (Carder, *et al.,* 2014; Lewis-Whelan, *et al.,* in prep). For results and discussion on kopi luwak plantations and the welfare of the animals present in them, please see Chapter 7.

1.4. General aims and objectives of this thesis.

The aims of this work was to discover and address questions (stated below) related to the the behaviour, threats and husbandry of Asian palm civet and other sympatric species in the wild state, in the pet trade and in kopi luwak production on the islands of Java and Bali, Indonesia.

1.4.1. Activity period and habitat use of Asian palm civets in West Java.

Baseline data are needed to be established for the identification and clarification of the mesocarnivore assemblages throughout Indonesia. There was speculation whether various species were present or absent not helped by many species assumed as nocturnal and cryptic in their behaviour, so remain unseen. Data was collected from a model mosaic habitat of native forest and anthropogenically changed habitats (in West Java, Indonesia see Chapter 3) to determine the presence and absence of carnivores using camera traps distributed in various habitats and altitudes and habitat use in terms of spatial and temporal parameters of each species. Images and videos from camera traps indicated how species interact socially both inter- and intraspecifically and furthermore identified where possible behaviours that alludes to behavioural ecology and habitat use. Three questions are addressed in Chapter 5:

- *What species of mesocarnivores are present in West Java?*
- *What activity patterns are expressed by Asian palm civets and other mesocarnivores in West Java?*
- *Can camera traps provide any indication to behaviours, habitat use, intraspecific and interspecific interactions, competition and niches of Asian palm civets and other mesocarnivores in West Java?*

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Figure 3: Selection of images from kopi luwak Plantations (Agro Wisata) showing the narrative of how they typically appear; a) Roadside carpark and start of path; b) Demonstration of roasting coffee beans; c) cages of civet; d) Café for tasting kopi luwak, coffee, chocolate and herbal teas; e) View of the valley; f) Gift shop selling kopi luwak, Coffee, tea and confectionary.

1.4.2. Quantifying the pet trade and welfare in Asian palm civets, with demographics of keepers and welfare of the animals.

Trade in Asian palm civets as exotic pets and for the kopi luwak industry could be a major driver towards the species becoming threatened. The extent of the trade or if there are separate or single trade lines is unclear. This thesis aimed to use official CITES import and export records, observations in animal markets in Indonesia, observations in kopi luwak producing sites, online survey of owners and social media analysis to assess the trade extent and structure. This identified the origin, destination and age of civets, species traded, cost, husbandry methods and demographics of keepers. Good welfare standards are needed for any animal, though this can be difficult to determine in species novel to captivity due to the lack of predecessors. Assessments were made to identify the conditions of care for animals and the standard of husbandry in various states of trade and ownership linked with legislative requirements. The aim was to determine whether conservation and animal welfare legislation was affective in managing and informing required standards of animal husbandry in various states of trade and ownership. Are wild populations at threat or are pet civets sourced from captive trade breeding programmes? The final aim was to identify appropriate topics for further research, areas for concern and recommendations for study of civets and other carnivores in the Indonesian pet trade. Six questions are addressed in Chapter 6:

- *How are and to what extent are Asian palm civets traded within and outside Indonesia?*
- *How are Asian palm civets traded within Indonesia's pet trade?*
- *What are the demographics for Asian palm civets and their owners?*
- *What are the husbandry practices provided for the Asian palm civets as exotic pets?*
- *What if any are the welfare issues identified for Asian palm civets in the pet trade?*
- *What national (Indonesian) and international legislation related to the trade, husbandry and welfare comes in to play and how?*

1.4.3. Kopi luwak, civet welfare and the ethics of production with links to topics in thesis.

Coffee is one of the main commodity crops of Indonesia yet provides little income for farmers. It therefore pays for the farmers to diversify and produce higher value coffees such as civet coffee (kopi luwak) (more details about the coffee industry are given in the introduction to Chapter 7).

The popularity of kopi luwak to western people has increased hugely in recent years especially since the Bucket List (2007) (Chapter 2). This could lead to the exploitation of

captive civets and poor welfare considerations. Weak initial regulation of an immerging industry, such as kopi luwak, could attract unsuitable, untrained, underfunded and misguided people into it, seeking opportunities to trade to tourists. Research was needed to assess producers of kopi luwak to identify and quantify the standards of animal housing and welfare assessed for civets used in kopi luwak production. To also reference how standards meet or do not meet the five animal needs and how staff of kopi luwak plantations conveyed information to customers by written or verbal means within the kopi luwak trade was honest, accurate and current. Finally, to identify appropriate topics for further research, areas for concern and recommendations for the husbandry of civets in the kopi luwak industry and alternative production methods. Five questions are addressed in Chapter 7:

- *How does the Indonesia coffee industry function and how was kopi luwak born from this?*
- *What Indonesian legislation and religious code of practice is there related to kopi luwak production?*
- *What extent is kopi luwak produced and how many Asian palm civets are included within it?*
- *How are Asian palm civets procured and kept within kopi luwak production?*
- *What if any are the welfare issues identified for Asian palm civets in the kopi luwak production?*

WHAT IS THE ASIAN PALM CIVET (*Paradoxurus musangus*)?

2. WHAT IS THE ASIAN PALM CIVET (*Paradoxurus musangus*)?

In the 2007 film "*The Bucket List*", Carter Chambers (Morgan Freeman) hands Edward Cole (Jack Nicholson) a webpage printout that Cole then reads as follows: "*kopi luwak is the world's most expensive coffee, though for some it falls under the category of too good to be true. In the Sumatran village where the beans are grown lives a breed of wild tree cat, these cats eat the beans, digest them and then, defecate. The villages then collect and process the stools. It is the combination of the beans and the gastric juices of the tree cat that gives kopi luwak its unique flavour and aroma*" (The Bucket List, 2007).

The film raised awareness of the existence of civets to a wider audience but also popularised two inaccurate statements about them. This "*breed of wild tree cat*" is firstly a species not a breed, moreover it is secondly also not a cat but a viverrid. The true species common names are either Asian palm civet or Common palm civet (Figure 4; taxomic description of the civet is outlined in Appendix two). Even in the last few years the scientific name has been reassessed from *Paradoxurus hermaphroditus* for all Asian palm civets throughout their distribution to now separate out populations in parts of Indonesia. The new name of *Paradoxurus musangus* followed revision by Patou, *et al.,* (2010) and Veron, *et al.,* (2014) whom suggest division for Asian palm civets specifically from Sumatra, Java and Bali and distinct from *P. hermaphroditus* distribution that originally accepted elsewhere in Asia (see appendix two in chapter 11.2 for more details on the taxonomic reassessments) (Figure 5).

The Asian palm civet has a passing resemblance to raccoons (*Procyon lotor*), red panda (A*ilurus fulgens*) and smaller cats (*Felis* spp.), despite only being distantly related to them. The civet is around one metre in total length consisting of fifty percent tail to body. Typically, Asian palm civet weigh between 1.8 and 5.0kg and is recorded as living up to 22 years in captivity (Sanderson, *et al.,* 1955). Duckworth, *et al.,* (2016c) indicates that the generation time of Asian palm civets is around 7.7 years.

The animal seems slightly stocky in appearance compared to related species such as genets (*Genetta* spp.), linsang (*Prionodon* spp.) and civets of other genera (*Chrotogale, Diplogale, Macrogalidia* and *Viverra* for example). Asian palm civets often possess a face mask of dark fur around the eyes, a pale forehead and a variably coloured muzzle, light to dark with dark whiskers (Wemmer, 1977). The nose pad is typically dark and hairless superficially dog-like with a deep concave vertical channel between the two nostrils. Their ears are cat-like albeit more rounded in shape, though like cats they are erect and independently mobile presumably used for hunting and locating prey (Wemmer, 1977). Characteristic of many Viverridae, the Asian palm civet possess a cryptic pelage, consisting of base colouration blend of browns, yellows, black and white furs with areas of dark spots and sometimes stripes arranged in horizontal plain along the flanks of the

Figure 4: The Asian palm civet (*Paradoxurus musangus*) [Carnivora: Viverridae] held by an employee in a Kopi Luwak Agro Wisata in Bali, Indonesia in 2018.

Figure 5: Distribution of *Paradoxurus hermaphroditus* in Asian countries.
Shading Key: Yellow = Resident population; Purple = Introduced populations.
Red outline = Area suggested as the approximate distribution of *P. musangus.*
Adapted from: http://maps.iucnredlist.org/map.html?id=41693 [Accessed 5th May 2013].

torso from the back of the head and lateral neck region to the upper third of the tail. The tail on occasion possessing a white tip but most commonly brown to black. There is a dark dorsal stripe of erectile hairs along their spine from back of head blending with tail fur at its termination (Wemmer, 1977).

Owing to the reported nocturnal nature reported for Asian palm civet (Jennings & Veron, 2009; Patou *et al.,* 2010; Borah & Deka, 2011) they likely possess a short-range colour-blind vision, focused through a vertically aligned cat-like slit pupil (Wemmer, 1977; Figure 4). Dusenbury (1992) proposes the pupil-type as an adaptation to highly variable light conditions as in habitat conditions of dappled lunar light in forests and woodland and also likely for improved vision in the vertical plain. Asian palm civets are believed to be accomplished climbers and spend much of their time foraging, scent marking, mating and sleeping at height using non-prehensile tail as a balance aid (Wemmer, 1977; Rozhnov & Rozhnov, 2003; Borah and Deka, 2011). Civets' feet are also darker than the body from elbow and knee to digits (Figure 4). Each paw has plantigrade stance, and equipped with retractile claws (Wemmer, 1977). The dexterity of Asian palm civets' paws provides manipulation ability for such as food and in allowing greater grasping ability for climbing (see Chapters 5, 6 and 7; Figure 4). This dexterity is facilitated by superior flexion and limb articulation related to the short flexor muscles (as in Ursidae, Procyonidae, some smaller Canidae, Herpestidae and most Felidae (excluding *Acinonyx jubatus*) (Alexander, 1993).

Consistent with other viverrids and most other small carnivores (Sandell, 1989), Asian palm civets are reportedly mainly solitary (Joshi, *et al.,* 1995; Nakabayashi, *et al.,* 2012) and due to this expected to have overlapping home ranges (Heydon & Bulloh, 1996; Parikesit, Withaningsih & Prastiwi, 2019) and as mentioned in Chapter 1.1, using scent to communicate between individuals (Wemmer, 1977; Rozhnov & Rozhnov, 2003). Few datasets exist about the Asian palm civets' social structure, mating, gestation and allometry, Borah and Deka (2011) observed a pair of civets mating in India within a tree, 50 metres from habitation and in daylight. Whilst the tree mating is considered normal, it is suspected that the proximity to humans and the daylight activity is more unusual. Nakabayashi, *et al.* (2012) observed civets in social interaction including feeding by two males and a female in close proximity with no signs of aggression between them. Al-Razi, *et al.* (2014) similar to Borah and Deka (2011) noted mating between two masked palm civet *Paguma larvata* in a tree and in the early hours of the morning. Copulatory plugs have been recorded in *P. larvata* and indicative of prevention of semen leakage post ejaculation, to promote semen storage increasing fertilisation success and as a chastity enhancement and mate guarding (Jia, *et al.,* 2001; Jia, *et al.,* 2002). It can be assumed that the copulatory plug also occurs in the Asian palm civet for the same reasons.

STUDY AREAS

3. STUDY AREAS

3.1. Focusing on the wild civet study site

The principle locality of research for wild ecology of the Asian palm civet was on the mountain slopes overlooking the village of Cipaganti, in the parish of Cisurupan, of the regional authority of Garut, on the Island of Java in Indonesia (7° 6' 6" S; 107° 46' 5" E) (Figure 6). The village (1,345 metres above sea level) and surrounding anthropogenically changed and native habitats and species are believed to be representative of Javan biodiversity. The village lies in the foothills of an actively volcanic area sited on the slope of Mount Puntang overlooked by Gunung Papandayan (Nekaris, *et al.,* 2017). The population census of the Cisurupan parish for the 2008 elections for Garut region (Garut City, Cisurupan and Pakenjeng subdistricts) gave 186,556 residents (Sukmahari & Haryanto, 2012). In Cipaganti specifically there are around 3,000 residents at a density of 135 people km^2 (Nekaris, *et al.,* 2017).

Gunung Papandayan's peak (2,675 metres above sea level) is located within sight to the west of Cipaganti (07° 19' 42" S and 107° 44' 00" E) and last produced a major eruption in 2002 (Sulistyawati, *et al.,* 2008) though was on high alert following the Anak Krakatoa eruption in 2018 (Nekaris pers comm). The area is seismically active and mild earthquakes can be felt periodically in Cipaganti (Roberts *pers obs.*). The volcano is designated at a nature reserve though it is surrounded by unprotected zones of agricultural lands, including areas around Cipaganti, consisting of small plots of cultivated crops (Figure 7). Small holdings plots are maintained by villagers argely without mechanised assistance or with oxen. Access to the forest and agricultural land is via exposed soil footpaths and deeply rutted motorcycle trackways (Figure 7 top right image). There is no four-wheeled access into the agricultural areas beyond to edge of the village and sports field. Crops gathered area removed from the hillside in sacks stacked high to the motorcycles (Figure 8).

The topography of Cipaganti area is specifically defined as Sub-montane (1,200 metres above sea level – 1,800 metres above sea level) with bands of habitat types (village, cultivated land and fragments of secondary and primary forest. At approximately 1,300 metres away from the village is the boundary of the protected forest on steep slopes of the ridges that are not cultivated, while the first contiguous forest is about 2km away from the village (Rode-Margono, 2015). The Mount Puntang altitude reaches up to 2,223 metres above sea level and most areas above the village are characterized by a mosaic of cultivated arable fields up to around 1,750 metres above sea level. Fields boundaries are defined by trees or stands of bamboo *Bambusa* spp*. a*nd *Dendrocalamus asper.* Calliandra *Calliandra calothyrsus* and plantations of Eucalyptus with a generally connected canopy (Rode-Margono, 2015). Pressure for cultivated land and harvesting of timber and bamboo is causing loss of remaining green corridors and fragments of forest (Spaan, *et al.,* 2014)

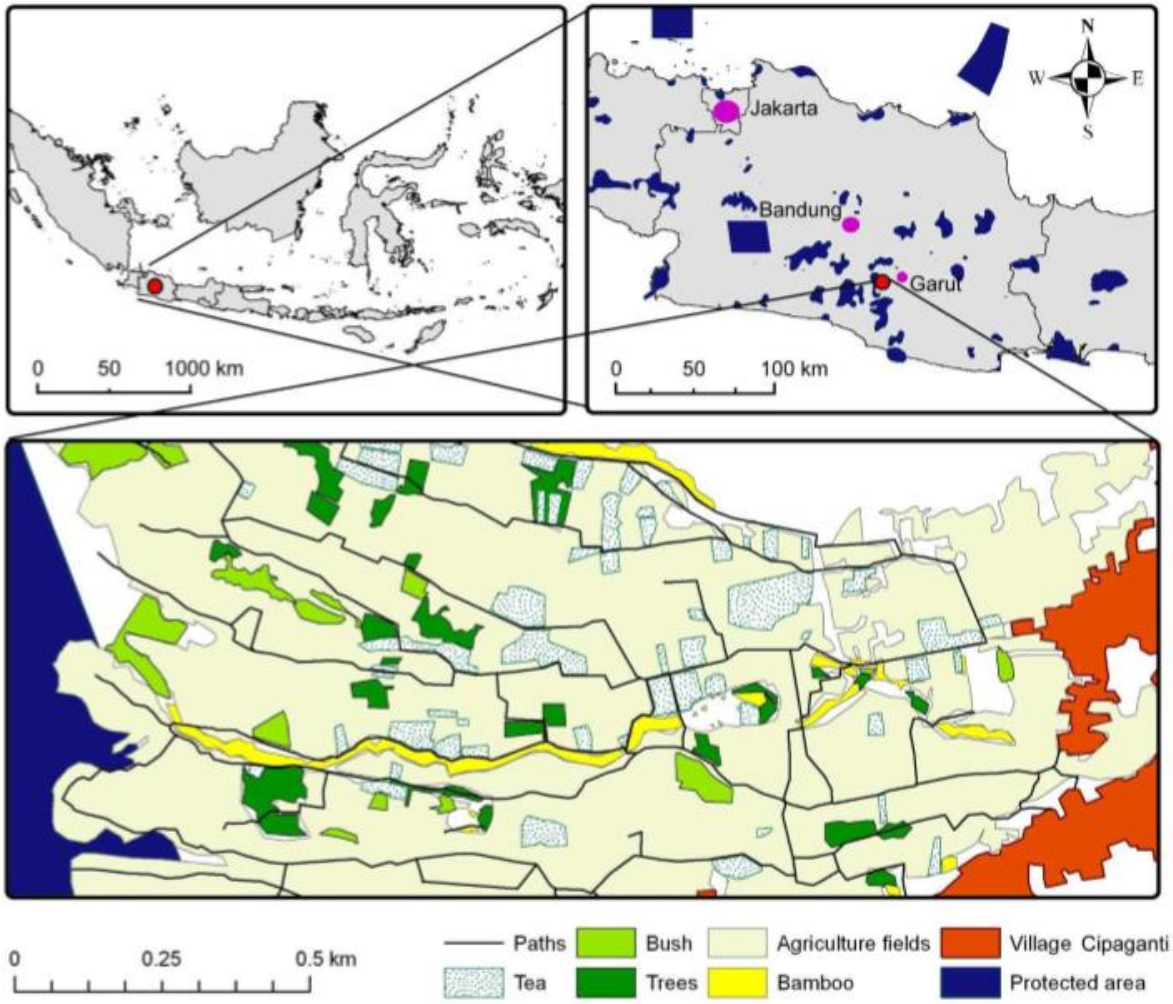

Figure 6: Maps indicating the location of Cipaganti, Cisurupan, Garut, Java, Indonesia (7° 6’ 6” S; 107° 46’ 5” E); the principle study site for the research on *Paradoxurus musangus* (courtesy of the E.J. Rode-Margono of Little Fireface Project) (Rode-Margono, 2015).

Cipaganti village in the east (red) and the protected area Mount Papandayan in the west (Blue). Blue areas on map two indicates other protected areas in West and Central Java. The habitat in Cipaganti is characterized by a mosaic of agriculture fields, plantations and fragmented patches of bushes, trees and bamboo. Habitat of white areas not assessed.

Figure 7: A selection of photographic images of Cipaganti, near Garut, West Java, Indonesia representing habitat types available. Taken between June 2013 and December 2013.

Figure 8: A motorcycle ridden by a villager stocked with carrots having just been harvesting the crop above the village of Cipaganti, near Garut, West Java, Indonesia. Taken 9th June 2013.

(Figures 6, 7 and 11). While there are no official figures of deforestation for Cipaganti, though Papandayan has seen significant conversion from forest to cultivation, between 1994 and 2001, approximately 2,700 hectares of Papandayan's forest has been replaced (Sulistyawati, *et al.,* 2008).

Soil in Cipaganti is seemly uniform across the area and characteristically of volcanic origin and typically brown to reddish ochre in colour. It is noticeably clay-like when wet, it is claggy, slippery and difficult to walk on (Figure 7). The underlaying rock of Gunung Papandayan is identified by Nasution, *et al.* (2008) as *dominated by young Quaternary andesitic rocks*. This is also likely true for Cipaganti. The hillsides and valleys seen in Cipaganti are caused by uplift and folding of the land by tectonic processes and erosion thereof by surface water runoff, carving ditch-like tributaries and streams flowing down the hillsides. Heavy rainfall in the wet season could cause erode soil depth or leach nutrients into the rivers in the streams in areas that are not bound by crops or native vegetation. Despite this it has been observed that farmers are still able to grow three yields of crops per annum in each field (Nijman, pers comm).

The climate in Cipaganti is consistent with being seven degrees south of the equator and well within the monsoon zone of the tropics. The area has a wet and a dry season with rains increasing during the months of October to April each year; at its peak in it can be over 500 metres of rainfall a month, dropping to less than 50 metres in dry season months (Sulistyawati, *et al.,* 2012). At sea level in Java, temperature ranges between 26^{o}c - 29^{o}c (Rode-Margono, *et al.,* 2014) though at altitude like that of Cipaganti, temperatures are reduced to between 14^{o}c - 22^{o}c (Mustikaningrum, 2018).

3.2. Flora and Fauna of the area around Cipaganti

Cipaganti consists of a mosaic of plots of cultivated plants such as: carrots, chayotes, tomatoes, coffee, rice, tea, cabbages, beans, capsicums, chilli and fruit trees (Figure 7) and tended by villagers largely without mechanical assistance (excluding the motorcycles, Figure 8). The native forest flora remains now on the summit of the highest slopes or where the landscape is too steep to clear and to cultivate. Boundaries between fields are defined by earthwork ridges topped with grass and scatterings of native vegetation (occasional trees and bamboo stands) and narrow footpaths. Most fields are not fenced, walled or bordered by ditches. Some fields at lower elevations below Cipaganti Village are terraced to create rice paddies.

In the neighbouring Gunung Papandayan, Sulistyawati, *et al.* (2012) identified two zones of assemblages of flora species. The interior zone assumed to include the caldera which maintains 47 tree species, 25 shrub species and 50 herbs species. The second area

defined as forest edge areas has more trees with 54 tree species, though fewer shrubs and noticeably less herbs at 16 and 17 species respectively. An earlier study from Sulistyawati *et al.* (2008) found: 42 tree species, 14 shrub species, 106 herb species and 23 species of climbers. It is likely that in Cipaganti deforestation has depleted native assemblages severely. Ongoing work by the Little Fireface Project aims to identify and quantify the tree, shrub and herb species present in Cipaganti. Table A lists some examples of plant species found in the area but does not represent an exhaustive list.

In Cipaganti it is striking that despite being within the tropical biome the number of species and populations of birds observed was noticeably less than expected (Roberts *pers obs.*). Sulistyawati, *et al.* (2008) noted that for Papandayan there were 73 species from 26 families present, yet, compared to earlier surveys a further 64 species were not observed. Possible reasons for apparent reductions are the deforestation and/or trapping of birds for the exotic pet trade (Nijman, 2010). It is considered in Indonesia that caged songbirds in the house promotes good luck to the household (Nijman *pers comm*). Owls are also very popular among raptors traded as exotic pets possibly enhanced by popularity of owls on the back of the Harry Potter Film franchise (Nijman & Nekaris, 2017). Birds are often trapped from the wild and traded through the animal markets in the towns and cities throughout the country (Nijman, 2010). It is suggested that there are nearly 22% of households in Indonesia with at least one pet bird (Jepson & Ladle, 2005) with upto 1.745 million bird keeping households in Java and Bali's six major cities alone, plus 70,000 hobbiest breeders of birds (Tidemann & Gosler, 2010). The detrimental effect of the Indonesian bird trade in causing catastrophic collapse of wild bird populations is well documented (Jepson & Ladle, 2005; Shepherd, 2006; Nijman, 2010) and the wildlife trade is likely to extensively apply to Indonesia's wild mammals also such as civets, bats and monkeys (Nijman, *et al.,* 2014) (See Chapters 6 and 7).

Whilst the birds seem under-represented in Cipaganti, the Invertebrate assemblages are extensive and numerous, represented overtly by large lepidopterans, orthopterans and great numbers of arachnids (Roberts, *pers obs*). These are likely predated upon by the many insectivorous mammals, birds, amphibians and reptiles. Many invertebrate species would likely be pests for farmers of crops, so species of natural predators benefit towards higher yields of crops (Koh, 2008). On the otherhand the removal of bird population into the pet trade has likely increased the population densities of their prey invertebrate species (Koh, 2008). There is subsequently also plenty of invertebrate prey for Cipaganti's lizard and frog species. Cipaganti is unlikely to be home to any otter species as the streams and tributary systems lack depth, prone to drying up in the dry season and are strune with plastic waste (Rode-Margono, *et al.,* 2014). Deeper bodies of water occur in the village adjacent to the residences though these are how the houses deal with human excreta. These pools contain fish that aid in the processing of the waste.

Table A: Vegetation present around Cipaganti, near Garut, West Java, Indonesia. Names of plants given in English, Indonesian and Scientific names. Adapted from unpublished data from the Little Fireface Project.

Species	Indonesian Name	Family Name
Avacado, *Persea americana*	Alpukat	Lauraceae
Bamboo, *Dendrocalamus asper*	Bambu besar	Poaceae
Bamboo, *Gigantochloa* sp.	Bambu Surat	Poaceae
Banana, *Musa acuminata*	Pisang	Musaceae
Cadamba, *Anthocephalus cadamba*	Jabon	Rubiaceae
Calliandra, *Calliandra catothyrsus*	Kaliandra Merah	Fabaceae
Calliandra, *Calliandra tetragona*	Kaliandra Putih	Fabaceae
Candlenut, *Aleurites moluccanus*	Kayu kemiri / Mucang	Euphorbiaceae
Chayote, *Sechium edule*	Labu siam	Cucurbitaceae
Chinquapin, *Castanopsis argentea*	Barangan	Fagaceae
Coffee, *Coffea arabica*	Kopi	Rubiaceae
Common Guava, Yellow Guava, or Lemon Guava, *Psidium guajava*	Jambu	Myrtaceae
Eucalyptus, *Eucalyptus* sp.	Kayu Putih	Myrtaceae
Green Wattle, *Acacia decurrens*	Wartel	Fabaceae
Indonesian Cinnamon, *Cinnamomum burmannii*	Kayu Manis or Kiamis	Lauraceae
Jackfruit, *Artocarpus heterophyllus*	Nangka	Moraceae
Key Lime, *Citrus aurantifolia*	Jeruk	Rutaceae
Lead Tree, *Leucaena leucocephala*	Peuteuy Seiong or Silong	Fabaceae
Loquat, *Eriobotrya japonica*	Lokat	Rosaceae
Lycianthes, *Lycianthes denticulata*	Semak	Solanaceae
Magnolia, *Manglietia blumei*	Baros	Magnoliaceae
Magnolia, *Michelia montana*	Manglid or Cempaka hutan	Magnoliaceae
Melochia, *Melochia umbellata*	Bentinuh	Malvaceae
Mistflower or Croftonweed, *Ageratina riparia*	Semak / Tekian	Compositae
Needlewood Tree, *Schima wallichii*	Puspa	Theaceae
Orange Jessamine, *Cestrum aurantiacum*	Dayang	Solanaceae
Papaya, *Carica papaya*	Papaya	Caricaceae
Partridge Berry or Checkerberry, *Gaultheria* sp.	Semak	Ericaceae
Persimmon, *Diospyros kaki*	Kesemak	Ebenaceae
Pomelo, *Citrus maxima*	Jeruk Bali	Rutaceae
She-Oak, *Casuarina equisetifolia*	Kayu angin / Kayu besi	Casuarinaceae
Siam Weed, *Chromolaena odorata*	Karinyu	Compositae
Southern Silky Oak, *Grevillea robusta*	Salamandar	Proteaceae
String Bamboo, *Gigantochloa apus*	Bambu Tali	Poaceae
Sugar Palm, *Arenga pinnata*	Aren	Palmae
Sweet Bamboo, *Gigantochloa atter*	Bambu Temen	Poaceae
Tea, *Camellia chinesis*	The	Theaceae
Turmeric, *Curcuma longa*	Koneang	Zingiberaceae
Umbrella Tree, *Maesopsis eminii*	Afrika	Rhamnaceae

On the outset of research in Cipaganti there was an unconfirmed assemblage of mammalian carnivores. The Asian palm civet is already confirmed and considered ubiquitous. There are suggestions from villagers that there are more unconfirmed carnivore species including binturong (*Arctictis binturong*) and Javan leopard (*Panthera pardus*). Other known mammals include: Javan slow loris (*Nycticebus javanicus*), grizzled leaf monkey (*Presbytis comata*), European wild boar (*Sus scrofa*), tree shrews (*Tupaia glis*) and various rodentia. There are no megaherbivores such as Javan rhino (*Rhinoceros sondaicus*) that may have been in the region historically but are now restricted to the far west of Java only in Ujung Kulon National Park. Camera traps and sightings carried out by Rode-Margono, *et al.,* (2014) confirmed the presence of leopard cat (*Prionailurus bengalensis*), Javan mongoose (*Herpestes javanicus*), Javan ferret badger (*Melogale orientalis*), yellow throated marten (*Martes flavigula*) and small Indian civet (*Viverricula indica*). This thesis will determine if there are other carnivores in Cipaganti and give indications as to their behavioural ecology (Chapter 5.2.1.).

MATERIALS AND METHODS

4. Materials and Methods

4.1. Materials and methods for the study of the activity period and habitat use of Asian palm civets in West Java with notes on sympatric carnivore species.

As aforementioned in the aims and objectives (Chapter 1.4.1.), this study is a preliminary study as to the presence or absence of native and non-native carnivore species in west Java and to ascertain baseline data on their niches and possible interactions. Between 14th August 2012 and 31st December 2018 (2,167 days) camera traps (Cuddeback® 1187 IR Attack, Bushnell® Trophy or Emperor of Gadgets® Model RD1003) were deployed throughout Cipaganti, West Java. Cameras numbered from two in 2012 rising to twenty in 2018 and accumulated 11,146 trap nights with some results published in Rode-Margono, *et al.,* (2014). Placement of cameras were selected along walked one kilometre transect lines used during the research conducted related to the Javan Slow Loris (*Nycticebus javanicus*) (Rode-Margono, *et al.,* 2014; Spaan, *et al.,* 2014; Rode-Margono, 2015). Effort was made to place cameras no closer to each other than 100m.

Cameras here sited were in various habitats and topographic elevations plus height above the ground to indicate to habitat usage by species captured (Giman, *et al.,* 2007; Evans, Vickers, *et al.,* 2016). Some cameras were mounted on mature Eucalyptus trees at one end of the waterlines or the experimental loris bridges that traverse Cipaganti raised at heights of 1.5 metres – 4 metres above the ground (Little Fireface Project, 2014). The waterlines were made of 32 milimetres diameter; 142 metres long hard PVC pipe with a supporting wire running the entire length to prevent fracture (Spaan, *et al.,* 2014) (Top right image Figure 9). Ladder-like Loris Bridges (introduced by the Little Fireface Project) (Top left image Figure 9) were designed to enable Javan slow loris to traverse between patches of fragmented habitat without needing to pass through crops at ground level (Little Fireface Project, 2014). Some cameras were mounted on trees or bamboo at 1.5 metres - 2.5 metres above the ground overlooking bamboo and wire frames used to grow Chayotes (Top right image Figure 9). The number of these frames increased notably during the period of study. Other cameras were mounted on trees or bamboo at 0.2 metres - 0.5 metres above ground level trained on adjacent watercourses, fields and animal trails through bamboo and primary forest (Figure 9). All cameras were calibrated to ensure that metadata recorded time and date were accurate when the images were recorded plus all cameras were set to record a burst of 3 images and a video when triggered used to determine behaviour of animals captured including locomotion, interactions, scent marking, foraging and directionality for example (Wemmer, 1977; Rode-Margono, *et al.,* 2014). Each of the cameras had their habitat details recorded and specific location recorded using GPS so that location could be checked to ensure two cameras were not too close together and to assess if any habitat preferences could be determined by the species recorded.

Figure 9: Images of location examples of camera traps for the identification of small carnivores present in Cipaganti, near Garut, West Java, Indonesia

Times were recorded for each of the species triggering the cameras and these were categorized in to one-hour slots over 24 hours. Times were logged as hour: minute: second (e.g. 11:32:59 and 22:15:08) and therefore these examples would be tallied into 11am and 10pm respectively. Each hour category started and ended on the following principles (start: 12:00:00; end: 12:59:59). As aforementioned, three images were recorded each time the camera was triggered by only one would be recorded as to the time and date. Times and dates were used to create indications of activity patterns of the species recorded. Activity was assessed to determine whether species were nocturnal (active between 20:00:00 and 03:59:59), diurnal (active between 08:00:00 and 15:59:59), crepuscular (active between 16:00:00 and 20:00:00 and between 04:00:00 and 07:59:59) or cathemeral (active throughout the 24-hour period without regularity into the predefined categories. Sunrise and sunset times vary in Indonesia by approximately 15-20 minutes eitherside of 05:45 and 17:45 throughout the year, with the longest days in the southern hemisphere in December each year. Dates and times were also used to determine if there were any preferences of the species to the lunar illumination levels (for nocturnal and crepuscular species and possibly the cathemeral also (see definitions below). Lumination data was procured from: https://www.timeanddate.com defined by the date when the image was taken; e.g. for 1st January 2014 the luminosity was 0.3% rising to 99.6% on the 15th day.

Allaby (1991) defines diunal activity as events or awakening period of the circadian rhythm occurring only in daylight hours within which it is assumed that foraging, locomotion and social interactions such as mating occurs. The reverse of this, namely where active period for a species is at night rather than the day is therefore the nocturnal activity period. Crepuscular activity Allaby (1991) states a circadian rhythm where the active period is at twilight at dawn and/or dusk. Some species are active throughout the day and night and therefore cannot be easily prescribed into the other categories.

Cameras were checked once a week swapping SD cards and replacing batteries. When developing faults cameras were removed and when possible, replaced. Cameras photographing purely movement of wind driven vegetation were repositioned to reduce false positives. Any false positives were subsequently deleted (Rode-Margono, *et al.,* 2014). Each remaining image was assessed to identify animal species recorded, numbers of individuals and behaviour expressed by them. The faulty cameras were one constraint to the study, as was the organic growth of the number of cameras from two to twenty over the study period. An improvement would be to have twenty cameras or more from the outset arranged in an equidistant grid across the study area that extends both up to the summit of the mountain and down through the village and at lower altitude. As target species could be both terrestrial and aboreal these differences in habitat use needs consideration as well as habitat and vegetation types, otherwise behaviours, habitat use or representation could be overlooked.

Alongside transects used to set up and monitor cameras, species were also recorded through adhoc direct sightings. Like with cameras, the locations were recorded with GPS coordinates, the habitat characteristics were recorded (e.g. vegetation, topography and proximities to features and habitations). Also like the cameras the time of day and date of the sighting were recorded, and notes taken as to the behaviour of the animal(s) observed, for example: locomotion method, reaction to observation, social, scent marking or foraging behaviours.

4.2. Materials and methods for the study of quantifying the pet trade and welfare in asian palm civets, with demographics of keepers and welfare of the animals.

There were several lines of data collection used to answer the aims and objectives in Chapter 1.4.2. related to the pet trade of Asian palm civets. Firstly, CITES (Convention for the International Trade in Endangered Species) records were accessed for trends in trade of *Paradoxurus hermaphroditus* and other species of small mesocarnivores identified in Chapter 5 and 6 and Appendix Chapter 11.3. via the trade database available online (https://trade.cites.org/) between 1975 and 2016 (*Paradoxurus musangus* is not listed in the CITES database). The CITES database has been used by other researchers to assess the trade various species such as: Mahogany (Blundell & Rodan, 2003); Monitor Lizards (Pernetta, 2009) and Poison arrow Frogs (Nijman & Shepherd, 2010) plus most recently the extent of wildlife trade across all vertebrate taxa (Cookson, 2019; Vaughan, 2019). Data downloaded procures as raw data in to excel from which pivot tables and statistics can be applied. Analysis enables importing and exporting countries to be identified and the condition of specimens, whether animals were living, dead or whether the export or import was of parts or products derived from the animals. In addition, information in the records provided the proposed purposes of animals' (commercial use, exhibition, scientific use or personal use). Evidence of trade in Asian palm civets, status and any disrepancies were analysed and discussed.

Facebook and other social media platforms can easily allow communication, advice and trade to occur related to animals but can also desiminate husbandry misinformation potentially dangerous to animal (Nekaris, *et al.,* 2013). To enable more clarity in to the "personal use" and the welfare and husbandry of civets within trade, a survey of ten questions (see below) was prepared via online site www.surveymonkey.com (Chapter 6.2.3.). The method has been used by other researchers in gathering trade and husbandry data on other species (Ceballos-Mago, *et al.,* 2010; Gardiner, *et al.,* 2018; Sackman & Houpt, 2019). The survey was anonymous and was developed to understand the demographics of owners and their civets plus to provide baseline data on pet civet husbandry methods including housing, diet and the numbers of civets kept. Survey monkey records the duration taken to complete the survey, an Internet Service Provider (IP) address allowing tracing of a geographical location using www.spy-ip.com. The standardised questions were deseminated via Facebook to promote inclusion and engagement from civet owners over a wider geographical range of Indonesia that would

not have been possible in person. The survey ran for two periods, the first from 27th March 2014 to 30th September 2014 (188 days) and the second instance was from 12th September 2017 to 7th July 2018 (299 days). Participants were procured by promoting the survey online by posting the weblink on "*Musang Lovers*" sites and the "Civet Research Project Indonesia" page on Facebook™. The ten questions listed below where set so that contributors could write as little or as much as they would like. The survey presented question in two languages: English and Bahasa Indonesia.

1. How old are you?
2. What is your nationality?
3. How long have you owned civets?
4. How many civets do you own?
5. Where did your animals come from?
6. What country (island) do your animals come from?
7. What do you feed your civets?
8. Where do your civets live?
9. What other animals do you keep?
10. How old are your civets?

The second edition of the survey in 2017-18 had an additional 5 questions as a response to limitations found from the first issue, these questions were:

1. What is the species of civet you have?
2. What is the gender of your civet?
3. Why did you choose a civet as a pet?
4. How much did the civet(s) cost?
5. Rate the suitability of civet as a pet (0 being very unsuitable, 100 highly recommended).

The membership recruitment were monitored for 235 *Musang Lovers* Clubs on Facebook from 4th February 2018 to 4th February 2019. Each club was was identified where possible to specific towns and cities and subsequently to regions, islands and countries. Analysis will explore trends of member recruitment and patterns of interest in pet civets and civet ownership across Indonesia in particular. A secondary analysis of Facebook was also carried out on a sample of photos downloaded from the *Musang Lovers* Facebook pages. A sample of 2,020 photos were assessed between 14th February 2018 to 28th December 2018 for their content and situation (whether at home, in a street, for sale advert, animal market or club meeting). Photos were assessed for the presence and number of people and whether they were male, female or children and note taken in to how many people were wearing *Musang Lovers* club branded clothing. Animals were counted and categorised into species and the age group of individuals (neonate, juvenile or adult). Health and welfare were assessed in each image including identification of housing,

handling and restraint equipment, food and water available, condition score of animals and signs of good and poor health.

Finally, 17 animal markets were visited by the author and collaborating researchers in nine towns on Java between February 2012 and October 2014, and two markets in two towns in Bali between July 2013 and July 2014, and one Bali town in 2018 (Nijman, *et al.,* 2014). All were open animal markets (known as 'Pasar Burung' or 'Pasar Satwa' in Indonesia), ranging from the Pramuka market in Jakarta with some 200 shops to smaller, sometimes mobile, markets comprising a dozen or so shops. The towns surveyed are spread over large parts of western Java, eastern Java and Bali; to be representative for the trade in wider Indonesia (Nijman, *et al.,* 2014). Asian palm civets were traded openly in the animal markets so there was no need to resort to undercover techniques, only once did researchers observe one hidden from view, in a plastic box (D. Spaan, *pers. comm*). Markets were walked through slowly, recording civet by typing the species and their numbers into a mobile phone or by memorising numbers and writing them in a notebook immediately on leaving the market (Nijman, *et al.,* 2014). Counts include what is known in the trade as 'Musang Bali', which appears to be a pale morph of Asian palm civet, with a pinkish nose and pale soles of feet. Age class (infant, juvenile, adult) were noted when possible, with photographs taken opportunistically. In Jatinegara market in Jakarta, the sheer number of animals for sale, and the many civets (of multiple species) often in one cage, sometimes precluded exact counts (Nijman, *et al.,* 2014). No civets were purchased by researchers. For analysis, markets were grouped into large (typically more than 50 stalls selling animals), medium (20–49 stalls) and small (fewer than 20 stalls). For each market the average number of civets is the total number of civets observed divided by the number of visits. Five markets in three towns surveyed at least twice during each of the three study years allowed some check for annual differences of the civet trade (Nijman, *et al.,* 2014). Four markets, surveyed over three years and with a substantial number of civets recorded, were used to calculate the proportion of non-adults in trade, allowing comparison between years and between markets. Constraints of these approaches relates to the willingness disclosure by keepers and traders to allow accurate records to be maintained and for trade and welfare to be accurately monitored. Each of these routes of data was used to give insights into the trade of civets and other animals as exotic pets, continue to the results in Chapter 6.

4.3. Materials and methods for the study of Kopi luwak, civet welfare and the ethics of production with links to topics in thesis.

To address the aims and objectives in Chapter 1.4.3.; visits were conducted to civet coffee plantations in Bali in 30th December 2013 to 2nd January 2014 and 3rd to 8th April 2018 (n=6 in 2013-4; n=34 in 2018. During visits, guides delivered their script of information about the plantation, civets and the characteristics of kopi luwak. There were a number of

questions also asked of plantation guides if they did not volunteer the information within their script. These questions are:

1) How many civets do you have altogether?
2) How old are the civets?
3) Where do they come from?
4) How long do civets live?
5) How long do you keep them for?
6) What do you feed them?
7) How much coffee do they produce per day?
8) How much is your coffee?

During visits, multiple photographs and video were recorded and used to assess the housing standards of the animals observed. Housing and welfare standards were assessed against criteria devised from the five animal needs aka five freedoms (Table B), the quality of conditions ranked on a scale from 0-5 for each category. Zero on this scale defined by absence of item or absolutely unacceptable standard from housing or welfare, through to the score of five where the condition, practice and welfare is excellent. Statements were created for each of the criteria to assist with the assessment (Tables C-F). A similar method was also used by Carder, *et al.,* (2016).

The origin of civets that were in plantations were queried from guides, the number of civets, per plantation, duration the animals were kept for and the ages of them, the quality of printed materials in the plantation and the knowledge of the staff and quality of the customer service were also requested. Cage size was assessed in line with Carder, *et al.,* (2016) with three groups: small cages (around 0.5x0.5x0.5 metres), Medium Cages (1x1x1 metre) and Large Cages (Larger than Medium). Comparisons between the Carder, *et al.,* (2016) data and *in scripta* data were made for the 2013-14 visits shared by both. The issues with cage sizes devised by Carder, *et al.,* (2016) are discussed and recommendations are indicated with reference to: *Freedom from discomfort, freedom from fear and distress and freedom to behave naturally* in Chapters 7, 8 and 9.

Both the pet trade and the kopi luwak trades are regulated by at least three laws that includes capture and harvest quotas in Law no.447 (from 2003) and standards of animal welfare in Law no.18 (from 2009) and kopi luwak in Law no.37 (from 2015). Results were assessed against these laws when appropriate and implications discussed followed by recommendations (Chapters 6 and 7). A further law, no.479 (1998) sets out standards of education requirements of wild plant and animal institutions that is relevant to the kopi luwak plantations (Kutilang, 2011) (Chapter 7).

Observer error could be a factor throughout the visits to the kopi luwak plantations. Only what is on show to the public can be recorded. In respect to the animal welfare status it is

Table B: Assessment of the five animal needs in relation to the housing and welfare of Asian palm civets (*Paradoxurus musangus*) within agritourism plantations producing or selling kopi luwak (civet coffee)

Title of Animal Need	**Categories included in assessment**
Freedom from Hunger and Thirst	Condition Score, Food Present, Number of Food Items, Freshness of Food, Hygiene of Food, Water Present, Hygiene of Water.
Freedom from Pain, Injury and Disease	Condition Score, Signs of Injuries, Signs of Parasites, Hygiene of Food, Hygiene of Water, Enclosure Hygiene, Walls.
Freedom from Discomfort	Substrate Type, Shelter, Construction standard, Enrichment, Enclosure Hygiene, Roof, Security, Walls.
Freedom from Fear and Distress	Signs of Stereotypic Behaviour, Shelter, Roof, Security, Warning Signs, Walls.
Freedom to Behave Naturally	Awake during the day, Signs of Stereotypic Behaviour, Cage Score, Substrate Type, Shelter, Construction standard, Enrichment.

Table C: The scale of zero to five for the assessment of food and water standards of Asian palm civets (*Paradoxurus musangus*) within agritourism plantations producing or selling kopi luwak (civet coffee); Zero = poorest standard or condition. Five = Preferred standard or excellent conditions.

Score	0	1	2	3	4	5
Food Present	No food or empty food bowls present	No food present but Fresh faeces containing remains of food items	Empty bowls with statement from guide that the animals are fed in the evening.	Evidence of remains of food items that aren't fresh	Evidence of remains of recent food items	Fresh Food Present
Number of Food Items	No food seen or referred to by guide	Coffee berries only	No food but guide refers to "vegetarian" or plant-based foods only	No food present though guide referring to several plant and animal sources.	Single type of food with guide referring to several plant and animal sources.	Multiple sources including plant and animal sources (>4)
Freshness of Food	No food seen	Mouldy, very dry food	Old and dry food	New day before	New Evening before	New that day
Hygiene of Food	No Food Seen	Very Poor, covered in dirt, flies or immediately adjacent to faeces	Poor, partially covered in dirt, flies or near faeces	Good, clean food in a bowl, some flies but not many and away from faeces	Very Good, , clean food in a bowl, little flies and away from faeces	Excellent, clean food in a bowl, no flies and away from faeces
Water Present	No water or empty water bowls present	Fresh urine present	Empty bowls or statement from guide that the animals are watered in the evening.	Evidence of remains of water that isn't fresh	Evidence of remains of recent water	Fresh water Present
Hygiene of Water	No water bowls seen in cages	Very Poor, very dirty bowl, little or dirty water	Poor, dirty bowl with dirty water in it	Good, reasonably clean bowl and water within	Very Good, Clean bowl with fresh water in it	Excellent, Very recently cleaned bowl and very fresh water

Table D: The scale of zero to five for the assessment of health and welfare standards of Asian palm civets (*Paradoxurus musangus*) within agritourism plantations producing or selling kopi luwak (civet coffee); Zero = poorest standard or condition. Five = Preferred standard or excellent conditions.

Score	0	1	2	3	4	5
Activity Pattern	All Awake and Distressed	All Awake and Active	Awake and some Active	Awake but resting	Most Asleep	All Asleep
Duration Kept	Whole Life	<4 years	<3 years	<2 years	<1 year	<6 Month
Signs of Injuries	Extensive severe injuries including loss of limb or tail	Animals showing injuries old and new	More than 1 animal with minor injuries but healing	1 animal minor injured but healing	Animals with healed injuries no new ones	No Injuries Evident
Origins	Market	Wild	Rescue	Some Wild Some Captive Bred	Captive Bred	No animals
Signs of Parasites	Obvious affliction from Mites, fleas etc with extensive hair-loss, head shaking, constant scratching	Strong evidence of possible parasites including pawing at head, scratching and discomfort	Some evidence of possible parasites including pawing at head, scratching and discomfort	Possible evidence of previous parasites e.g. hair loss, haematoma, no current irritation	Guide explains treatments for parasites have been given	No Parasites Evident
Signs of Stereotypic Behaviour	All awake animals showing stereotypic behaviour	Most awake animals showing stereotypic behaviour	Several awake animals showing stereotypic behaviour	1 animal showing stereotypic behaviour whilst being observed	1 Animal showing intermittent stereotypic behaviour	No Stereotypic Behaviour Evident

Table E: The scale of zero to five for the assessment of housing standards of Asian palm civets (*Paradoxurus musangus*) within agritourism plantations producing or selling kopi luwak (civet coffee); Zero = poorest standard or condition. Five = Preferred standard or excellent conditions.

Score	0	1	2	3	4	5
Cage Size	Only small Cages	Some mixture of cage sizes	Medium cages	Some large and medium cages	Mostly large Cages	All large enclosures
Construction standard	Not at all fit for purpose. Dilapidated and in need of immediate replacement. No animal should be housed in it. Imminent danger to animals' safety and welfare.	Very poor state of repair, needing immediate and very extensive repairs or replacement of most parts. Dangerous to animals' safety and welfare.	Poor state of repair, needing immediate and extensive repairs or replacement of several parts. Dangerous to animals' safety and welfare if not addressed in the next few months.	Fair construction, showing some deterioration of materials that would mean more immediate repairs or replacement of parts needed. Potentially dangerous to animals' safety and welfare in the next year.	Good materials, solid construction, minor deterioration since being built. In need of some maintenance. Unlikely to cause a danger to animals' safety and welfare in the next year.	Well maintained or new, high quality, hygienic and easily cleaned cage. Very unlikely to cause injury or disease in the animals contained within.
Enclosure Hygiene	Unacceptable. Cage shows evidence of a lack of cleaning for up to one week. High risk of vermin attraction and subsequent diseases.	Poor. Cage shows evidence of a lack of cleaning for up to 3 days. High risk of vermin attraction and subsequent diseases.	Fair. Cage shows evidence of a lack of cleaning for up to one day. Increased risk of vermin attraction and subsequent diseases.	Good. Cage shows evidence of fresh faeces only. Some risk of vermin attraction and subsequent diseases.	Very good. Cage shows evidence of some cleaning for with no faeces present. Washed down with plain water. Low risk of vermin and disease.	Excellent hygiene, everything looks extensively cleaned and hygienic. Very low risk of vermin and disease.
Enrichment	No enrichment in cage at all.	A single branch or level for climbing on.	Multiple branches or platforms but no natural vegetation and other devises for mental stimulation	Multiple branches or platforms with a single plant or devises for mental stimulation	Some enrichment with planted enclosure, a series of platforms, branches and devises for mental stimulation.	Extensive programme of enrichment with planted enclosure, a series of platforms, branches and devises for mental stimulation.

Table E Continued: The scale of zero to five for the assessment of housing standards of Asian palm civets (*Paradoxurus musangus*) within agritourism plantations producing or selling kopi luwak (civet coffee); Zero = poorest standard or condition. Five = Preferred standard or excellent conditions.

Score	0	1	2	3	4	5
Roof	No roof on enclosure. No shelter from rain and sun.	Partial roof on enclosure in need of maintenance and cleaning. Likely noisy when rained on. Fair protection from some of the sun.	Partial roof on enclosure in good standard and cleanliness. Likely to be a little noisy when rained on. Fair protection from some of the sun.	Full roof in need of maintenance and cleaning. Likely to be noisy when rained on. Good protection from the sun.	Full roof on enclosure in good standard of repair and cleanliness. Likely to be little noisy when rained on. Good protection from the sun.	Excellent roof with drainpipes for channelling rainwater. In excellent state of repair and not too noisy when rains. Excellent protection from the sun.
Security	No padlock only a simple catch, likely to fail.	No padlock; a good slide bolt or similar.	small padlock and a good slide bolt or similar.	Sturdy padlock and a good slide bolt or similar.	Two padlocks and a two good slide bolts or similar.	Two padlocks and a two good slide bolts or similar. Plus CCTV coverage.
Shelter	No Box or platform	Simple Platform on cage floor	Simple Platform raise off ground	Partially enclosed box on the cage floor	Partially enclosed box off the ground	civets have a sleeping area hidden from public view
Substrate Type	Wire Floor	Plastic Sheeting	Timber slats	Concrete Floor	Concrete Floor with covering of absorbent bedding	Natural Substrate
Walls	Mostly blocks or corridated metal sheet with panel of wire mesh with small access door	All Wire mesh with small access door	Mix of wire and another material with single large access door	Mix of wire and another material with double door access	All Wire mesh with large single door	All wire mesh with Full height double door access

Table F: The scale of zero to five for the assessment of Information standards of Asian palm civets (*Paradoxurus musangus*) within agritourism plantations producing or selling kopi luwak (civet coffee); Zero = poorest standard or condition. Five = Preferred standard or excellent conditions.

Score	0	1	2	3	4	5
Details on civets	No written details of civets	Only explanation of kopi luwak in the coffee shop in one language	Only explanation of kopi luwak in the coffee shop though in two or more languages	Good details of civet behaviour and ecology and the origin of kopi luwak, though only in one language	Good details of civet behaviour and ecology and the origin of kopi luwak, in two or more languages	Excellent details of civet behaviour and ecology and the origin of kopi luwak, in two or more languages
Education Signs	No signs for education	Crude paper, handwritten sign	Simple printed sign with in one language	Good quality sign in one language	Good quality sign in two languages	Good quality sign in multiple languages
Quality of Guide information and Customer Service	No interest in a guided tour of the plantation. Very poor and inaccurate details.	Basic and inaccurate guide of the plantation. Rushed and with little interaction or answers to questions.	Basic but largely accurate guide of the plantation. Rushed and with little interaction or answers to questions.	Good guide with some inaccuracies. Good duration, some problems answers to questions.	Good guide with little inaccuracies. Good duration, little problems answers to questions.	Excellent detailed guide, high degree of detail and accuracy, Questions answered with either evidence of self-research or staff training from the plantation.
Warning Signs	No signs related to public safety	Crude paper, handwritten sign	Simple printed sign with in one language	Good quality sign in one language	Good quality sign in two languages	Good quality sign in multiple languages

partly assessed against observer interpretation and partly against legal stipulation. The observer/author holds qualifications in animal care and zoology achieved since 1994 and has taught animal care for over eight years, so is highly experienced in making animal welfare assessments and recommendations. Not all locations visited in this study had an online presence and were discovered due to roadside signage. Bias could be given therefore to only sites that have a visibility on the roads travelled in Indonesia. Not all kopi luwak sites could be visited so comparisons between different locations could not be achieved. Additionally, as the guides met in the plantations were speaking English as their second language, some of the questions could be misinterpreted therefore answers could have been incorrect.

4.4. Statistical analyses within this thesis

With data such as the proportion of carnivores recorded in camera traps, diet of civets from online surveys and husbandry categories in facebook analysis and within surveys in markets and kopi luwak plantations, mean and frequency of occurrence (equations below). These calculated how common a sample arises in the dataset and are common analyses used also by other literature sources, therefore allows comparison against other datasets. Particular comparisons were made with respect to the findings of the datasets in Shepherd, 2008; 2012; Shepherd & Shepherd, 2010; Nijman, *et al.,* 2014; Rode-Margono, *et al.,* 2014; Carder, *et al.,* 2016; Fung, 2016; Cahill, 2017; and Lewis-Whelan, *et al.,* in prep; among others that all use frequency of occurrence and means in their analysis.

The sum for calculation of mean (average) throughout the thesis was as follows:

$$\text{Mean} = \frac{\sum \text{of Sample terms}}{\text{Number of sample terms}} \times 100$$

The sum for the calculation of commonness of categories in datasets was as follows:

$$\text{Frequency of Occurrence} = \frac{\text{Count of the category occurrence in dataset}}{\text{Count of all sample categories}} \times 100$$

Throughout Chapter 5, 6 and 7 datasets were assessed and presented to determine whether findings of research are statistically significant. Chi-square analysis (χ^2) tested homogeneity or independence of results against expected values (EV) (EV=probability of

occurrence x sample size) (Fowler, Cohen & Jarvis, 1998). The equation below tested the correlations and discrepancies in the species' preferences for activity pattern over 24-hour periods and for preferences in the activity versus illumination provided by moon phase provided by percentage (source data from: https://www.timeanddate.com /moon/ @7911819). Chi-square was also used to determine if there is any significant variation in the findings within Indonesian animal markets, in pet trade data, facebook trade and information, online survey results and kopi luwak trade.

$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

The resulting χ^2 value was assessed against the significance value table within Fowler, Cohen & Jarvis (1998) and further validated with https://www.socscistatistics.com/ pvalues/chidistribution.aspx using degrees of freedom calculated via sample quantity minus 1 (n = -1).

ACTIVITY PERIOD AND HABITAT USE OF ASIAN PALM CIVETS IN WEST JAVA.

5. ACTIVITY PERIOD AND HABITAT USE OF WILD ASIAN PALM CIVETS

5.1. Introduction

Asian palm civets are members of a wider community or guild of mesocarnivores within their geographic range with divergences and convergences in niche. The mesocarnivore guild is also likely to constitute carnivores of various families and species with assemblages differing in regions due to habitat preferences, radiation routes available and local densities, carrying capacities, introductions and eradications (Bu, *et al.,* 2016). Niche separation between otherwise similar species may enable conspecific species to coexist in a habitat. Without divergence of character, behaviour and ecology competition would ensue between similar species and this would lead to the spatial and temperal displacement or total removal of the losing species. Separation can take form in many ways, for example; the inclusion or exclusion of food items, favouring different proportions of food items, utilisation of different wider habitat and microhabitat characteristics, selection of core areas and sleeping locations, avoidance of competing species, and differences in temporal activity patterns (Jennings & Veron, 2011; Nakabayashi, *et al.,* 2014; Bu, *et al.,* 2016).

Many mesocarnivore species are commonly, but not exclusively found to be solitary with overlapping territories with conspecifics of either breeding age or previous offspring that have dispersed or are dispersing to find new home ranges (Borah & Deka, 2011; Jennings & Veron, 2011; Evans, *et al*., 2016; Parikesit, Withaningsih & Prastiwi, 2019). The term solitary is often misunderstood as being unsocial, however, even solitary species must have social interactions between individuals or the species' extinction is inevitable (Soso, *et al.,* 2014). Social interactions can be variable at different periods of the year depending on migration, breeding season, increased or decreased availability of resources (food and habitat) and prevailing weather conditions. The Asian palm civet is not known to be particularly migratory so distribution and territory changes would likely to be due to displacement or animals dispersing from parental territory to establish a new home range. Heydon & Bulloh (1996) indicates population densities of Asian palm civets as 6.4 individuals per square kilometre in logged forest and 31.5 individuals per square kilometre in primary forest. Parikesit, Withaningsih & Prastiwi, (2019) recorded between 12 and 66 civets with a territory size of between 2-17ha each meaning a population density of 5.9 - 14.4 civets per per square kilometre in Sukaresmi village, West Bandung Regency. High population densities therefore leading to intraspecific interactions being common. There is no indication on whether population density changes significantly seasonally (allowing for breeding fluctuations) yet males appear to have larger ranges than females (Parikesit, Withaningsih & Prastiwi, 2019). Interactions between individuals are more likely in areas with greater densities (in landscapes of native vegetation) though as habitat is degraded carrying capacity seems to be reduced (Heydon & Bulloh, 1996; Parikesit, Withaningsih & Prastiwi, 2019).

The temporal or spatial separation for solitary species is often overcome by carrying out their social communications using range of defined behaviours such as body language, vocalisations and scent markings (Gorman & Trowbridge, 1989; Shorey, 2013; Wyatt, 2014). As camera traps are used *in scripta* it is not possible to determine the scent chemistry and vocalisations in this study (see Chapter 9). For solitary mesocarnivore species, a primary method of indirect communication is through scent marking with chemical substances produced by specific exocrine glands (Wemmer, 1977; Gorman & Trowbridge, 1989; Shorey, 2013; Wyatt, 2014). Scent marking in carnivores incorporates behaviours such as head rubbing, flank rubbing, deposition of faeces and urine as well as the use of phyla specific glands such as the anal glands (used by e.g. canids, felids and mustelids) and perineal glands (used by viverrids) (Ralls, 1971; Wemmer, 1977; Rozhnov & Rozhnov, 2003; Trowbridge, 2013; Soso, *et al.,* 2014). Scent is believed to convey messages related to status, health, quality of diet and reproductive receptiveness (Krukk, 1982; Gorman & Mills, 1984; Zala, *et al.,* 2004; Müller & Manser, 2008; Trowbridge, 2013; Soso, *et al.,* 2014; Wyatt, 2014). Kean, *et al.,* (2011) found in European otter that scent differed between juveniles and adults and between individuals of differing gender and reproductive status, suggesting that one animal could distinguish another from the scent marks. Owing to the limited direct contact of solitary conspecifics in an area, scent must remain viable to convey the messages effectively. It also needs to be located in a place that is easily discoverable (Gorman & Mills, 1984). These sites are typically on junctions and sides of wildlife paths and roads, on riverbanks and in trees and on large rocks (Ralls, 1971; Krukk, 1982; Gorman & Mills, 1984; Rozhnov & Rozhnov, 2003; Roberts, *et al.,* 2007; Soso, *et al.,* 2014; Green, *et al.,* 2015). It is likely that this recognition of individuals by their scent occurs in other mesocarnvores also and that the siting of scent marks reflects the communication of scent between conspecifics (Wemmer, 1977).

Few datasets exist about the guild structure of the mesocarnivores in Indonesia, when it comes to relatively common species such as the Asian palm civet (*Paradoxurus musangus*) or the Javan ferret badger (*Melogale orientalis*) (Krishnakumar, *et al.,* 2002; Duckworth, *et al.,* 2008; Shepherd, 2012). Whilst direct sightings and camera trap records have been recorded for these and other small carnivores (Brinkle, 2007; Eaton, *et al.,* 2010; Rode-Margono, *et al.,* 2014; Spaan, *et al.,* 2014) more research is needed on the ecologies, populations and interactions of mesocarnivore species in order to design effective conservation strategies or monitor their conservation status. Camera trapping in West Java noted in Rode-Margono, *et al.,* (2014) and Spaan, *et al.,* (2014) is still ongoing and yielding previously unconfirmed species in the study site. This is important because the trade in several small carnivore species for exotic pets is putting pressure on these wild populations (Nijman, *et al.,* 2014). As aforementioned in Chapters 1.4 and 4.1 for the assessment of Asian palm civet and other small carnivores will involve the deployment of camera traps in defined sites in Cipaganti to record the presence of species and to catalogue the activity pattern through the time and date recorded and to also give indication how the species utilise the available habitats. Results are reported in Chapter 5.2.

5.2. Results

5.2.1. What species of mesocarnivores are present in Cipaganti?

Camera traps recorded mesocarnivores present along transect lines in Cipaganti from 14th August 2012 to 6th July 2018 (a total of 2,152 days, logging a total of 11,146 trap nights). Over this period the effort recorded 4,525 images (2.1 images per day / 0.4 images per trap night) and enabled the identification of eleven carnivora (n=11) from the Viverridae, Mustelidae, Canidae, Felidae and Herpestidae families. Nine species were wild species of carnivore (52.6%) and two were domesticated (2.1%), (Table G). The remainder were other mammals from Suidae and Primate groups (46.3%). The Asian palm civet were represented in, by far the greatest number of recorded images with 44.4% of camera trap images (n=2,008) (χ^2=194.1 P=<0.01 Significant). No Carnivora were second and third with these being Javan slow loris recorded in 35.7% (n=1,614) (χ^2=113.9 P=<0.01 Significant) and wild boar in 10.2% of images (n=463) (χ^2=1.3 P=>0.01 Not Significant) respectively. The other carnivores that were represented in camera trap images were: Javan ferret badger (4.0%), domestic dog (2.1%), leopard cat (1.3%), yellow throated marten (0.9%), Javan mongoose (0.5%), Sunda stink badger (0.2%), banded linsang (0.2%), small Indian civet (0.1%), Javan leopard (0.1%) and the domestic cat appeared twice only (0.04%) (Table G). When only assessing the wild carnivora in the camera trap images, these total 2,335 image with 86.0% represented by Asian Palm Civet (χ^2=504.2 P=<0.01 Significant), and yet still the most common for terrestrial animals the civet is represented in 36.0% of images (n=509) (χ^2=104.5 P=<0.01 Significant). At height Asian palm civets are second to Javan slow loris in their occurrence rates in images (1,499 civet images to 1,614 loris images) (χ^2=0.1 P=>0.01 Not Significant). Despite the duration and various locations of the camera traps, it has not been possible to confirm the locations of the presence of binturong (*Arctictis binturong*) in Cipaganti, even though there's been unformally recorded previous sightings by Rode-Margono, *et al.* (2014).

Five wild carnivore species were additionally recorded through chance sightings (collectively n=87). As with the camera traps the Asian palm civet is represented by the majority recorded (56.3%) (χ^2=214.6 P=<0.01 Significant) and always nocturnal (Figure 10). Leopard cat were recorded in 32.2% of sightings again all at night (χ^2=49.2 P=<0.01 Significant) (Figure 10) with Javan mongoose at 6.9% (χ^2=1.0 P=>0.01 Not Significant) and both the small Indian civet and banded linsang recording 2.3% of sightings (χ^2=5.9 P=>0.01 Not Significant) (Table G). Sightings of the Javan mongoose, banded linsang and small Indian civet suggest nocturnal or crepuscular activity, though not enough records are available to confirm which. The remaining four carnivore species (yellow throated marten, Javan ferret badger, Javan leopard and Sunda stink badger were not sighted. For three species it could be due to living at higher elevations and/or small population densities (Table G). The Javan ferret badger however were relatively common in camera trap images yet never sighted (Table G). It can be said therefore that camera traps are much more reliable at confirming the presence of carnivores in a location than sightings. The domestic dogs and cats were sighted daily in the proximity of and within the village

Table G: The frequency of camera trap images and sightings of mammalian carnivores in Cipaganti, Garut, Java, Indonesia between 2012 and 2018. Days per camera trap image and sighting is the number of days between the first and last image or sighting divided by the total images of 4,525 or the total sightings of 87. MASL = Altitude at metres above sea level.

Species	Family	Camera trap image frequency (% total)	Days Elapsed 1st to last image	Sighting Frequency (% of Total)	MASL, Low-high (mean)	Mean group size (Range of group size)
Asian palm civet	Viverridae	2,008 (44.4)	2,072	49 (56.3)	1,008 – 1,761 (1,429)	1.0 (1-5)
Ferret badger	Mustelidae	183 (4.0)	2,077	0 (0.0)	1,330 – 1,787 (1,447)	1.0 (1-2)
Domestic dog	Canidae	93 (2.1)	2,058	n/a	1,330 – 1,725 (1,493)	1.2 (1-3)
Leopard cat	Felidae	60 (1.3)	2,008	28 (32.2)	1,350 – 1,747 (1,465)	1.0 (1-2)
Yellow throated marten	Mustelidae	42 (0.9)	1,750	0 (0.0)	1,330 – 1,725 (1,477)	1.3 (1-2)
Javan mongoose	Herpestidae	22 (0.5)	1,911	6 (6.9)	1,407 – 1,564 (1,484)	1.0 (1-2)
Banded linsang	Viverridae	7 (0.2)	112	2 (2.3)	1,459 – 1,787 (1,705)	1.0 (1)
Sunda stink badger	Mustelidae	7 (0.2)	56	0 (0.0)	1,751 – 1,808 (1,776)	1.0 (1)
Javan leopard	Felidae	4 (0.1)	1,676	0 (0.0)	1,493 – 1,761 (1,676)	1.0 (1)
Small Indian civet	Viverridae	3 (0.1)	1,796	2 (2.3)	1,462 – 1,725 (1,637)	1.0 (1)
Domestic cat	Felidae	2 (0.0)	1,097	n/a	1,365 – 1,489 (1,427)	1.0 (1)

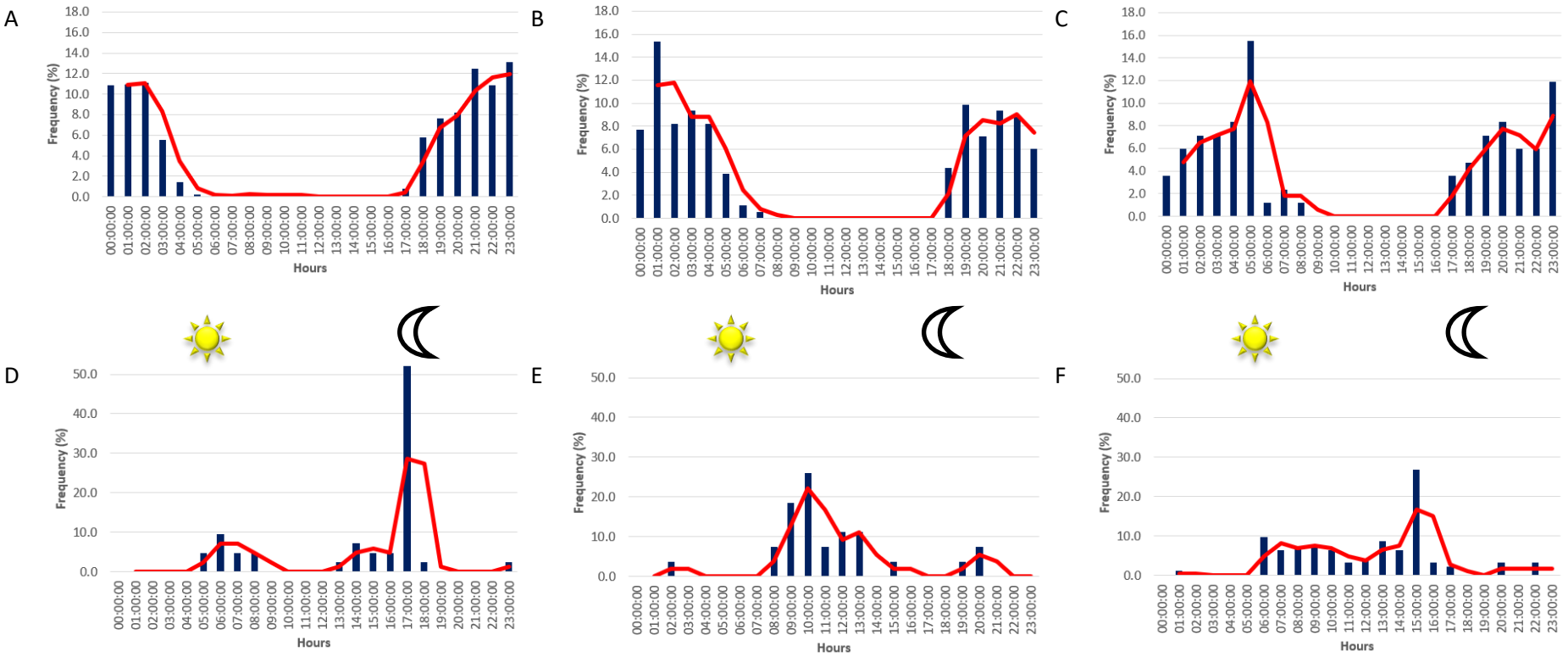

Figure 10: Graphs showing recorded and trend in the activity pattern of six carnivore species in Cipaganti, Garut, Java, Indonesia determined by camera trap images and sightings. A) Asian palm civet [Nocturnal] (n=2,057 records), B) Javan ferret badger [Nocturnal] (n=183 records), C) leopard cat [Nocturnal] (n=88 records), D) Yellow throated marten [Crepuscular] (n=42 records), E) Javan mongoose [Diurnal] (n=28 records), F) domestic dog [Cathemeral] (n=93 records). Sun symbol depicts typical sunrise time around 06:00 and moon symbol the sunset of around 18:00. Frequency in dataset displayed as the mean frequency for each species. Hour of day in 24hr from midnight to 23:59.

and in close association with people and therefore were not included in the sightings analysis. Results here clarify findings related to the recapitulated aims below:

5.2.2. Activity patterns, behaviours and interactions of carnivores in Cipaganti

- *What activity patterns are expressed by Asian palm civets and other mesocarnivores in Cipaganti?*
- *Can camera traps provide any indication to behaviours, habitat use, intraspecific and interspecific interactions, competition and niches of Asian palm civets and other mesocarnivores in Cipaganti?*

Camera traps and sightings recorded GPS (global positioning system) location, habitat, time of day and elevation in metres above sea level (MASL), height from the ground where the animal was and also recorded was the behaviour that animals recorded were showing; including scent marking, social and whether running, playing, walking, climbing or foraging. Data in Table G shows that the Asian palm civet has been recorded at elevations below and above Cipaganti with a range of 753 vertical metres (1,008 – 1,761 metres above sea level). Other species only at elevations above the village. Species at lower elevations show a tolerance for the anthropogenically changed habitats with ranges that reach the primary forest but also lower elevations that border the perimeter of the village (Table G; Chapter 3.1). As all the species recorded here have ranges that overlap considerably, there is ample opportunity for interactions between species to occur.

Data from camera traps include date and time plus dates and time from sightings were indicative of nocturnal activity patterns in the Asian palm civet (n=2,057) (18:14 – 06:39HRS) with 98.2% of activity during the nocturnal hours (Figure 10). The civet seems to show a slight preference for nocturnal activity before midnight rather than after (18:00-00:00 = 58.1%; 00:00 – 06:00 = 40.2%; (χ^2=3.3 P=>0.01 Not Significant) and there was no significant difference in activity throughout the lunar phases cycle being almost equally likely at new to half moon (47.2%) as half to full moon (52.8%) (χ^2=11.2 P=>0.01 Not Significant). There was no significant difference between activity of the Asian palm civet at full moon (90%-100% illumination) and new moon (0%-10% illumination) (χ^2=1.8 =>0.01 Not Significant). Javan ferret badgers (n=183) (active between 19:00 – 07:56HRS) were also nocturnal (Figure 10) with 98.4% of activity at night with similar levels of activity before and after midnight, 52.7% of activity between 1800HRS and midnight and 45.6% from midnight until 0600HRS (χ^2=0.5 P=>0.01 Not Significant). Activity patterns showed preference for a brighter lunar phase with 43.7% at 75% to 100% of fullness (χ^2=14.0 P=<0.01 Significant). All Javan ferret badger activity was recorded at elevations of 1,330 metres – 1,787 metres (mean: 1,447 metres above sea level) (Table G). Leopard cat sightings and camera trap images (n=88) occurs at elevations 1,350 – 1,747 metres above sea level (mean of 1,465 metres above sea level) (Table G) and shows a nocturnal pattern (17:44 – 08:06HRS) (Figure 10) that might be more crepuscular with more records. There

is no significant difference between Leopard cats' nocturnal and crepuscular activity (χ^2=1.8 P=>0.01 Not Significant) The species were more active at dawn and dusk than at midnight and only one record was recorded for diurnal activity at 08:06HRS. Some lunar light however is preferred as leopard cats show greater activity (63.2%) when the lunar cycle is more than half moon (χ^2=7.9 P=<0.01 Significant).

The low number of records obtained for the remaining Carnivora species limits firm deductions about behaviour patterns that can be drawn from this study. Records of the yellow-throated marten (n=42), were suggestive of a crepuscular activity pattern. Javan mongoose (n=28) appeared to be diurnal. Banded linsang (n=9) suggests nocturnal activity. Javan leopard was recorded in 4 images, small Indian civet (n=3) and the Sunda stink badger on 7 occasions, all could be crepuscular or nocturnal with more data. The records of domestic dogs and domestic cat where linked with the activity of people were also recorded passing the camera which occurred cathemerally.

Most records of carnivore species showed largely solitary character, with occasionally occurrences of pairs or more shown. Asian palm civet was solitary in 2,040 images and sightings (99.2%). In two sightings an Asian palm civet was recorded with 4 cubs in October and November 2014 with further 15 camera trap and sightings showing pairs. Ferret badger where recorded as singular in 178 images (97.3%) (5 as a pair); domestic dog was singular in 80 images (86.0%) (13 with group size of up to 3). Leopard cat were solitary in 85 (96.6%) (with a further 3 pairs recorded). Yellow throated marten were solitary in 30 records (71.4%) (12 images showing martens in pairs). Javan leopard, linsang, Sunda stink badger and small Indian civet were only recorded solitary. Ten Javan Leopard have been recorded on the neighbouring Gunung Papandyan through a camera trap survey carried out in 2016-18 by the West Java Natural Resources Conservation Agency (BBKSDA) (Jakarta Post, 2019), there is a possibly that the Leopards recorded *in scripta* are either the among the same individuals recorded or of a population that has continuity with that of the Papandayan specimens.

The only carnivore species to use the overhead irrigation waterlines and Loris bridges was the 72.8% of the records of the Asian palm civet (n=1,499). The civet remains the most common carnivore also terrestrially (n=509; 60.8% of the 837 images of all carnivores) (χ^2=222.3 P=<0.01 Significant). Asian palm civets were recorded more that 1.5 metres off the ground in 80.7% of all camera trap images recorded with notable uses of waterlines at 3 and 5m elevation (31.0% and 38.4% respectively; (χ^2=192.6 P=<0.01 Significant). Like the civet, slow loris (n=1,614) is strictly nocturnal and commonly utilised pipelines with 59.7% of activity at 3m elevation and 23.7% at 5m (χ^2=385.2 P=<0.01 Significant). Pipelines provide water to irrigate the fields and also channel water to homes in the village. These are laid along the ground in some areas but also (like with the Loris Bridges) suspended up to 5 metres off the ground over valleys and streams. In the fragmented undulating landscape these routes provide an easier means of movement between

habitat fragments. Civets occurred every 1.38 days on waterlines or bridges and Loris at 1.04 days, both species expressing only night-time use. There were no images of civet and Loris on the waterlines at the same time, however the species do appear within 5 minutes of each other on some nights. It indicates a strong mutual use of the waterlines and no competition for them. There is also no evidence from the waterlines and loris bridges that the civet is predatory towards the Lorises. Lorises were never recorded scent marking whilst the civet was recorded scent marking 143 times (7.1% of camera trap images) with 53 in mixed bamboo woodland (37.1%), 29 occurrances on labu frames (20.3%), 28 times in woodland canopes (19.6%), 15 on pipelines and loris bridges (10.5%), 11 occurrances on the ground (7.7%), and 7 on lower branches of trees (4.9%). The mean height of scent marks were 2.4m from the ground. No other small carnivore or primate in Cipaganti were recorded using waterlines and loris bridges even though several would have been agile and light enough to do so. Reasons are discussed. Mice, tree shrew and some birds including kingfisher and owls; used the waterlines, the rodents using them as the civet and Loris, the birds only perching.

Scent marking by Asian palm civets were also recorded during terrestrial activity with the greater potential of including intraspecific and interspecific communication. A camera trap was located overlooking a rock naturally positioned and orientated, approximately 0.8 metres x 0.5 metres x 0.3 metres (L x W x H) on an animal trail through native bamboo and forest fragment (elevation 1,489 metres above sea level) (Figure 11). Seven carnivore species (five wild and two domestic) explored and/or scent marking the rock a total of 45 times out of 150 visits (29.8%) (Table H; Figure 12). Scent marking was indicated by animals' exhibiting characteristic postures indicative of depositing faeces and/or urine. Asian palm civet also appeared to engage in perineal gland rubbing. Both the Asian palm civet and Javan ferret badger visited most (n=44 and n=57 respectively) resulting in the civets marking on 20.5% of visits (χ^2=42.7 P=<0.01 Significant) and the Ferret badger marking 28.1% of visits (χ^2=17.1 P=<0.01 Significant) (Table H). Most frequent markers were yellow throated marten visited on 6 occasions marking 5 times (83.3%) (χ^2=13.3 P=<0.01 Significant) and domestic dog visiting 14 times and urinating on 28.6% of occasions (χ^2=16.1 P=<0.01 Significant). Small Asian mongoose investigated scent markings on 42.8% of visits though marked just once (14.3%) (Table H; Figure 12). Leopard Cats were frequent visitors (n=22) with ten scent marking occurrences (45.5%) (χ^2=0.5 P=>0.01 Not Significant) (Table H; Figure 12). Domestic cat did not mark on the rock (Table H). Each carnivore species usually visited the scent site alone, though pairs of animals were also recorded for yellow-throated marten (33.3% of visits) (χ^2=0.2 P=>0.01 Not Significant), domestic dog (7.1%) (χ^2=1.8 P=>0.01 Not Significant), Asian palm civet (6.8%) (χ^2=9.3 P=<0.01 Significant) and Javan ferret badger (5.3%) (χ^2=8.9 P=<0.01 Significant). Dogs also occurred as a trio (7.7%) (χ^2=1.8 P=>0.01 Not Significant). There images of some mice, squirrels and tree shrews on top of the rock, though only one shrew seemed interested in the scent markings. There were an additional eleven images of up to seven wild boar (*Sus scrofa*) (group size: 4 (9.1%), 6 (27.3%) and a 7 (9.1%)) (χ^2=3.0 P=>0.01 Not Significant) passing the rock but without any attraction and scent marking on the rock. No species was recorded visiting at the same time as another. It seems though the scent marks of carnivores were only of interest to species of carnivores.

Figure 11: A camera trap location in Cipaganti, Garut, Java, Indonesia in 2017 (left) and 2018 showing habitat before and after clearance of woodland and bamboo for fuel and building materials. Taken by camera trap (Left) and Hélène Birot (right).

Table H: Seven species of carnivore identified through a camera trap and scent marking site on a rock near the village of Cipaganti, Cisurupan, Garut, Java, Indonesia (7°6'6"S; 107°46'5"E).

Common Name	**IUCN Status**	**Camera-Trap Images Recorded (% showing scent marking behaviour) Days between images**
Javan ferret badger, *Melogale orientalis*	Least Concern	57 (28.1%) 34.9
Asian palm civet, *Paradoxurus musangus*	Least Concern (as *P. hermaphroditus*)	44 (20.5%) 45.8
Leopard cat, *Prionailurus bengalensis*	Least Concern	22 (45.5%) 91.3
Domestic dog, *Canis familiaris*	Least Concern	14 (28.6%) 143.4
Yellow throated marten, *Martes flavigula*	Least Concern	6 (83.3%) 222.8
Javan mongoose, *Herpestes javanicus*	Least Concern	7 (14.3%) 268.4
Domestic cat, *Felis catus*	Least Concern	1 (0.0%) n/a

Asian palm civet (*Paradoxurus musangus*)

Domestic dog (*Canis familiaris*)

Javan ferret badger (*Melogale orientalis*)

Leopard cat (*Prionailurus bengalensis*)

Small Asian mongoose (*Herpestes javanicus*)

Yellow throated marten (*Martes flavigula*)

Figure 12: Camera-trap still images and video frames taken with a Bushnell Trophy camera from one carnivore scent marking site near the village of Cipaganti, Cisurupan, Garut, Java, Indonesia showing marking or interest in markings by six carnivore species (August 2012 – January 2014).

5.3. Discussion

5.3.1. The carnivores of Cipaganti and wider West Java

- *What species of mesocarnivores are present in Cipaganti?*
- *Can camera traps provide any indication to behaviours, habitat use, intraspecific and interspecific interactions, competition and niches of Asian palm civets and other mesocarnivores in Cipaganti?*

Nine wild carnivore species were recorded from four families (Mustelidae, Felidae, Viverridae and Herpestidae), a further two domesticated carnivore species (domestic dog and domestic cat), two primate species and the non-native Suidae European Wild boar. The Asian palm civet is represented in a high proportion of camera trap images (44.4%) and in the greatest range in altitude and different habitat types. This frequency and range indicates that the species is a generalist and common in the area, and commonly use trails in the landscape to move around their habitat (Sollmann, *et al.,* 2013), though more study would need to take place to ascertain the population density. Parikesit, Withaningsih & Prastiwi, (2019); Subrata, *et al.,* (2017) and Heydon & Bulloh, (1996) all recorded civets as impacted negatively by anthropogenic changes to habitats yet in Cipaganti the species appears to be ubiquitous in various habitats having been recorded on every camera placed, though whether densities of civet are uniform across habitat types is unknown yet is likely to be patchy as in Heydon & Bulloh (1996) and Parikesit, Withaningsih & Prastiwi (2019). Deforestation and habitat changes appears to affect distributions of other species too in West Java. Megantara, *et al.* (2019) showed greater diversity of mammalian species (n=38) present in native forest versus degraded habitats (n=16). In studies by Megantara, *et al.,* (2019) found Asian palm civets in forest, plantations, in riparian habitats and in settlements but absent in areas where slash and burn clearances had occurred, in rice paddies and also in areas of shrubby vegetation. Burning has occurred in Cipaganti to clear vegetation to make way for chayote frames (see Introduction title in page 14 *in scripta*), whilst there is no evidence of animals using newly cleared land, once the chayote (*Sechium edule*) frames are established, civet and also lorises are recorded commonly. According to Megantara, *et al.* (2019), Javan Mongoose prefers shrubby habitats. Banded linsang and yellow throated marten prefer native forest and small Indian civet prefers agricultural areas. The study *in scripta* finds all these species in various habitat types including: forest, agricultural and shrubby habitats. Megantara, *et al*. (2019) do not state preferences for Javan ferret badger and Sunda stink badger.

What may aid carnivores in Cipaganti, despite the deforestation that has occurred, is the introduction of chayote frames between 2011 and 2015 (increasing to 12% of the habitat available in 2015 (Nekaris, *et al.,* 2017)). Chayotes provide cover between the understorey and canopy (the latter lost to create the frames) that benefits these species to reduce predation risk and easier movement between patches (Nekaris, *et al.,* 2017). However, on the reverse of this, more of Cipaganti is becoming monoculture of Chayotes

leading to loss of biodiversity impacting on native foodwebs and endemism (Nijman, 2010). The hillsides around Cipaganti provide food and resources harvested and sold by the resident human population and any conservation aspiration to promote biodiversity mustn't contravene people's economic interests (Philpot, *et al.,* 2008). To do so means any restrictions about harvesting of resources would lead to unregulated exploitation and failure of protection schemes. To protect an area from further anthropogenic degradation requires alternative sources of income to be established for people such as employment as rangers, educators and researchers (Sodhi, *et al.,* 2010a; Sodhi, *et al.,* 2010b) or encouraging sustainable mixed crop yields over widespread monoculture (Philpot, *et al.,* 2008; Sodhi, *et al.,* 2010a; Sodhi, *et al.,* 2010b) whilst maintaining green corridors between the native habitat patches remaining (Yuliastuti, *et al.,* 2017). As stated in the thesis introduction (*in scripta*) the carnivores in Cipaganti are aiding the reduction of crop pests such as rodents and herbivorous invertebrates (Pin & Tiong, 2008; Zaki, 2018) and civets particularly have been recorded elsewhere as excellent seed dispersers too (Rabinowitz, 1991; Nakashima, *et al.,* 2010; Jothish, 2011; Nakabayashi, *et al.,* 2012; Fung, 2016).

The Asian palm civet shows its adaptability and capability by utilising the waterlines, loris bridges and chayote frames as opportunities for moving more widely around the available habitats, it is possible that this is contributing to the species apparent population numbers over other species and also why they are notably more evident in camera trap images. By using the niche available above ground the civet is providing itself with more opportunities for food, nesting sites, avoid conflict with other carnivores and avoid attack from terrestrial predators (Su Su & Sale, 2007). The low density/frequency of small Indian civets, banded linsang and yellow throated marten in camera trap images may well be why these have not been recorded at height above the ground when their physiology appears to allow them to utilise this niche also and they do (albeit it infrequently) elsewhere (Su Su & Sale, 2007; Nandiwadekar*, et al.,* 2013; Rode-Margono, *et al.,* 2014). The Asian palm civet is present in a wide variety of habitats throughout Cipaganti showing the species' adaptability to native and anthropogenically altered habitat types. The aforementioned waterlines may promote a higher than normal density of Asian palm civets in disturbed habitats. Other species with potentially viable populations in Cipaganti were Javan ferret badger and Javan slow loris. The Javan ferret badger whilst Least Concern in the IUCN red list and apparently present in all of Java and Bali there appears to be very little known related to densities and trends (Duckworth, *et al.,* 2016). The Loris on the otherhand is well studied in Cipaganti with around 76 individuals known, 19 of these wearing radio collars (25%) and 38.2% camera trap Loris records show collared animals (Voskamp, *et al.,* 2014; Nekaris, *et al.,* 2014; Rode, 2015; Cabana, 2016; Nekaris, *et al.,* 2017; Nekaris, pers. comm.). Though it seems that populations of this loris only occur in West Java and high populations in Cipaganti particularly are due to *in situ* monitoring and education and conservation programmes in local communities that protect these lorises from losses due to hunting, conflict, superstition and pet trades that occurs elsewhere (Voskamp, *et al.,* 2014; Nekaris, *et al.,* 2014; Rode, 2015; Cabana, 2016; Nekaris, *et al.,* 2017; Nekaris, pers. comm.). Traditionally Cipaganti's agroforest habitat is less suited to

lorises that the original native forest that was replaced (Nekaris, *et al.,* 2013; Little Fireface Project, 2014; Nekaris, *et al.,* 2014).

Rode-Margono, *et al.* (2014) recorded Asian palm civet present in ten out of fourteen sites surveyed including Cipaganti, which was the most frequent of any species in terms of both site presence and occasions recorded in each site. Rode-Margono, *et al.* (2014) researched the presence or absence of twenty-one species of carnivore across different sites in Java, finding twelve species overall with six wild carnivores specifically recorded in Cipaganti, omitting the Javan leopard, Sunda stink badger, banded linsang from the study *in scripta*, and all typically at the higher altitude. Husodo, *et al.,* (2019) investigated species diversity in West Java, recording 54 species including 12 species of carnivora. The Asian palm civet was the only civet found in all of sites surveyed by Husodo, *et al.,* (2019). Additionally, they recorded other carnivores: Leopard Cat, Javan Leopard, Javan mongoose and Asian short clawed otter in all five sites also. The small toothed palm civet (*Arctogalidia trivirgata*) was recorded by Husodo, *et al.,* (2019) in West Java, but is not known to be be present in Cipaganti. The leopard's main prey is likely to be the non-native European wild boar (*Sus scrofa*) present in Cipaganti and other sites, so even though wild boar is a pest species to farmers it is fundamental to the survival of the Javan leopard.

Data (*in scripta*) includes confirmed records for Javan leopard (*Panthera pardus melas*) in the study area yet ten have been also confirmed within the area of Guntur Papandyan (Jakarta Post, 2019). The IUCN suggest that there maybe as few as 350 individuals of Javan leopard remaining in the wild (<250 breeding) and the Red list status is Critically Endangered (Stein, *et al.,* 2016). As the Javan leopard is present in this study area, this should be utilised to secure further legal protection and habitat rewilding and restoration for the landscape above Cipaganti and therefore promote the continued population of leopard *in situ* (Wibisono, *et al.,* 2018). With green corridors to other sites would also enable subpopulations to share genetics and prevent gene-diversity bottlenecks as with Cheetah (*Acinonyx jubatus*) (Dalton, *et al.,* 2013). With greater conservation in this site this would also promote populations of other species also as suggested by Heydon & Bulloh (1996) and Parikesit, Withaningsih & Prastiwi (2019) reducing island effects, lack of genetic flow and reducing localised extinction risks (Dalton, *et al.,* 2013).

There still maybe one more Viverridae, namely the binturong that has not been documented in camera trap images, possibly because of limited camera traps being located in the denser forest at higher altitudes. Rode-Margono, *et al.* (2014) recorded two direct observations of the Binturong in Cipaganti (both showing this arboreal species on the ground in open habitat). Like probable with Sunda stink badger particularly in this study site, if the habitat is anthropogenically change further at increasingly higher altitudes, it may mean the viability of populations may be at threat. Otter species (*Aonyx cinereus* for example) are considered as absent in Cipaganti as waterways are both

polluted with plastic waste and lacking depth and width in which to allow the otters to forage, the species could however find suitable habitat using pools around the village that hold stocks of prey and typically maintain size and depth (Wright, *et al.,* 2015), however this is likely to bring conflict with people also. It is unknown if otters have ever been present in this part of West Java, however Husodo, *et al.,* (2019) states that Asian short clawed otters are present in West Java at around 20 miles from Cipaganti. Continuation of a camera trap study in Cipaganti therefore may yet uncover more carnivore species but rare species or with those with a specific preference in habitat restricting range. It is also suggested that the camera traps should also be trained on the streets, alleyways, more waterways and perhaps even roof-tops in the village itself to indicate if wild carnivores utilise or avoid human habitations (Spaan, *et al.,* 2014; Husodo, *et al.,* 2019). This as not been done yet in Cipaganti due to the risk of theft or tampering of research equipment (Chapter 9).

It is unknown whether the lesser capturing of some carnivores on camera traps in Cipaganti is caused by the species being at lower densities or whether the cameras were located in sites and habitats that are less favoured by the species, therefore appear to be less common (Sollmann, *et al.,* 2013). Very little data exists for any population sizes and home range sizes of small carnivores in Java or wider Indonesia in literature, research is urgently required to ascertain if deforestation, anthropogenic habitat changes, hunting and trapping of animals is benefitting or adversely affecting the viability of carnivore populations. Prediction is that forest dwelling carnivore populations are adversely affected by deforestation as suggested by Heydon & Bulloh (1996). The occurrence of civet traps in Cipaganti appears to be on the rise (Nekaris, pers. comm.) and it is likely that animals captured would be subsequently traded in the animal markets of Garut for entry into the pet trade or directly into captivity for kopi luwak production. The other small carnivores in Cipaganti also likely have a presence in the pet trade and, as they appear to already be at lower densities, any extraction of yellow throated marten, Javan ferret badger, Javan mongoose, small Indian civet and Sunda stink badger will lead to localised extinction (Shepherd, 2008; 2010; 2012; Rode-Margono, *et al.,* 2014; Nijman, *et al.,* 2014; Nijman, *et al.,* 2019). See Chapter 6 and 7.

5.3.2. Activities and Interactions of carnivores in Cipaganti

- *What activity patterns are expressed by Asian palm civets and other mesocarnivores in Cipaganti?*
- *Can camera traps provide any indication to behaviours, habitat use, intraspecific and interspecific interactions, competition and niches of Asian palm civets and other mesocarnivores in Cipaganti?*

Data from Cipaganti suggest that Asian palm civet, Javan ferret badger and Javan slow loris are nocturnal, while yellow-throated marten shows a crepuscular activity and the

leopard cat shows mainly nocturnal with some crepuscular activity especially at around dawn. The activity pattern reported here is consistent with the findings for the Asian palm civet, Javan ferret badger and Javan slow loris from other studies (Kumara, *et al.,* 2014; Nekaris, *et al.,* 2014; Rode-Margono, *et al.,* 2014). The yellow throated marten is suggested as both nocturnal and diurnal in other study locations and prefers greater lunar light levels (Chutipong, *et al.,* 2016). The leopard cat being crepsuscular contrasts with those of Rabinowitz (1990) who reported the leopard cat is arrhythmic. Grassman (2000) reported arrhythmic tendencies with marked crepuscular/nocturnal activity for this species, supporting data here, it is expected with more records that the leopard cat will be shown to be more nocturnal. Small Asian mongoose seem to be diurnal, though more data are needed to confirm assertion. Domestic dogs are cathemeral and closely associated to the village where they are either used by farmers to guard crops from pest species such as the wild boar (cathemeral) or possibly from theft, or where dogs scavenged as feral animals. Only one species at a time was recorded scent marking so no apparent direct competition was recorded yet this doesn't rule out that interspecies conflict was reduced by avoidance and niche separation. The preferences in activity pattern between nocturnal, diurnal and crepuscular plus the preference of nocturnal animals for the first or second halves of the night may indicate potential temporal niche separation. It is likely that diet also differs between the carnivore species to further mitigate competition between them. Diet data was not collected in this study. It is likely that the civets and other carnivores benefit the farmers in the area by predating on crop pests such as invertebrates, rodents and birds (Koh, 2008). However, the civet being indicated as potentially frugivorous also, these may also cause crop losses, though provide a benefit by dispersing viable seeds (Joshi, *et al.,* 1995; Roberts, *et al.,* 2007; Mudappa, *et al.,* 2010; Jothish, 2011; Fung, 2016).

Further niche separation appears to occur with elevation up the mountain with particularly with Sunda stink badger and grizzled leaf monkey occurring at higher elevations compared to other species. This maybe due to the lesser degree of deforestation on the higher slopes. The continuity of the forest over higher ridges may allow more elusive and cryptic species such as Leopard to traverse peak to peak without risking conflict with humans. However, as deforestation reaches these ridges the contact or displacement of the species is inevitable (Nyhus & Tilson, 2004). The creation of protected areas on the higher slopes of Cipaganti that have been established may slow the loss of habitat and therefore buffer the conflict between carnivores and humans (Nyhus & Tilson, 2004; Rode-Margono, *et al.,* 2014; Nekaris, *et al.,* 2017).

Scent comprises volatile chemical components (Müller & Manser, 2008). It is deposited by solitary and social animals alike to convey signals of status, territorial ownership and receptiveness for reproduction (Wemmer, 1977; Krukk, 1982; Gorman & Mills, 1984; Zala *et al.,* 2004; Müller & Manser, 2008; Kean, Müller & Chadwick, 2011; Trowbridge, 2013; Soso *et al.,* 2014; Wyatt, 2014). Prominent locations such as large rocks may have strong advantages that are beneficial to multiple species. It appears that the raised waterlines and Loris Bridges have importance for scent marking for Asian palm civet also. On the

ground, scent would be absorbed by the soil or more readily covered over by leaf litter (Ralls, 1971; Gorman & Trowbridge, 1989; Roberts, *et al.,* 2007; Soso, *et al.,* 2014; Green, *et al.,* 2015). It is likely that the volatile chemicals in scent travel further from raised sites and can be traced back to source more easily by receiving animals (Müller & Manser, 2008; Kean, Müller & Chadwick, 2011). Marking in prominent places has been previously noted in other viverrids (Wemmer, 1977; Rozhnov, & Rozhnov, 2003; Roberts, *et al.,* 2007; Widdows & Downs, 2015); mustelids (Kruuk, 1982; Gorman & Trowbridge, 1989; Kean, Müller & Chadwick, 2011), Felids (Broomhall, *et al.,* 2003; Piñeiro & Barja, 2012) and canids (Sillero-Zubiri & Macdonald, 1998; Barja, *et al.,* 2004). It is not known what gender the animals are in this study, therefore cannot draw on the conclusions of Palomares (1993) for comparison.

While multiple carnivore species can share the same marking site it cannot yet be concluded that these species can discriminate the subtleties between each other's scent. Increased scent marking at one location may not only be related to the prominence, location and characteristics of the site, but also to the exchange of information about the intra and interspecific community (Kean, Müller & Chadwick, 2011; Saraiva, *et al.,* 2014; Wyatt, 2014). Gas Chromatography Mass Spectrometry techniques could be used to confirm that the different carnivores share similarities in the chemistry of their scent marks despite species belonging to different taxonomic families. Other studies have also found multiple carnivore species using mutual scent mark sites. De Monte & Roeder (1990) indicated that there is mutual use of scent marking sites in Pine Marten (*Martes martes*), Stone Marten (*Martes foina*) and genets (*Genetta genetta*) but found no evidence that the animals were discriminating between their own species' marks and those of the other species. Allen, *et al.,* (2017) recorded shared marking site choice in Puma (*Puma concolor*) and Gray Foxes (*Urocyon cinereoargenteus*) and suggest that the larger predator's scent being present may benefit the smaller due to deterring other predators. Further data are needed across the study area to clarify activity patterns for all species, niche separation and confirm that mutual choice of scent marking site is also observed elsewhere. See Chapter 9 for recommendations of further research.

QUANTIFYING THE PET TRADE AND WELFARE IN ASIAN PALM CIVETS, WITH DEMOGRAPHICS OF KEEPERS AND WELFARE OF THE ANIMALS

6. QUANTIFYING THE PET TRADE AND WELFARE IN ASIAN PALM CIVETS, WITH DEMOGRAPHICS OF KEEPERS AND WELFARE OF THE ANIMALS

6.1.1. Introduction

Wildlife trade is a threat to wild species populations causing declines and increased extinction risk because, the harvested quantities are unsustainable (Li, *et al.,* 2000; McNeely, *et al.,* 2009; Smith, *et al.,* 2009 Siriwat & Nijman, 2018). Internationally, Southeast Asia is an identified hotspot for illegal trade in wildlife (Nijman, 2010, Rosen & Smith, 2010; Nijman, *et al.,* 2014; Siriwat & Nijman, 2018) and animal markets in Asia are also a likely origin for the zoonotic diseases, Coronavirus (Guo, *et al.,* 2020), SARS (Sudden Acute Respiratory Syndrome) from masked palm civets (*Paguma larvata*) (Guo, *et al.,* 2020; Moutou & Pastoret, 2010; Clark, 2012) and Avian Influenza (Kan, *et al.,* 2005; Roberton, *et al.,* 2006; Clark, 2012). In markets, different wild and domestic species are regularly adjacent to each other with little or no biosecurity measures (Nijman, *et al.,* 2014). Wild species are traded by suppliers despite often being legally prohibited by Indonesian and international legislation (Nijman, *et al.,* 2014). The high volume of trade in wildlife in markets and via internet sales in South East Asia is raising significant concern for biodiversity and ecosystem functionality of the contributing countries (Sodhi, *et al.,* 2010a&b). Nijman (2010) highlighted unsustainable internet wildlife trade with over 53,000 records showing over 35 million specimens of butterflies, seahorses, fish, reptiles, birds and mammals including mesocarnivores, pangolins, tigers and bears, 85% of which were wild caught. Lee, *et al.* (2005) recorded 96,586 mammals in markets over two years in Indonesia with a further 6,963 mammals described as *en route to markets*.

As with *P. hermaphroditus* and *P. musangus*, some species of mesocarnivores may not receive as much specific protection as the IUCN lists their status as Least Concern or they are yet to be assessed. However, wild habitats may be given protection and therefore species are given some level of protection with priority towards endemic species (Indonesian Law 447; Flevin, 2003). Generalist mesocarnivores such as civets are more numerous than large carnivores (both in population numbers and number of taxa) yet less is known about the roles of mesocarnivores in maintaining habitat biodiversity. Roemer, *et al.,* (2009) indicates that mesocarnivores influence trophic cascades affecting both bottom-up and top-down controls by providing prey for large predators, also controlling population densities of mesocarnivore's prey and even dispersing seeds throughout the landscape (Jothish, 2011; Joshi, *et al.,* 1995). Even if individual protection isn't provided to all the mesocarnivores in a habitat they may benefit from protection of the habitat itself.

The internet and social media could be used to trade in animals and disseminate welfare information, through that information could actually also be grievously misleading to the prospective animal keepers (Nekaris, *et al.,* 2013). It is becoming increasingly clear that

the care of wild animals in captivity is not to a standard that considers normal behavioural ecology, it is likely that the civet's behavioural ecology is affected by their husbandry. There are no specific codes of practice to the civets' normal behaviour and welfare requirements as pets, and guidance in these areas was mainly disseminated via facebook "*Musang Lovers*" pages. To what influence "*Musang Lovers*" has on civet welfare is assessed in Chapter 6.2.2. Legislation specific to civet welfare and husbandry is only linked to the Kopi luwak trade and production (See Chapter 7), the laws introduced in 5.1.1. are generic to wide taxa and phyla.

6.1.2. Trade legislation relevant to civets

Indonesia's Law no.5 from 1990 is one legal provision conserving habitats through establishing reserves and protected areas promoting native species and legal eradication of non-native species (Flevin, 1990). Chapter 8 article 36 in Law 5 states how plants and animals may be utilised if not otherwise protected and includes: for study, trade, breeding, hunting and rearing for hobbies among others. However also within the same law in article 19, it contradictorily states practices which alter species composition of protected areas are prohibited unless related to habitat creation and improvement / restoration or as aforementioned for the removal of non-native species. Removing animals and trading in them and altering habitat availability would alter local species composition (Heydon & Bulloh, 1996; Parikesit, Withaningsih & Prastiwi, 2019). It is mainly under Article 19 and article 21 of Law no.5 that the prosecution case would be built. The provisions restricting trade of animals from protected areas including: capture, killing, trade in live or parts of animals and restrictions in transport especially export beyond Indonesia's boundaries (Flevin, 1990).

Shepherd (2008) outlines the legal trade status of civets in Indonesia with a decree of the Ministry of Forestry in Indonesia (no.447/Kpts-11/2003 revised from Decree of the Ministry of Forestry No. 62/KtpsII/1998), stating that trading and transporting wildlife is regulated under quotas and requires legal documentation and all traders need to be registered with the Natural Resources Conservation Agency (BKSDA) under the Directorate General of Forest Protection and Nature Conservation. In Indonesia trade in three species of civets are regulated (*P. hermaphroditus*, *V. tangalunga* and *V. indica*) (both domestic and international) through a wild harvest and trade quota set annually that permits trade in civets as: 10% for domestic use, the remaining 90% exported (Shepherd, 2008) (Table I) (no status exists under the name of *Paradoxurus musangus*). In returning to Law no.447 (Flevin, 2003) part three paragraph two; the non-commercial utilisation of animals through import and export of animal must consider restrictions under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) for live or dead animals, including whole or samples and products of animals (fur, blood, excreta, tissue and secretions. If quotas not used in a calendar year cannot be

Table I: Quota records stating the permitted trade of Asian palm civet (*P. hermaphroditus*) in Indonesia (in individuals). Domestic use = in Indonesia's pet trade. No trade is permitted in Indonesia for commercial use. ? = not stated Figures but likely quantities. Hyphen indicates missing data or not stated.

	Location named in Quota							
Year	**West Java**	**Sunda Islands**	**Sumatra**	**Lampung**	**Central Java**	**Total Harvest Permitted**	**For Domestic Use**	**For Export**
2006	50 (25%)	-	50 (25%)	50 (25%)	50 (25%)	**200**	**20 (10%)**	**180 (90%)**
2007	-	-	-	-	-	**0**	**0**	**180 (100%)**
2008	50 (25%)	-	50 (25%)	50 (25%)	50 (25%)	**200**	**20 (10%)**	**180 (90%)**
2009	-	-	-	-	-	-	-	-
2010	-	-	-	-	-	**300?**	**30? (10%)**	**270 (90%)**
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-	-
2016	-	50 (20%)	100 (40%)	50 (20%)	50 (20%)	**250**	**25 (10%)**	**225 (90%)**
2017	-	-	-	-	-	-	-	-
2018	50 (20%)	-	50 (20%)	50 (20%)	100 (40%)	**250**	**25 (10%)**	**225 (90%)**
2019	-	-	-	-	-	-	-	-

rolled over to the following year's quota (Shepherd 2008). A species cannot be harvested legally from a province with no specified quota.

Harvest quotas are derived by criteria in paragraph 2 article 13 and paragraph 3 of Article 15 of Law no.447 (Flevin, 2003). Any allowance set or the geographic location is required to be reviewed and updated every two years. It is not known what information is prerequisitely required in setting civet quota or what permits have been granted or how they are enforced. According to Wirdatati of the Indonesian Institute of Sciences, most of the five years up to 2014 only 30–50% of the Asian palm civet quota was realised (unpublished data). In 2014, a Jakarta-based company was given provisional permission by the Directorate General of Forest Protection and Nature Conservation (PHKA) to captive-breed 30 Asian palm civets, the offspring to be sold as pets, pending a recommendation from the Indonesian Institute of Sciences (Partono 2014). Part three of Law no.447 (Flevin, 2003) Article 19 states that there should be an upper limit in animals produced through captive breeding, whether they are protected through CITES or not. It is not known if any such cap on offspring exists for civets, however in 2016 only one animal trader/broker (CV Pasundan) had plans to produce or had produced civets, the number stated was 32 animals and is likely a huge underestimation of animals actually bred across Indonesia (Janssen & Chng, 2017). The website Trip Advisor suggests a breeding facility near Bandung, Java that holds 300 civets. Such commercial ventures to breed animals are defined in Law no.447 (2003) Part four paragraph 1 articles 43-49. Breeders and keepers should consider the welfare of animals with provisions and facilities that maintain health and to reduce mortality. There should be trained and monitored staff to ensure good animal husbandry is maintained. Approval or rejection of such ventures will be given based on business feasibility, breeding stock numbers and welfare, standards of welfare and husbandry, knowledge of staff and legal status and value of species (Flevin, 2003) (assumed meaning of value is conservation or economic yet the law does not specify).

To date, Asian palm civet trade in Indonesia is poorly monitored and enforcement efforts are limited (Shepherd, 2008, 2012; Carder, *et al.,* 2016). Across much of Asia, civets are traded for bushmeat (Corlett 2007; Shepherd 2010). In Indonesia, Asian palm civet has received an unprecedented increase in popularity over recent years due to exotic pet and civet coffee (kopi luwak) trades (Shepherd, 2012, D'Cruze, *et al.,* 2014; Carder, *et al.,* 2016). A likely origin for most civets is direct from the wild or via the animal markets in most large towns in Indonesia (Carder, *et al.,* 2016). Exotic pet trade has increasingly received wider critical attention owing to the ethics of procurement and sale plus the husbandry standards and survivorship of animals in captivity (Nijman, 2010; Nijman, *et al.,* 2014) plus the aforementioned risk of zoonoses. Shepherd (2008, 2010 and 2012) states that the harvest quota of civets in Indonesia is not enforced and moreover trade actually takes wildly more civets than quota allowances per annum and has done for some time (Spaan *et al.,* 2014; Shepherd, 2008). Three further viverrid species (binturong *Arctictis binturong*, otter civet *Cynogale bennettii* and Sulawesi palm civet *Macrogalidia musschenbroekii*) are totally protected in Indonesia and zero harvest quotas allotted. The

IUCN red list ranks binturong and Sulawesi palm civet as Vulnerable and the otter civet as Endangered. All three are indicated as having population trends that are decreasing (Ross, *et al.,* 2015; Tasirin, *et al.,* 2015; Willcox, *et al.,* 2016). Civet and other carnivore numbers-traded and/or locations traded in are defined in the results *in scripta* in Chapter 6.2.

6.1.3. Indonesian animal welfare legislation related to civets

Within animal welfare there are five declarations denoting the minimum standard of husbandry know as the five freedoms or five animal needs. In recent years these declarations progressed from codes of practice to legal statute in several countries, among them, Indonesia. Indonesia issued the five needs in Law no.18 in 2009 (an update of law from 1945) in reference to animal husbandry and animal health (Flevin, 2009). This law only pertains to vertebrates and invertebrates that "*can feel pain*", though no further elaboration to which invertebrate species would be represented is given (Flevin, 2009). Article 1 refers to husbandry as "*all matters relating to animal health care, animal medication, animal health service, control and management of animal disease, disease prevention, medical reproduction, medical conservation, animal medicine and animal health apparatus, and food security*" (Flevin, 2009).

Keepers are obliged to provide good food and health care to their animals. Providing surveillance of health status, prevention and treatment of diseases in animals including provision of isolation, quarantine and safeguarding of biosecurity plus provision of veterinary care to animals that have become unwell. Any medication used on animals intended for the food chain should be carefully regulated. Chapter 6 of Law no.18 gives particular reference to prevention and treatment of zoonoses and the handling of sanitation, hygiene and a disease outbreak. Article 66 sections are concerned with Animal Welfare and specifically to care, transport, and reduction of pain, torture, misuse, injury, discomfort, fear and distress of animals. Animals should also be housed in such manner to promote normal behaviours (Flevin, 2009).

Any business establishment that holds animals for breeding, husbandry or health related reasons must under Chapter 8 of Law no.18 article 76: maintain physical and financial records pertaining to marketing, costs, promotion, health care and husbandry provision for animals and source of breeding stock (Flevin, 2009). It is also necessary to develop, improve and implement education and training inhouse and publicly (Flevin, 2009), e.g. for welfare of animals concerned, religious constraints (e.g. Halal) or prevent violations that compromise the integrity of animal or human's health (Flevin, 2009). Law no.18 provides the greatest prosecution levy is against violations against animal welfare, the provision of import or export of animals or products of animals that allows the vectoring of infectious diseases with prosecution levies between two to five years and 150 million to 1.5 Billion Indonesian Rupiah (US$10,582 to US$105,826).

The animal related laws outlined above underpin how vertebrate animals including civets should be kept and traded in Indonesia. The results and discussion that follows explores trade of civets and other mesocarnivores via official CITES records, trade in markets and online and what advice is available to owners online.

6.2. Results

6.2.1. CITES Records

- *How are and to what extent are Asian palm civets traded within and outside Indonesia?*
- *How are Asian palm civets traded within Indonesia's pet trade?*

The CITES database shows trade in *Paradoxurus hermaphroditus* between 1990 and 2016 (there are no records of *P. musangus*). Over that period 720 appear to be recorded though as some are reported by both exporter and importer the actual number is adjusted to 701 from 84 records, with mean 81.7% as "live specimens", a further 14.3% labelled as "specimens" and 4% collectively as either as skins, bodies or skulls. A mean of 85.3% from wild source, 10.8% from captivity with 2.3% labelled as confiscated. The purpose of civet trade states 70% for "commercial use" with 21.7% additional for "scientific use", 0.9% for exhibition and 1.5% labelled as for "personal use" (Table J). Levels of trade indicate a mean of all animals of 27.0 civets per year including live, specimens, pelts, garments and tissue samples. CITES records indicate 17.3 civets per year are wild caught, 2.2 civets per year are from captive bred sources and 0.7 civets are traded per year from confiscated sources. The remainder of the 27.0 civets per year indicated are from unknown or unspecificied sources (χ^2=111.9 P=<0.01 Significant). Years 2014 and 2015 trade recorded 82 and 250 civets traded (71 and 226 live specimens respectively) in each respective year, most animals noted as from wild sources (98.8% and 81.3% in 2014 and 2015 respectively) (χ^2=239.3 P=<0.01 Significant). However, in 2016 just 3 civets were apparently traded all from the wild (Figure 13). According to CITES there has been no civets from captive bred sources traded since 2008 and had been decreasing since 1992 (8 civets each in 1990, 1991 and 1992) (Figure 13).

Twenty-one countries were in the records as exporters of *P. hermaproditus*, a mixture of countries where the civets occur in the wild and several countries in Europe and the Americas where civets are not endemic. Major exporters of civets are Indonesia (n=530; 75.3% through 14 trades over 16/23 years) and United States of America (n=57; 8.1% through 10 trades over 4 years) (Table K). There were 15 importing countries lead by Italy (n=179; 25.4% through 9 trades over 8 years), Korea (n=148; 21.0% in 3 trades over 2 years), Japan and United States equal (16.3%) trading 115 civets each in 3 (2 years) and 34 trades (16 years) respectively (Table K). Records do not show any trade in civets into the United Kingdom within the period of 1990 to 2016 (Table K). Also, little trade recorded for China and India, two countries known to use civets as bushmeat (see chapter discussion).

Table J: Records of trade in Asian palm civet (*Paradoxurus hermaphroditus*) globally between 1990 and 2016 as recorded by CITES and extracted via the CITES trade database (https://trade.cites.org/) [Accessed 24/07/2018].

		Form				Purpose					Source			
	Civets Traded	Live	Skins / Bodies	Skull	Specimen (inc. Hair and Blood samples)	To Zoos	Commercial Use	To Exhibit	For Science	Personal Use	From Wild	Bred in Captivity	Impounded	Unknown
n=	**701**	570	14	14	100	28	326	4	101	7	409	50	15	3
Per Year	27.0	21.9	0.5	0.5	3.8	1.1	12.5	0.2	3.9	0.3	15.7	1.9	0.6	0.1
% in category		**81.7**	**2.0**	**2.0**	**14.3**	**6.0**	**70.0**	**0.9**	**21.7**	**1.5**	**85.7**	**10.5**	**3.1**	**0.6**
% of civets Traded		**81.3**	**2.0**	**2.0**	**14.3**	**4.0**	**46.5**	**0.6**	**14.4**	**1.0**	**56.8**	**7.1**	**2.1**	**0.4**

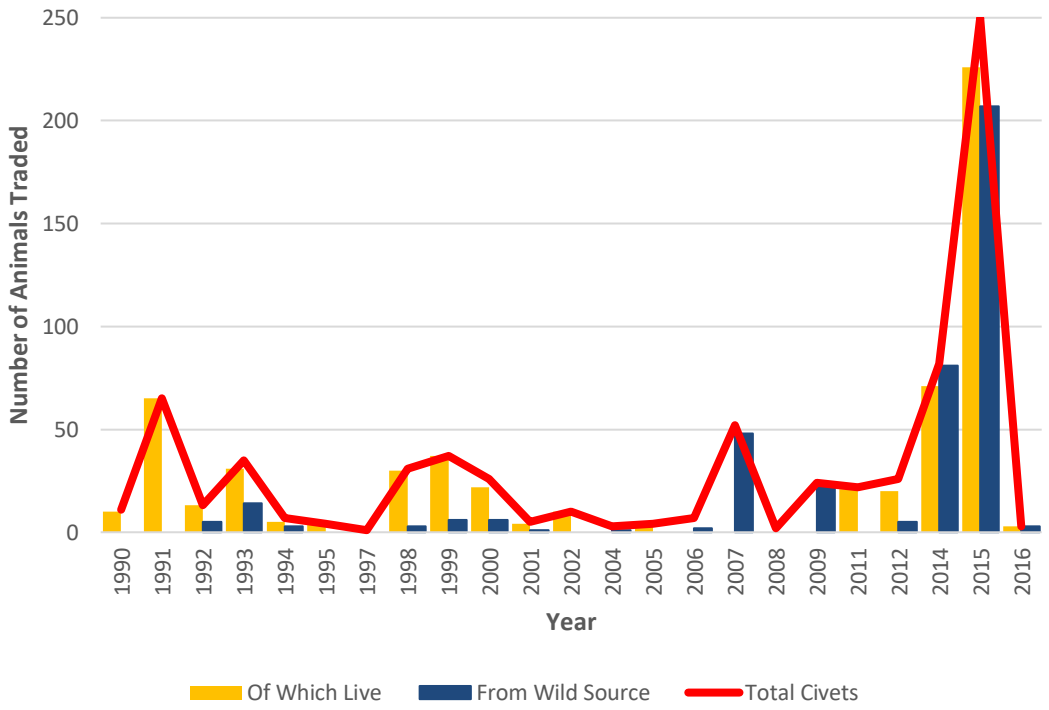

Figure 13: Records of all CITES recorded trade in specimens of Asian palm civet (*Paradoxurus hermaphroditus*) and quantity declared as live and wild caught between 1990 and 2016 as recorded by CITES and extracted via the CITES trade database (https://trade.cites.org/) [Accessed 24/07/2018]. (Total civets include live animals, pelts, garments, skulls, hair and blood samples)

Table K: Trade in Asian Palm Civets (*Paradoxurus hermaphroditus*) from exporting countries to their respected importing countries. Data is the sum of the number of civets from 1990 – 2016 extracted via the CITES trade database (https://trade.cites.org/) [Accessed 24/07/2018]. (Total civets include live animals, pelts, garments, skulls, hair and blood samples). Country codes are International Organization of Standardization (ISO) codes. Figures listed below are: total number of civets (number of trade records) *number of years.* Country codes are transcribed in Appendix 4; Chapter 11.4; Table FF.

Importer	BR	CM	CN	CZ	DE	FR	HR	ID	IT	JP	KR	NL	QA	SG	US	Total	%
Exporter																	
CH	-	-	-	-	1 (1) *1*	-	-	-	-	-	-	-	-	-	-	**1** (1) *1*	**0.1**
CN	-	-		-	-	-	-	-	-	-	-	-	-	-	1 (1) *1*	**1** (1) *1*	**0.1**
CZ	-	-	-		1 (1) *1*	-	-	-	-	-	5 (2) *1*	-	-	-	-	**6** (3) *2*	**0.9**
DD	-	-	-	-	-	-	-	-	-	-	-	8 (1) *1*	-	-	-	**8** (1) *1*	**1.1**
DE	-	-	-	1 (1) *1*		-	3 (1) *1*	-	-	-	-	-	-	-	-	**4** (2) *2*	**0.6**
ES	4 (1) *1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**4** (1) *1*	**0.6**
HU	-	-	-	-	2 (2) *1*	-	-	-	-	-	-	-	-	-	-	**2** (2) *1*	**0.3**
ID	-	-	-	-	-	-	-		179 (9) *8*	104 (2) *1*	143 (1) *1*	25 (3) *3*	2 (1) *1*	-	77 (13) *1*	**530** (30) *14*	**75.3**
JP	-	-	-	-	-	-	-	1 (1) *1*	-		-	-	-	-	-	**1** (1) *1*	**0.1**
KR	-	-	-	-	-	-	-	-	-	-		-	-	-	1 (1) *1*	**1** (1) *1*	**0.1**
LA	-	13 (1) *1*	-	-	-	-	-	-	-	-	-	-	-	-	-	**13** (1) *1*	**1.8**
MM	-	-	-	4 (1) *1*	-	-	-	-	-	-	-	-	-	-	-	**4** (1) *1*	**0.6**
MY	-	-	-	-	-	-	-	-	-	-	-	-	-	8 (1) *1*	2 (2) *1*	**10** (3) *2*	**1.4**
NL	-	-	-	-	-	-	-	-	-	-	-		-	-	4 (2) *2*	**4** (2) *2*	**0.6**
PH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17 (8) *5*	**17** (8) *5*	**2.4**
QA	-	-	-	-	-	-	-	1 (1) *1*	-	-	-	-		-	-	**1** (1) *1*	**0.1**
SG	-	-	6 (3) *3*	-	-	-	-	-	-	11 (1) *1*	-	-	-		5 (1) *1*	**22** (5) *5*	**3.1**
US	-	-	-	-	3 (1) *1*	54 (9) *3*	-	-	-	-	-	-	-	-		**57** (10) *4*	**8.1**
VN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6 (4) *2*	**6** (4) *2*	**0.9**
ZA	-	-	-	-	6 (2) *2*	-	-	-	-	-	-	-	-	-	2 (2) *1*	**8** (4) *3*	**1.1**
ZC	-	-	-	-	-	-	-	-	-	-	-	4 (2) *1*	-	-	-	**4** (2) *1*	**0.6**
Total	**4** (1) *1*	**13** (1) *1*	**6** (3) *3*	**5** (2) *2*	**13** (7) *6*	**54** (9) *3*	**3** (1) *1*	**2** (2) *2*	**179** (9) *8*	**115** (3) *2*	**148** (3) *2*	**37** (6) *5*	**2** (2) *1*	**8** (1) *1*	**115** (34) *16*	**701** (84) *23*	**100.0**
%	**0.6**	**1.8**	**0.9**	**0.7**	**1.8**	**7.7**	**0.4**	**0.3**	**25.4**	**16.3**	**21.0**	**5.3**	**0.3**	**1.1**	**16.3**	**100.0**	

6.2.2. Facebook results from *Musang Lovers* pages

- *How are Asian palm civets traded within Indonesia's pet trade?*
- *What are the demographics for Asian palm civets and their owners?*

The online survey in 6.3.3. was posted on 36 Facebook civet owner's group sites initially. The groups totalled 85,314 members (accessed: 17th May 2014) and rose despite being reduced to 25 clubs to 198,064 on 4th February 2019 showing a slowing of recruitment to 10.5 members per day suggesting members may be plateauing (Figure 14). Average recruitment was 76.5 people per day over 1,724 days monitored. On 4th February 2018, identified *Musang Lovers*-type clubs were expanded to 235 groups and monitored until 4th February 2019. Each was founded between 12th January 2012 and 20th January 2018. At its peak, 59 (25.1%) clubs were founded in 2014 (Figure 15) (χ^2=39.0 P=<0.01 Significant). In Java, 52 clubs originated in West Java, East Java n=35, Central Java n=31, and 8 clubs from Banten (Figure 16) (χ^2=264.5 P=<0.01 Significant). Peak membership growth differs per year with West Java highest in 2012 (2.4 members per day) and 2013 (1.4 members per day), Central Java in 2014 (5.5 per day); East Java in 2015 (7.8 per day) and 2017 (13.1 per day) and Banten in 2016 (9.9 per day) (Figures 16 and 17).

These 235 clubs' membership totalled of 768,603 members on 4th February 2018 (3,271 members per club) increasing to 947,280 on 4th February 2019 (4,031 members per club) the mean increase of 760 members per club. Over 365 days membership rose by 489.5 members per day totalling 178,677 new members. Indonesian clubs and members were the greatest of *Musang Lovers* on Facebook (99.2%) (Table L), with a 68.6% in Java (West Java, 32.2%; Central Java, 15.5%; East Java, 16.9%) (Table L). The Indonesian, Javan and especially west Javan clubs drive the largest membership recruitment across all *Musang Lovers* groups (Figure 17), with Indonesian groups increasing by 416.5 members per day, in Java by 406.1 members per day, in West Java by 159.7 members per day and specifically in Bandung by 60.6 per day, Bogor by 34.0 per day and Jakarta at 20.9 per day (Table M). Semerang in Central Java saw the greatest city increase in members with 75.7 new members per day (25.2 members per day per club from that city) (Table M).

Musang Lovers clubs' mission statements were assessed to determine whether their main focus was trade in animals, rehabilitation of animals and those that were for general husbandry information and a forum for discussion and advice. The rehabilitation group saw least membership rise of 11% from 109,685 to 123,202 (an increase of 13,517 members). The general husbandry group saw membership rise from 344,103 to 397,184 over the year (up by 53,081 members), an 13.9% increase. The greatest rise was the Trade group that rose 26.3% from 311,405 to 422,413 (up by 111,008 members). This implications for the civets and other animals of the marked increase in the trading facebook pages' readership is discussed in Chapter 6.3.

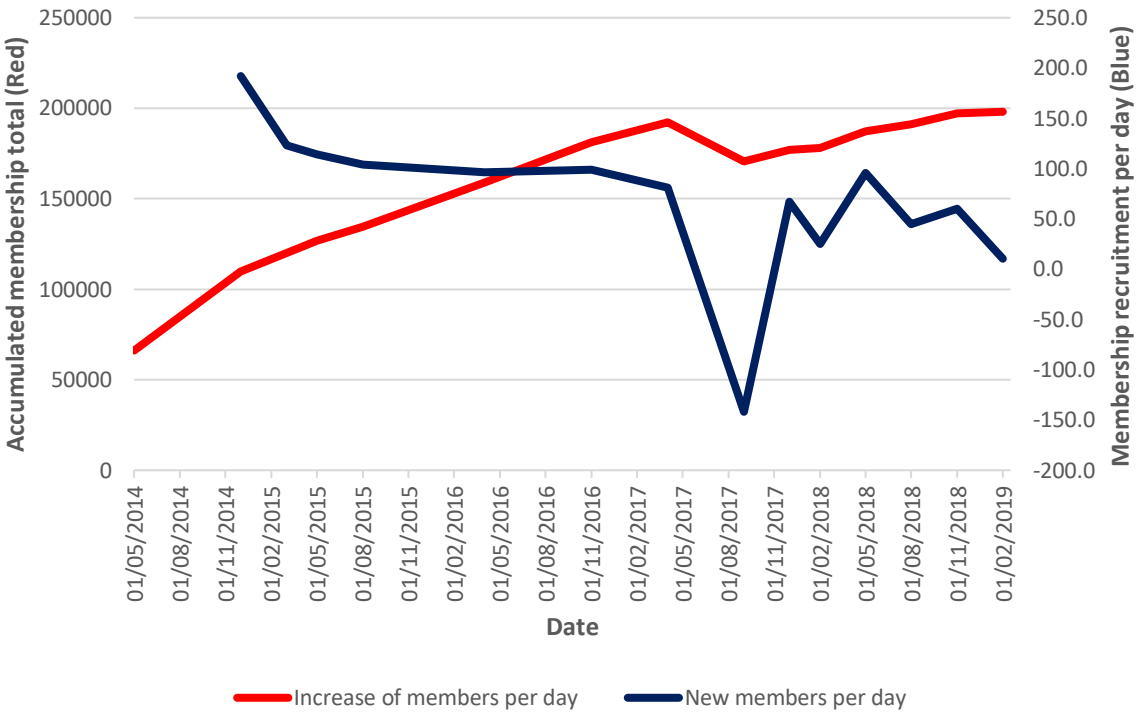

Figure 14: Graph showing the membership increase overall (red line) and recruitment per day (Blue line) of 30 civet Owners Clubs (*Musang Lovers*) on Facebook from 17th May 2014 to 4th February 2019.

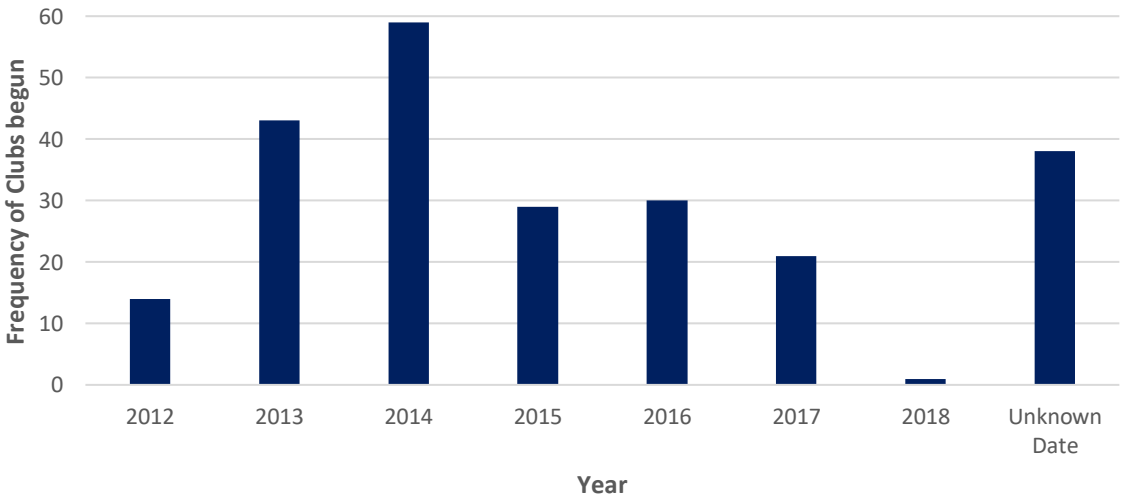

Figure 15: Musang Lovers Facebook Page foundation year for 235 clubs as sourced from the dates on the pages.

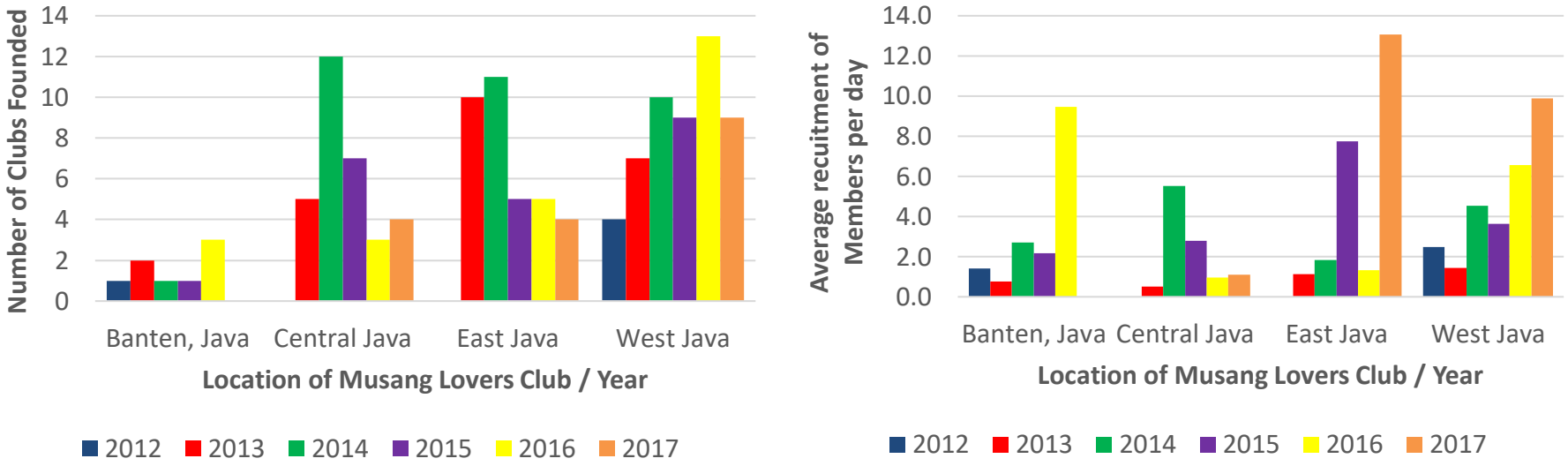

Figure 16: Number of *Musang Lovers* clubs and year founded in Java (left) and average recruitment per day since the foundation date.

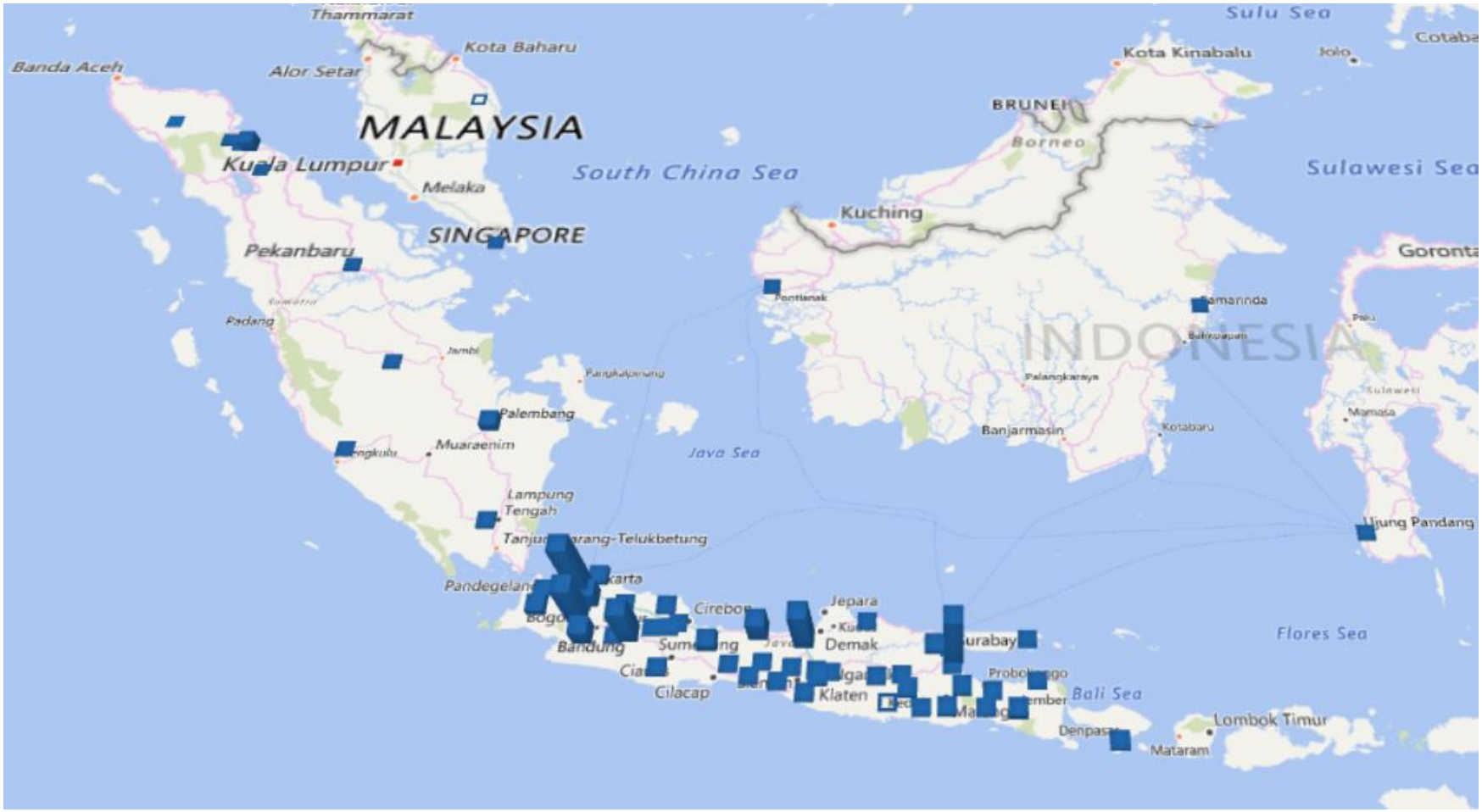

Figure 17: Map of South East Asia showing bars illustrating the sum of member recruitment in *Musang Lovers* Clubs.

Table L: Membership of 235 civet owners (*Musang Lovers*) clubs searched and located on Facebook arranged by country, island and region of origin and monitored on 4th February 2018 and 4th February 2019 (365 days) with rate of membership increase indicated.

Country / Island	Region	Number of Clubs	Membership of Clubs on 4th February 2018	Membership of Clubs on 4th February 2019	Increase of Members between dates	% of all clubs (n=235)	Daily Increase of Membership (per club)
Indonesia		**224**	**762,793**	**940,064**	**177,271**	**99.2%**	**485.7 (2.2)**
Java		147	501,396	649,623	148,227	68.6%	406.1 (2.8)
	West Java	66	246,950	305,248	58,298	32.2%	159.7 (2.4)
	East Java	38	119,134	159,776	40,642	16.9%	111.3 (2.9)
	Central Java	33	105,617	146,934	41,317	15.5%	113.2 (3.4)
	Banten	9	29,429	37,366	7,937	3.9%	21.7 (2.4)
Sumatra		20	35,218	39,380	4,162	4.2%	11.4 (0.6)
	North Sumatra	8	17,672	19,288	1,616	2.0%	4.4 (0.6)
	South Sumatra	6	9,764	12,095	2,331	1.3%	6.4 (1.1)
	West Sumatra	2	3,132	2,142	-990	0.2%	-2.7 (-1.4)
	Jambi, Sumatra	2	1,406	2,079	673	0.2%	1.8 (0.9)
	Lampung, Sumatra	1	2,713	3,266	553	0.3%	1.5 (1.5)
Borneo		9	23,456	22,170	-1,286	2.3%	-3.5 (-0.4)
Bali		3	3,749	4,837	1,088	0.5%	3.0 (1.0)
Sulawesi		2	990	626	-364	0.1%	-1.0 (-0.5)
Papua		1	754	779	25	0.1%	0.1 (0.1)
Riau Islands		1	631	813	182	0.1%	0.5 (0.5)
Other Locations		**11**	**5,810**	**7,216**	**1,406**	**0.8%**	**3.9 (0.4)**
Grand Total		**235**	**768,603**	**947,280**	**178,677**	**100.0%**	**489.5 (2.1)**

Table M: Membership of the top 20 member recruiters in civet owners (*Musang Lovers*) clubs searched and located on Facebook arranged by town or city of origin and monitored on 4th February 2018 and 4th February 2019 (365 days) with rate of membership increase indicated.

Town/City	Number of Clubs	Membership of Clubs on 4th February 2018	Membership of Clubs on 4th February 2019	Difference of Member numbers between dates	% of all clubs (n=235)	Daily Increase of Membership (per club)
1. Unknown City	54	230,879	260,740	29,861	27.5%	81.8 (1.5)
2. Jakarta, Java	13	88,884	96,526	7,642	10.2%	20.9 (1.6)
3. Surabaya, Java	6	60,950	85,403	24,453	9.0%	67.0 (11.2)
4. Bogor, Java	6	50,744	63,153	12,409	6.7%	34.0 (5.7)
5. Semarang, Java	3	34,797	62,434	27,637	6.6%	75.7 (25.2)
6. Bandung, Java	9	32,896	55,001	22,105	5.8%	60.6 (6.7)
7. Pekalongan, Java	2	26,495	29,674	3,179	3.1%	8.7 (4.4)
8. Bekasi, Java	4	16,306	22,763	6,457	2.4%	17.7 (4.4)
9. Sukabumi, Java	6	16,163	21,750	5,587	2.3%	15.3 (2.6)
10. South Tangerang, Java	1	13,569	19,901	6,332	2.1%	17.3 (17.3)
11. Tangerang, Java	6	12,914	15,091	2,177	1.6%	6.0 (1.0)
12. Medan, Sumatra	2	12,725	14,239	1,514	1.5%	4.1 (2.1)
13. Palembang, Sumatra	4	8,796	11,224	2,428	1.2%	6.7 (1.7)
14. Banten, Java	4	4,411	8,921	4,510	0.9%	12.4 (3.1)
15. Jember, Sumatra	2	4,129	9,426	5,297	1.0%	14.5 (7.3)
16. Malang, Java	3	3,815	4,816	1,001	0.5%	2.7 (0.9)
17. Brebes, Java	1	3,717	8,963	5,246	1.0%	14.4 (14.4)
18. Klaten, Java	2	3,397	4,598	1,201	0.5%	3.3 (1.6)
19. Tegal, Java	4	2,805	3,824	1,019	0.4%	2.8 (0.7)
20. Pasuruan, Java	2	1,409	6,247	4,838	0.7%	13.3 (6.6)

6.2.3. Online survey results

- *How are Asian palm civets traded within Indonesia's pet trade?*
- *What are the demographics for Asian palm civets and their owners?*
- *What are the husbandry practices provided for the Asian palm civets as exotic pets?*
- *What if any are the welfare issues identified for Asian palm civets in the pet trade?*
- *What national (Indonesian) and international legislation related to the trade, husbandry and welfare comes in to play and how?*

a) Survey monkey results

One hundred and forty-nine (n=149) people were surveyed in 188 days (27/03/14 – 30/09/14), and one hundred and nineteen (n=119) people were surveyed in 299 days (12/09/17 – 07/07/18). Total recruitment summed to 0.55 participants per day (0.79 in 2014 and 0.40 in 2017-8). Time taken on average to participate in the survey was 3 minutes 47 seconds (range: 1 second up to 30 minutes 42 seconds). Participants declared their nationality as: Indonesian (89.6%), British (6.3%), Filipino (2.2%), Malay (0.7%) and Arab, Swedish and American (0.4%) with a mean age of 24.8 years (range 11-66 years; χ^2=114.7 P<0.01 Significant) (Figure 18).

In the survey monkey questionnaire, a total of 648 civets were recorded in ownership averaging 2.42 per respondent (range: 0-50; the person with 0 claimed theirs had recently died at 3 years old). The survey determined that 46.3% of these animals were declared at less than 1 year of age rising to 95.3% of animals under 5 years old, 99.0% under 10 years χ^2=198.0 P<0.01 Significant). The average civet age was 1.58 years (range: 1 month – 14 years). In parallel the ownership duration averaged to 1.97 years and equates to the typical age of civet at acquisition at 4.62 months. There is no significant difference between civet age and their acquision. Data suggests that 52.8% of owners are first time owners of civets (χ^2=150.8 P<0.01 Significant) and the age of the civet and ownership duration is closely correlated (χ^2=262.4 P>0.01 Not Significant) (Figure 19). Data shows that 30 (4.6%) civets were 8 weeks old or less and implications on the animals are discussed in section 6.3.

Data indicates the ownership of several other animals including other Viverridae (n=49). All mammals total n=832; 74.8% followed by birds and reptiles (n=87 13.6%; n=68 10.6% respectively (χ^2=220.0 P<0.01 Significant) (Table N). The most popular viverrid is the Asian palm civet (72.3%), followed by masked palm civet (13.6%) and small toothed palm

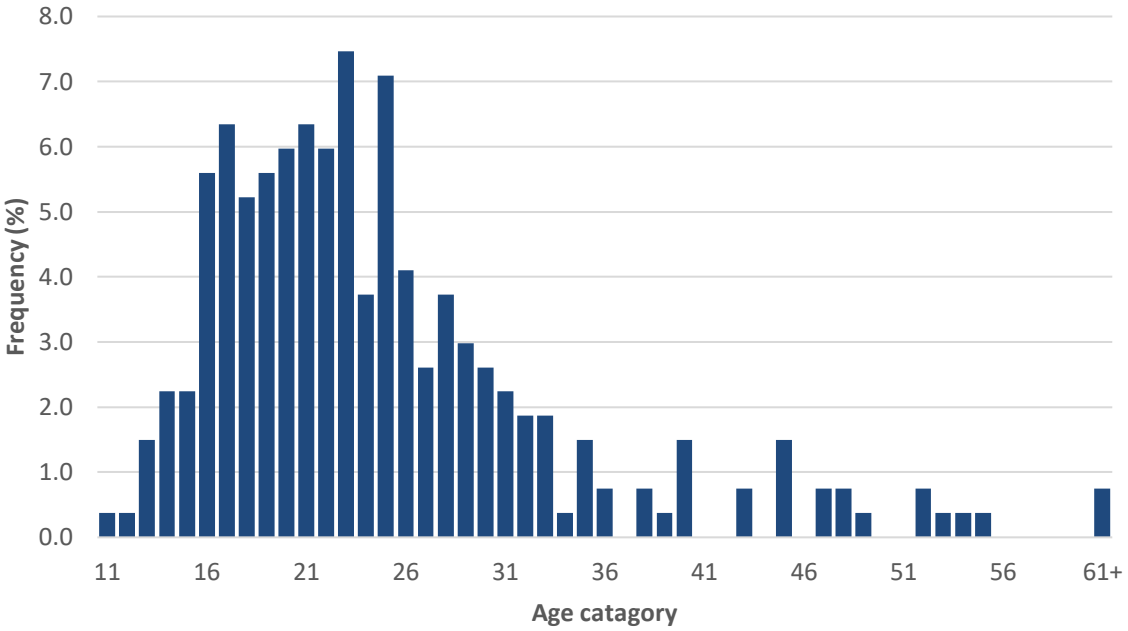

Figure 18: Age of the owners of Asian palm civets reported in a Survey Monkey Questionnaire, bars showing all data from respondants (n=268). Results show an average of 25.3 years in 2014; 24.3 years in 2017-18 and 24.8 years overall. Range: 11-66 years.

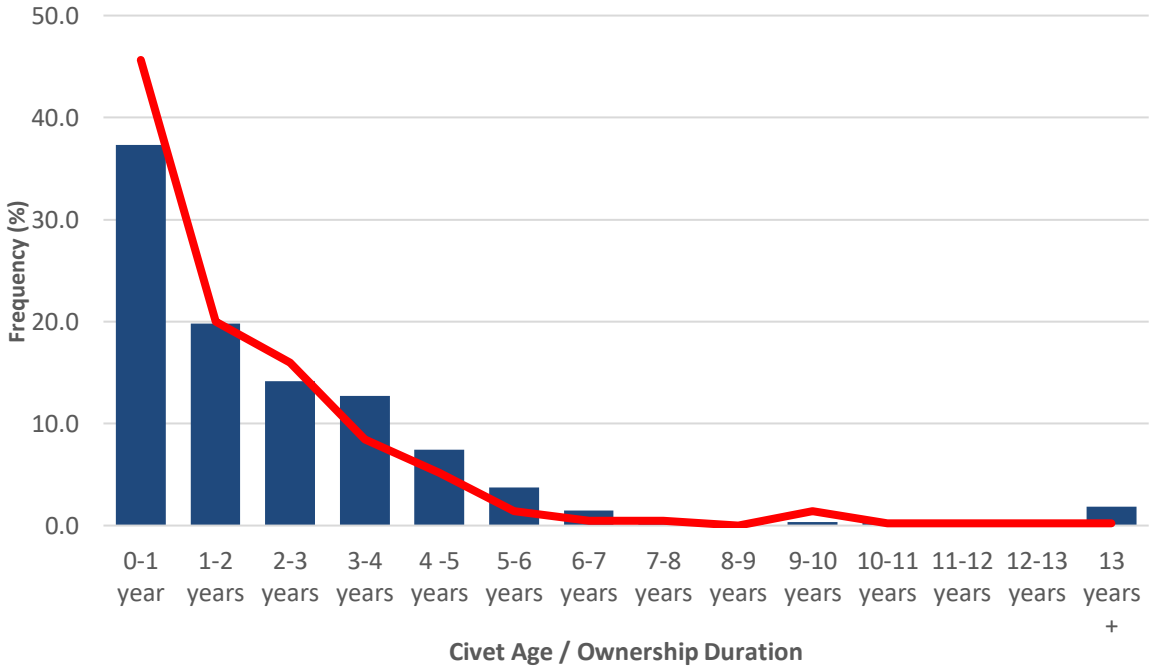

Figure 19: A graph showing the results of a civet owners' survey in relation to the duration of ownership and the age of the civet. Blue Bars = Ownership duration; Red line = civet age

Table N: Ownership of selected companion and exotic pet species by people who also keep civets determined by a surveymonkey questionnaire in 2014 and 2017, results reported by 268 participants.

Species and Group		n=	Frequency of Occurence	Percent Occurrence
All Mammals		**832**	**74.8**	
	Unspecified Civet	379	34.1	99.3
	Asian Palm Civet	195	17.5	79.0
	Domestic Dog	60	5.4	22.5
	Masked Palm Civet	37	3.3	13.4
	Domestic Cat	21	1.9	7.8
	Small toothed Civet	18	1.6	9.2
	Sugar Glider	16	1.4	6.1
	Squirrel	11	1.0	4.1
	Hedgehog	7	0.6	2.7
	Otter	6	0.5	2.2
	Domestic Rabbit	6	0.5	2.2
	Small Indian Civet	5	0.4	3.4
	Skunk	5	0.4	1.9
	Banded Linsang	3	0.3	0.8
	Binturong	2	0.2	0.8
	Mongoose	1	0.1	0.4
All Birds		**87**	**7.8**	
	Unspecified Bird	42	3.8	15.7
	Chicken	25	2.2	9.3
	Owl	6	0.5	2.3
	Domestic Foul	5	0.5	2.0
	Parrot	4	0.4	1.5
	Eagle	3	0.3	1.2
	Parakeet	1	0.1	0.4
	Canary	1	0.1	0.4
All Reptiles		**68**	**6.1**	
	Snake	22	2.0	8.3
	Lizard	22	2.0	7.2
	Chelonia	10	0.9	3.7
Unknown		**21**	**1.9**	**7.8**
Fish		**15**	**1.3**	**5.7**
Invertebrates		**12**	**1.1**	**4.5**
Amphibian		**4**	**0.4**	**1.4**
No other pets		**74**	**6.6**	**27.3**
	Total	**1,113**		

civet (6.7%). Also recorded were small Indian civet (1.9%), banded linsang (1.1%) and binturong (0.7%). No Malay civets were recorded in this survey. Including all owned species (n=49) along with the Viverridae still has Asian palm civet (17.5%) as the most common species that could be n=574; 51.5%) if unidentified civets are assumed as Asian palm civets (Table N). Survey monkey participants readily report a wide selection of domesticated (20.8%) and wild species (79.2%) (χ^2=34.2 P<0.01 Significant).

On facebook owners were at organised club meetings, shows and competitions (Figure 20) wearing clothing branded with *Musang Lovers* club affiliation including t-shirts, shirts and headgear mainly (n=836; 25.3%). The wearers were mainly males that (n=595; 71.1%). Shows and meetings were merchandised with adverts and banners (n=116; 5.7%) identifying specific locations in Indonesia and indicate to various categories to be judged including civet age categories, species categories, best of each gender and emergent domesticated colour varieties (Figure 21). Whilst it was not quantified there are signs in some images of the processes of domestication of Asian palm civets with colour morphs that are not known to occur in the wild (Figure 21) yet the majority of animals are represented by wild-type specimens. This domestication process is apparent also in sugar gliders and tree shrews but isn't apparent in the other civet species, squirrels, linsang, binturong, otter, leopard cat or mongoose (this is discussed in Chapter 6.3.).

The civets' origins declared various routes of procurement, 17.7% declared Indonesia, 3.3% Sumatra, 1% Borneo (χ^2=52.3 P<0.01 Significant), a further 11.7% stated that their civets were wild caught, 11% from a market, 2.7% from a pet shop (χ^2=29.9 P<0.01 Significant). 12.3% came from a breeder, 21% from friends, 1.7 % said "adopted" and 3% "rescued", 2.3% "captive" and 0.3% from "quarantine" (χ^2=100.0 P<0.01 Significant). 2.7% stated that they had bought their civet through "the internet". All potential captive bred sources total 35.8% of animals. The majority of animals originate from the island of Java (45.5%) and 17.4% from Sumatra and including all islands in Indonesia this rises to 88.3% (χ^2=268.0 P<0.01 Significant). All Filipino respondents sourced their animal from the Philippines. Malaysia respondents suggested Indonesian origins for some of their civets despite the species being native to Malaysia also. This suggests some Indonesia to Malaysia movement of civets occurs, however CITES records don't record a single animal being traded between the two neighbouring countries (Table J).

Respondants declared 39-41 types of food given to civets listing 3.01-3.53 items each. Diet breaks down to descending order categories are: Fruit (36.0%), Meat (32.4%), Vegetables (12.4%) and 7.1% Diary products (χ^2=31.7 P<0.01 Significant). There was a further 12.1% including mineral water, baby food, eggs, honey, fruit cake, soy sauce, vitamins and sugar. Popular meat was chicken (15.9%), cat and dog food combined totalled 7.2%, the remainder is smaller amounts of undefined meat, turkey, rodents and invertebrates. Common fruits declared was banana (15.9%) and papaya (4.5%) with the rest defined only as fruit. There was no declaration of feeding their civet coffee berries in

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Figure 20: Three Musang Lover Club meeting and competition adverts examples posted on Facebook in 2018.

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Figure 21: Divergent pelage morphs as a result of captive breeding in Asian palm civet (*Paradoxurus musangus*) selected from *Musang Lovers* pages on Facebook in 2018.

2014 but three in 2017-8s data; other owners may have included coffee in with the "fruit" declared.

b) Facebook image analysis

Musang Lovers clubs had an additional 2,020 member Facebook posted images assessed with the principle use of photographs to be predominately for promotion of sale of animals, their paraphernalia and non-animal related goods such as mobile phones, other electrical goods, clothing and motorcycles (n=874; 43.3%) (χ^2=1.8 P>0.01 Not Significant). Photos contained a total of 2,424 animals and 3,299 people in 71.7% and 46.3% of images respectively. As predictable for *Musang Lovers* clubs the majority of photos with animals contained civet and other Viverridae species (n=1,660; 68.5%) (Table O); Asian palm civet (n=1,260; 52.0%), masked palm civet (n=148; 6.1%), small toothed civet (n=116; 4.8%), small Indian civet (n=96; 4.0%), binturong (n=15; 0.6%), linsang (n=6; 0.2%) and Malay civet (n=4; 0.2%) (χ^2=259.2 P<0.01 Significant). Other recorded carnivore species include otters (n=83; 3.4%), leopard cats (n=26; 1.1%), mongooses (n=20; 0.8%), yellow throated marten (n=4; 0.2%) and ferret badgers (n=4; 0.2%), and domestic dogs and cats (n=34; 1.4% and n=70; 2.9% respectively). Two images (0.1%) contained an unidentified viverrid species that resembles either an unidentified linsang species or the endangered Owston's civet (*Chrotogale owstoni*) and if the latter should not be traded as a pet species.

People were recorded in 46.3% of images with a dominance of males (n=2,347; 71.1%), followed by woman (n=665; 19.9%) and children (n=297; 9.0%) (χ^2=66.0 P<0.01 Significant). These owners of animals were photographing their animals in various locations, mostly at home (n=1,119; 55.1%) or in surrounding streets (n=302; 14.9%) though there is some representation from club meetings and shows (n=158; 7.8% and n=86; 4.2% respectively) (χ^2=251.7 P<0.01 Significant). This is also supported by the survey monkey questionnaire where respondants specified that they kept their civets in their homes (36%), 25.4% kept their civets in a cage, 6.1% in an enclosure and 2.2% in a garden and 0.6% in a garage. Most animals in photographs were handled by an owner (n=898; 37.0%), followed by caged animals (n=664; 27.4%), free-roam (n=514; 21.2%) and animals in carriers (n=235; 9.7%). The remainder of the animals were photographed whilst on a lead or harness (n=113; 4.7%). Carriers, cages, leads and harnesses shown in the images were often for sale amongst the paraphernalia also retailed. Carriers held on average 0.8 animals with cages containing 1.1 animals on average. Cages and carriers were typically a size to be considered temporary housing only and also devoid of enrichment of any kind including bedding, absorbent substrate or sleeping areas in the form of separate areas, boxes or hammocks. Bedding and substrate were recorded in 226 images (11.2%), litter box for toileting was in just 14 cages (0.8%) and a scratch post for 15 animals (0.8%). Hammocks were provided in 46 images (2.5%). Feeding and watering equipment was largely associated to cages and carriers yet was included in just 33.6% of housing setups. Most photos did not contain any of either food (91.7%) or water (94.0%)

suitable for animals photographed. Housing and husbandry invariably contravene all of the five animal needs.

The condition score was recorded for all animals photographed from 1 to 5. Most animals scored 3 (n=1,966; 82.3%) though there was also representation of underweight animals (score 1 and 2) (n=206; 8.6%), overweight and obese (score 4 and 5) (n=217; 9.1%) (χ^2=107.9 P<0.01 Significant). Seventy-nine percent (n=1,916; 79.0%) of animals shown in images had no apparent health issues in either weight or injury (χ^2=33.7 P<0.01 Significant). A few animals, (all of which civets) showed signs of ill health or injury. Thirteen animals were photographed following their death (0.5%). Injuries were on body, limbs, tail or head (n=27; 1.1%) with dirty or wet fur was seen on 28 occasions (1.2%). Fur loss was also seen (n=11; 0.5%), and probably the likes of the nose injuries are due to self-inflicted trauma (Figure 22). Containers of medication was recorded on 6 occasions (0.2%).

There is little evidence of wild trapping (n=8; 0.4%) and corporate breeding facilities (n=10; 0.5%) in facebook images. Captive breeding was evident in images through mainly within a domestic not business environment. Animal markets were represented by 68 images (3.3%). Survey monkey records over a third of animals as captive bred (see page 91 *in scripta*). Captive breeding of carnivores is shown in facebook images with animals represented by neonates (n=153; 6.4%) and juveniles (n=700; 29.1%) and not just adult animals (n=1,495; 62.2%). The remainder (n=56; 2.3%) are of animals were an age could not be determined as there was enough of the animals shown in the images. Of all species' neonates shown, the mother was only present on just 21 of occasions (13.7%). She may have been just out of shot though. Over eight percent (n=104; 8.3%) of all Asian palm civets were neonates with 30% (n=378) juveniles (χ^2=43.5 P<0.01 Significant) (Table O). Other common neonates and juveniles are otters with n=11; 13.3% neonates, n=29; 34.9% juveniles and n=43; 51.8% that are adults (χ^2=22.4 P<0.01 Significant) (Table O). Captive breeding is provisionally occurring with both small Indian civets and small-toothed palm civets recorded in images showing neonates (Small Indian civet n=5; 5.2%; small-toothed palm civets n=4; 3.4%) and juveniles recorded (Small Indian civet n=57; 59.4%; small-toothed palm civets n=20; 17.2%), though some adults may still have been wild sourced (Small Indian civet n=34; 35.4%; small-toothed palm civets n=92; 79.3%) (Table O). There were zero neonates of masked palm civets, Malay civets, binturongs, linsang, Ferret badgers or mongooses recorded in 2,020 Musang Lovers Facebook images (Table O).

Table O: The number and percentages of species recorded in 2,020 images analysed from *Musang Lovers* pages on Facebook during 2018 and whether individuals were adult, juveniles or neonates shown as n=? (%).

Species	Number of specimens in images - (Percentage of specimens in images)	Neonate	Juvenile	Adult
Asian palm civet	1,260 (52.0%)	104 (8.3)	378 (30.0)	778 (61.7)
Masked palm civet	148 (6.1%)	0 (0.0)	41 (27.7)	107 (72.3)
Small toothed palm civet	116 (4.8%)	4 (3.4)	20 (17.2)	92 (79.3)
Small Indian civet	96 (4.0%)	5 (5.2)	57 (59.4)	34 (35.4)
Unidentified otter Species	83 (3.4%)	11 (13.3)	29 (34.9)	43 (51.8)
Domestic cat	70 (2.9%)	5 (7.1)	9 (12.9)	56 (80.0)
Domestic dog	34 (1.4%)	0 (0.0)	19 (55.9)	15 (44.1)
Leopard cat	26 (1.1%)	5 (19.2)	13 (50.0)	8 (30.8)
Unidentified mongoose	20 (0.8%)	0 (0.0)	3 (15.0)	17 (85.0)
Binturong	15 (0.6%)	0 (0.0)	4 (26.7)	11 (73.3)
Unidentified civet	13 (0.5%)	0 (0.0)	1 (7.7)	12 (92.3)
Linsang	6 (0.2%)	0 (0.0)	1 (16.7)	5 (83.3)
Ferret badger	4 (0.2%)	0 (0.0)	0 (0.0)	4 (100.0)
Malay civet	4 (0.2%)	0 (0.0)	0 (0.0)	4 (100.0)
Yellow throated marten	4 (0.2%)	0 (0.0)	0 (0.0)	4 (100.0)
Other Viverrid	2 (0.1%)	0 (0.0)	0 (0.0)	2 (100.0)

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Figure 22: Three images of civets from *Musang Lovers* pages on Facebook showing typical signs of injury (Top, nose injury; Centre, tail injury and fur loss; Bottom, wet/dirty fur and blood in cage also underweight (condition score 2).

6.2.4. Trade prices for civets

Owners declared the costs of civets via survey monkey both in purchasing the animals and the monthly costs. Forty-five Indonesian owners specified their purchase price for their civet ranging from zero to 6 million Indonesian rupiah (US$426 approximately on 20th April 2019) averaging at 625,000IDR (US$44 approximately). The monthly running costs of keeping civets in Indonesia is around 365,000IDR (US$26 approximately). The purchase price in the United Kingdom is nearly 14-15x more expensive than in Indonesia at around £500-600 GBP (US$650-US$780), the monthly cost of keeping being around £130GBP (US$170). The indication from the animal markets questioned suggested a typical price of 250,000IDR (around US$18) for a civet with wild-type pelage, rarer variants would be more.

6.2.5. Market visit results

a) Numbers and temporal patterns

In total 92 visits recorded between 731 and 761 Asian palm civets in trade in 15 of the 19 markets surveyed, 4 markets did not have any civets when visited. This broke down to 121–126 civets in 2012, at an average of 7.1–7.3 civets per survey, 281 in 2013, at an average of 9.7 civets per survey, and 322–347 in 2014, a mean of 7.2–7.7 civets per survey and an average of 7 civets in 2018, overall with an average of between 7.9 and 8.3 civets per market (Table P and Figure 23). There is no significant difference in mean civets in markets between years surveyed (χ^2=0.46 P>0.01 Not Significant). Asian palm civet was the most commonly recorded civet in the markets, the second most common was the small Indian civet (n=42; 59.2%). A total of 71 individuals of four additional species were offered for sale (Table Q). Two of these species, Malay civet *Viverra tangalunga* (n=5; 7%) and masked palm civet *Paguma larvata* (n=14; 19.7%), are known to not occur natively on Java or Bali, therefore must have been imported, most probably from Sumatra or Kalimantan, the Indonesian part of Borneo (Duckworth, *et al.,* 2016b; Duckworth, *et al.,* 2016d). The small toothed civet *Arctogalidia trivirgata* whilst occurring in West Java is very limited in its distribution. A more likely source is from Sumatra, Borneo and Malaysia (Willcox, *et al.,* 2016).

The numbers of Asian palm civet recorded at individual markets differed substantially. In three markets none were observed. Few civets were traded in Pramuka market, Jakarta (nine civets / 10 surveys), Bandung Indah Plaza (BIP), Bandung (one civet / nine surveys) and Mawar, Garut (five civets / 11 surveys). Larger numbers were observed in Barito, Jakarta (42 civets / 11 surveys), Sukahaji, Bandung (38 civets / 11 surveys) and Satria, Denpasar (45 civets / four surveys). The Pujasera-Pakis market in Banyuwangi and Kupang

Table P: Asian palm civet *Paradoxurus musangus* surveys in animal markets in Java and Bali, Indonesia.

			2012 Visits	2012 civets	2013 Visits	2013 civets	2014 Visits	2014 civets	2018 Visit	2018 civets	Total Visits	Total civets	Average
Bandung	Bandung Indah Plaza	Small Mobile Market	1	0	3	0	5	1	-	-	9	1	0.1
Bandung	Sukahaji	Medium	2	9	3	15	6	18	-	-	11	42	3.8
Bandung	Sunday Market	Small Market	1	0	-	-	-	-	-	-	1	0	0.0
Banyuwangi	Pujasera-Pakis	Small Market	-	-	1	13	-	-	-	-	1	13	13.0
Bogor	Empang	Small Market	2	1	-	-	-	-	-	-	2	1	0.5
Bondowoso	Bondowoso	Small Market	-	-	1	0	-	-	-	-	1	0	0.0
Denpasar	Satria	Medium Market	-	-	1	17	2	21	1	7	4	45	11.3
Garut	Mawar	Small Market	2	1	3	3	6	1	-	-	11	5	0.5
Jakarta	Jl Kebayoran	Pet Shop	-	-	1	3	2	11	-	-	3	14	4.7
Jakarta	Jetinegara	Large Market	4	95-100	4	159	8	227-252	-	-	16	481-511	31.0
Jakarta	Barito	Medium	2	6	2	4	7	32	-	-	11	42	3.8
Jakarta	Pramuka	Large Market	2	7	3	0	5	2	-	-	10	9	0.9
Malang	Malang	Large Market	1	2	-	-	-	-	-	-	1	2	2.0
Mengwi	Beringkit	Small Market	-	-	1	0	1	0	-	-	2	0	0.0
Sukabumi	Sukabumi	Small Market	-	-	1	0	1	0	-	-	2	0	0.0
Surabaya	Kupang	Large Market	-	-	1	40	-	-	-	-	1	40	40.0
Surabaya	Bratang	Large Market	-	-	1	12	1	6	-	-	2	18	9.0
Surabaya	Turi	Medium	-	-	1	11	1	3	-	-	2	14	7.0
Tasikmalaya	Cikurubuk	Small Market	-	-	2	4	-	-	-	-	2	4	2.0
		Total	**17**	**121-126**	**29**	**281**	**45**	**322-347**	**1**	**7**	**92**	**731-761**	**8.1**
		Mean civets per market	**7.1 – 7.4**		**9.7**		**7.2 – 7.7**		**7.0**		**7.9 – 8.3**		

Surveyors: D. Spaan; E. J. Rode-Margono; P. D. Roberts; V. Nijman; K. A. I. Nekaris; J. K. Lehtinen; Wirdateti.

Large markets comprise over 50 shops, medium markets 20–49 shops, and small markets under 20 shops (see text for details).

Table Q: Civets other than Asian palm civet *Paradoxurus musangus* recorded in animal markets in Java and Bali, Indonesia February 2012 to April 2018.

Market, town	Malay civet *Viverra tangalunga*	Masked palm civet *Paguma larvata*	Small Indian civet *Viverricula indica*	Small-toothed palm civet *Arctogalidia trivirgata*
Bandung Indah Plaza, Bandung	-	-	-	1 (1.4%)
Barito, Jakarta	-	3 (4.2%)	1 (1.4%)	3 (4.2%)
Bondowoso, Bondowoso	-	-	1 (1.4%)	-
Bratang, Surabaya	-	1 (1.4%)	1 (1.4%)	-
Jatinegara, Jakarta	3 (4.2%)	7 (9.9%)	36 (50.7%)	1 (1.4%)
Jl Kebayoran Lama, Jakarta	-	2 (2.8%)	1 (1.4%)	3 (4.2%)
Satria, Denpasar	-	-	2 (2.8%)	1 (1.4%)
Sukahaji, Bandung	2 (2.8%)	1 (1.4%)	-	1 (1.4%)
Total	**5 (7.0%)**	**14 (19.7%)**	**42 (59.2%)**	**10 (14.1%)**

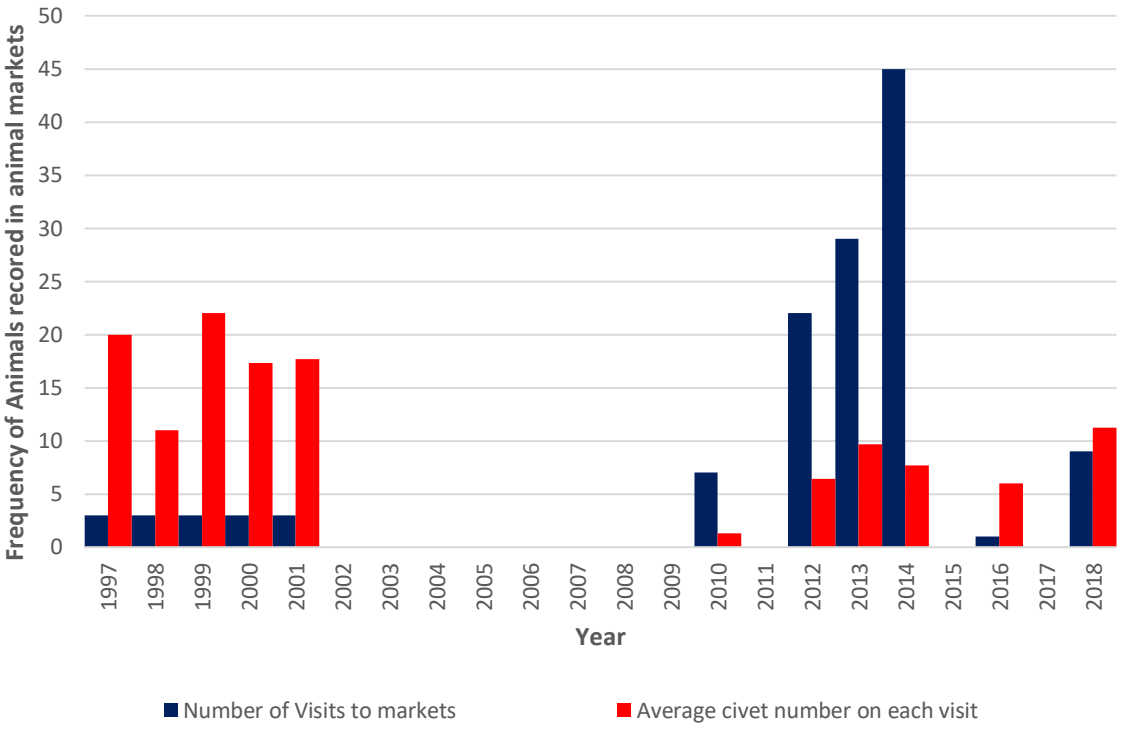


Figure 23: Average numbers of civets (*Paradoxurus hermaphroditus / Paradoxurus musangus*) recorded in visits to Animal Markets in Bali, Java and Sumatra, Indonesia between 1997 and 2018. Source literature: Shepherd 2008; Eaton *et al.,* 2010; Kim, 2012; Shepherd 2012; Nijman, *et al.,* 2014; Chng, Guciano, & Eaton, 2016; Lewis-Whelan, *et al*., in prep; Roberts, *in scripta*.

in Surabaya, both visited once, had 13 and 40 civets for sale, respectively. The largest numbers were recorded in Jatinegara market, Jakarta: around 500 civets during 16 surveys, with 54 on one survey. While Jatinegara was both the market surveyed most frequently and the one with most civets recorded for sale, other markets were frequently surveyed without encountering many civets (e.g. Mawar and BIP) and others with a large number of civets for sale were visited only once (e.g. Kupang, Surabaya and Pujasera-Pakis) (Table P).

Overall there was no relationship between number of visits and average number of civets recorded per market, though Figures show civets are omnipresent and consistent in availability. On average large markets had more civets for sale (average of averages 13.4 civets / survey) than medium (7.8 civets / survey) and small (2.0 civets / survey) ones. Notable exceptions were the small market of Pujasera-Pakis in Banyuwangi (13 civets, one visit) and the large markets of Pramuka and Malang, with few civets observed for sale, despite ten visits to the former. The five markets visited multiple times during each of the three study years seemed stable in numbers of civets for sale. Thus, Jatinegara consistently held 20–40 civets per survey, rarely as few as 12, with no notable difference between weekdays and weekends (survey of other markets was insufficient to compare weekdays with weekends). In Barito and Sukahaji the number was 2–5 with civets almost always present. In Garut and Pramuka the numbers of civets rarely exceeded 3–4 on any given survey, with frequently no civets openly for sale.

b) Age and physical condition

Asian palm civets in the markets ranged in age from newborn to adult (as via online sales, Table O). When asked, vendors said that these animals were all wild-caught, including those apparently 6–8 weeks old and not yet independent from their mother. Vendors said that they could easily get more civets, often within 1–2 weeks, with one vendor indicating that these animals will come from wild nests. Not once did a vendor state that any civets on offer were captive-bred. The clientele for market civets is, according to vendors, mainly people who seek civets as pets. At a few markets, mostly in East Java and Bali, civet coffee farms were mentioned. Four pale '*Musang Bali*' civets (initially thought to be bleached 'normal' Asian palm civets) were amongst the 521 civets in Jakarta. In 2013 in Surabaya five of the 44 civets were of the '*Musang Bali*' type and in Bali frequency was approximately a fifth of the total. The proportion of non-adult civets was generally high, i.e. 88% in Barito, 72% in Jatinegara, 57% in Sukahaji and 56% in Satria. These four markets held 86% of civets recorded. If the proportion of non-adults in these four markets is representative for Indonesian Asian palm civet trade as a whole, this suggests that about 76% of trade comprises non-adult civets.

Civets were mostly housed singularly, in pairs, or, especially with very young ones, in groups of 4– 6 (presumably siblings). Occasionally, groups of ten or more were observed in a cage. Civets were usually displayed close to other animals, such as domestic cats, rabbits, birds (such as owls, chickens and songbirds), bats or primates, without any discernible barrier to provide any biosecurity measures. Civets were mostly caged without food or water. Cages that contained food mostly had fruits such as banana, papaya or mango; they never had a balanced species-appropriate diet. Domestic cats were often seen with only rice in their food bowls despite being obligate carnivores. Several animals showed signs of starvation as well as other conditions with fur loss and 1 even emaciated and distinct cloudiness to its eyes (Figure 24). Civets and other animals were often openly exposed to the heat of the sun and many animals were panting, indicating distress and dehydration. Poor welfare is also shown towards other species including domestic cats, chickens, chelonia, bats, monkeys and fish.

Figure 24: Image of an emaciated and blind civet on sale in a Balinese Market in 2018. Cage was also not hygienic and had no food and water available to the animal.

6.3. Discussion

6.3.1. Volumes of civets in trade

- *How are and to what extent are Asian palm civets traded within and outside Indonesia?*
- *How are Asian palm civets traded within Indonesia's pet trade?*
- *What national (Indonesian) and international legislation related to the trade, husbandry and welfare comes in to play and how?*

Civets are not just increasingly common exotic pets but could be considered now as mainstream in Indonesia (Shepherd, 2012), with extensive numbers in captivity and owners whom organise themselves into clubs and also arrange competitions and breed shows to display their animals. Indicative of the probable numbers in captivity is the apparent arrival on the market of tinned food specifically formulated for civets (Figure 25). This is despite the trade in civets seemly regulated and restricted with a harvest quota, yet totally disregarded by traders (Shepherd, 2008; 2012; Peraturan Menteri Pertanian Republik Indonesia, 2015).

Ownership is significantly highest in Indonesia but indicates a small trade in Malaysia, the Philippines and into the United States, United Kingdom and other countries in Europe also. Data *in scripta* doesn't identify trade in civets in Vietnam, yet it is believed that trade is common for pets and for kopi luwak (Clark, 2012). There also seems to be a lack of trade recorded to and from China and India where it is known that civets are traded for bushmeat (Ghosh *et al.,* 2019; (Corlett 2007; Shepherd 2010), as civets are native to these countries its possible however that the animals are not imported or exported and the trade in the meat is local only. The potential zoonotic disease risk from civets however could have a global impact, SARS is likely to have originated and vectored in Masked palm civets (*Paguma larvata*) and infected over 8,000 of people, killing around 774 (BBC, 2020; Guo, *et al.,* 2020; Moutou & Pastoret, 2010; Clark, 2012). There are civets in the United Kingdom, however, though CITES doesn't indicate where this foundation population originated from. Trade into and from countries were the civet is not endemic indicates areas where there maybe foundation populations being established for zoological collections or the exotic pet trade. Italy may be an entry point for Europe as a whole and the civets that arrive there probably do not stay there. The Asian populations in captivity have shown a high proportion of civets captured from the wild directly into the pet trade through the pet shops and street markets (Shepherd, 2008; 2012; Nijman, *et al.,* 2014; Carder, *et al.,* 2016; Peraturan Menteri Pertanian Republik Indonesia, 2015). As shown there is evidence that more captive breeding is starting to take place leading to domestication of Asian palm civet but not yet commonplace in the other civet species. This domestication process is a normal biochemical and genetic drift from breeding from isolated populations (akin to that recorded with Silver Foxes (*Vulpes vulpes*) (Trut, *et al.,*

Figure 25 has been removed from this version of the thesis due to copyright restrictions

Figure 25: Tinned food specifically formulated for pet Asian palm civets in Indonesia [From: https://www.tokopedia.com/sugiartoshop/makanan-musang-organic-wet-food-rasa-chicken] [Accessed 20th December 2018].

2009), and such new traits could be of a higher demand and price that wild-type morphs (Harfoot, *et al.,* 2018). Owners whom are breeding their animals are then selling the offspring to other members of *Musang Lovers* clubs and sales are happening directly between members of the same group or via the internet (Table O). Trade in civets in countries other than Indonesia where the species is not native occurs only at low levels from breeding of captive animals from founding imports. Once founding captive populations are established there is more control of quality, health supply and demand plus the colour morphs can be derived (Harfoot, *et al.,* 2018; Pavlin, *et al.,* 2009; Trut, *et al.,* 2009). Harfoot, *et al.* (2018) states that there would then be a shift from wild to captive sourcing for the trade over time, hence such breeding centres like that in Bandung (Tripadvisor, 2016). It is believed that this process is occurring with the Asian palm civet trade, though more research is needed to confirm conjecture. It should be noted that members were often listed in more than one if not multiple *Musang Lovers* club sites particularly within the Indonesian membership, it is that several members of the same household owning civets are also probably members leading to potential over estimation in the numbers of civets in captive ownership. The extent to which the over-estimates occur is unknown.

Civet numbers being traded within *Musang Lovers* Clubs and via the internet is extremely difficult to quantify, though of the 2,020 pictures analysed in results 43.3% (n=874) were recorded as selling animals, their paraphernalia and other non-animal related products. This shows that sales through *Musang Lovers* sites are entirely normalised and extensive. Wildlife and pet trades via the internet have already been highlighted as routes for illegal movement of species despite CITES and local laws meant to restrict or prevent trade (Bush, *et al.,* 2014; Nijman & Nekaris, 2017; Harfoot, *et al.,* 2018; Morgan & Chng, 2018). Bush, *et al.,* (2014) further specifies that trade is more likely in species that are protected, and that trade in birds, reptiles and mammals is widespread throughout Asia (Gunawan, *et al.,* 2017). As the Indonesian quota limits suggest that it only regulates the wild caught harvest of civets and other species, it is implied that the captive breeding of animals circumvents quota as it is a wild harvest quota, however Carder, *et al.* (2016) suggests that captive breeding of civets is difficult but, does not elaborate what difficulties specifically.

Shepherd (2012) surveyed Jatinegara, Pramuka and Barito markets twice in 2010 and once in 2012 and obtained data from one survey of Satria market in 2012. He recorded one Asian palm civet in Barito and 20 in Jatinegara. His averages for all are somewhat lower than surveys in Table P (6.7 vs 30.0 for Jatinegara; 0 vs 0.9 for Pramuka; 0.3 vs 3.8 for Barito). Conversely, mean in Table P for Satria is less than Shepherd's (2012) single visit, i.e. 12.7 vs 25. Shepherd also surveyed three markets reported in his paper in 2008. Shepherd's markets were all in Medan, Sumatra (Jalan Bintang, Petisah and Sembahe), and visited a total of 59 times each in the period between 1997 and 2001. In total 264 civets were recorded (mean of 1.5 civets per market, or 4–5 for the three combined). These numbers from Sumatra are comparable to most small, and some of the medium-sized, markets here recorded from Java and Bali. Pasar Jatinegara in Jakarta stands out as

the largest market for civet trade although Kupang in Surabaya could hold similar numbers, there are many large *Musang Lovers* Clubs in Java that are likely to be fuelling the demand. Asian palm civet was recorded in all 16 surveys in Jatinegara and 10 out of 11 surveys in each of Pasar Barito and Sukahaji. Five markets were surveyed only once, precluding firm conclusions regarding availability. In 2018, Lewis-Whelan, *et al*., (in prep) surveyed eight markets with four housing civets recording 94 civets total, added to the 1 visit/7 civets from data *in scripta* results in 11.2 civets per visit. Several markets were considered as bird markets and many sizeable towns in Java has a bird market, however, didn't exclude them all from selling large numbers of civets and other species too. Based on visits prior to 2012 (Nijman, pers. comm.), the size of the market, and the frequency of its mention in relation to civet trade in online forums, Ngasem market in Yogyakarta and Depok market in Surakarta might be the most important civet markets that are not represented here. Both towns have large *Musang Lovers* Clubs possibly served by the trade through the markets. All documented datasets from 1997 to 2018 records, 1,150 civets in 128 visits, a mean of 11.9 civets per market visit (1-45 visits per year; 6-347 civets; mean of 1.3 – 22.0 civets per market (Figure 23).

Recent papers and this thesis have indicated that civet numbers occur in markets on Java particularly far in excess of annual quotas allowed for the species (Shepherd, 2008; Shepherd & Shepherd, 2010; Nijman, *et al.,* 2014). Plus, data from the survey monkey questionnaire *in scripta* indicates a further 91 animals over the quota allowance, an additional 36% of the annual quota per year. Yet the survey's dataset probably grossly underestimates actual numbers as it does not represent all civets captured and traded and in exotic pet ownership throughout Indonesia as the number of respondents to the questions is proportionately low. The market surveys again are not representing all civets traded in all markets during the year. Yet even using available data the excess of trade still rises to an additional 340 animals above quota allowance just from those markets visited. With the *Musang Lovers* club membership standing at 947,280 people increasing their membership by around 489.5 people per day there seems to be plenty of growth and demand in civet ownership. If civets were only wild caught this would severely damage populations, so increasingly more civets should be sourced from captive bred sources (Janssen & Chng, 2017). Trapping any civet species from the wild to meet rising demand from the pet trade would undoubtedly have a detrimental unsustainable effect on wild populations, so captive breeding is absolutely necessary to meet demand (Janssen & Chng, 2017; Harfoot, *et al.* 2018; Parikesit, Withaningsih & Prastiwi, 2019).

In a very approximate attempt to extrapolate market trade observed *in scripta* to formulate an annual civet trade total, data *in scripta* records 19 markets containing between 720 and 750 Asian palm civets total, an average of between 7.9 to 8.3 civets per market. If it takes one month to sell all stock of civets in each market, the potential output per market per year is 85.3 - 99.3 civets per year each. If expanded to the 19 markets known then the total annual output is 1,812 – 1,886 civets, the equivalent of up to 7.5 times the annual quota. The quota allows upto 300 civets per year to be traded, 90% of which should be exported, therefore just 25-30 animals should be supplied for

domestic use. The data here show hugely more civets are traded than the quota allows. In Bali there is no quota at all therefore none can be traded yet civets remain omnipresent in the animal markets and for sale on Bali's Musang Lovers Facebook pages. The markets and trade through facebook to the Musang Lovers is illegal, unsustainable, unregulated and out of control. There are likely to be many more markets that have not yet been accessed across Indonesia that also sell civets, so the trade figures are likely to be an underestimation of the extent of civet trade through markets (Shepherd, 2008; 2012; Nijman, 2010; Nijman, *et al.,* 2014; 2019; Carder, *et al.,* 2016; Lewis-Whelan, *et al.,* in prep).

Trade in four other species of civet were also observed in these markets (Table Q) are notably smaller than Asian palm civet, yet higher in 2014-2018 than those reported in Medan and Jakarta by Shepherd (2008; 2012). Analysis of *Musang Lovers* members photos shows other species not observed in the markets (e.g. binturong, linsang and Malay civet). The lesser numbers of small-toothed palm civets, small Indian civets and masked palm civets seen for sale in markets is also reflected in the photo analysis. This maybe because these species are just less popular or that wild populations are much lower and cannot be trapped as easily as the Asian palm civet then subsequently need to be imported from the islands on which they occur (see appendix chapter 11.3; Table EE). It is now believed that trade of all small carnivores in Indonesia is via Musang Lover type clubs, internet sales and trade between friends and these animals and even those traded through the markets are not being recorded by the authorities; it is apparent that 701 Asian palm civets traded in 26 years is a hugely gross underestimation. It is also believed that underestimation of trade also affects other species of civet and other small carnivores (Nijman, 2010). Small Indian civet *Viverricula indica*, small toothed palm civet *Arctogalidia trivirgata* and masked palm civet *Paguma larvata* were traded without apparent restrictions despite the indication that no quota set is equal to no legal trade allowed (Shepherd, 2008; 2012; McCarthy & Fuller, 2014) (see appendix chapter 11.3; Table EE). The photo analysis and survey monkey survey showed ownership these species and also otters, yellow throated marten, Javan ferret badgers, Primates and mongooses that has also been reported by other researchers (Nekaris & Jaffee, 2007; Shepherd, 2010; 2012; Siriwat & Nijman, 2018) (Table O). Trade restrictions and animal welfare laws are not enforced within markets or via private sales with some, or all, of the five animal needs disregarded by keepers and quota controls not just broken but rendered utterly inadequate.

6.3.2. Demographics of civets and owners

- *What are the demographics for Asian palm civets and their owners?*
- *What are the husbandry practices provided for the Asian palm civets as exotic pets?*
- *What if any are the welfare issues identified for Asian palm civets in the pet trade?*

- *What national (Indonesian) and international legislation related to the trade, husbandry and welfare comes in to play and how?*

In Indonesia, in particular in the larger towns of Java, Asian palm civet has become a popular pet in recent years especially since 2012. The club members keep in contact with each other through social media (Indonesia is the world's fourth most numerous Facebook user with 51.4 million registered users in 2014: Anon. 2014), mobile phone apps, and meet up on special events and competitions in public spaces. Musang Lovers operate nationwide with regional town/city specific devisions. These facebook sites are potentially great ways of disseminating advise quickly to new and existing owners on issues of ownership including care, feeding, behaviour, training and healthcare. In late 2018 a *Musang Lovers* Indonesia television channel was also launched. Of the towns and cities surveyed (one or multiple) civet-lover clubs occur, with most occurring in Jakarta (including Central Jakarta, Bekasi, Depok and Tangerang), Sukabumi, Bandung, Garut, Tasikmalaya, Malang and Surabaya (including Central Surabaya, Gresik and Sidoarjo). Traders are well-aware of these civet-lover clubs and promote Asian palm civet as a suitable pet and the clubs as useful sources of information on how to keep civets (pers comm).

Communities and forums via social media are a great way of disseminating advice to new owners and to post questions, it is unknown whether owners of civets joined before or after purchasing civets and whether advise is forthcoming enough to prevent welfare issues, unnecessary suffering and death of animals at the hands of inexperienced owners (Nekaris, *et al.,* 2013; Peraturan Menteri Pertanian Republik Indonesia, 2015). Civets cannot be properly provided for in captivity with keepers possessing firm guidance materials, therefore it is strongly advised that there is a concerted effort from experienced individuals to publish a husbandry guide for the species advising on ailments, prophylactic medications, diet, housing, enrichment, behaviour and guide to the new keeper of choice of individuals and certified sources (Nekaris, *et al.,* 2013; Janssen & Chng, 2017). It is considered that the markets in towns and cities in Indonesia are not a valid location to procure civets and should be avoided (Shepherd, 2008; 2012; Peraturan Menteri Pertanian Republik Indonesia, 2015). In recent years it has become apparent that Asian exotic pet trade through markets may lead and has vectored zoonotic diseases to emerge with the masked palm civet being the source of SARS (BBC, 2020; Guo, *et al.,* 2020; Moutou & Pastoret, 2010; Clark, 2012). As civets are often taken from the wild and kept in biosecurity impoverished conditions with alongside other species there is ample opportunity for pathogens to mutate and vector through and into new hosts that may include humans (BBC, 2020; Guo, *et al.,* 2020; Moutou & Pastoret, 2010; Clark, 2012). It would be expected that a population of captive civets would (if kept in hygienic conditions) possess proportionately less pathogens and zoonoses (Pavlin, *et al.,* 2009).

Three-quarters of the civets for sale in markets were not yet adult, with significant numbers apparently being young taken from their nests according to stall holders

(Nijman, *et al.,* 2014). Information from vendors and observations of dependent young invariably without their mothers both indicate that most civets were derived from the wild (Nijman, *et al.,* 2014; Shepherd, 2008; 2012). As aforementioned it is believed that since the market surveys were carried out, supply and demand has led to breeding more animals in captivity. This has not yet replaced wild capturing, however (Nijman, *et al.,* 2014). There is evidence that civets have now been bred in captivity for a sufficient duration that the offspring are starting to show the morphological signs of domestication (Harfoot, *et al.,* 2018; Trut, *et al.,* 2009) (Figure 21). In online survey, photos and market surveys there were civets recorded that should still be with mother. Photos also show a lack of mother with neonates but cannot be said whether she was out of shot at the time of the photo being taken. Many civets observed in the markets evidently should still be feeding from mother, but no mother is evident in cages (Nijman, *et al.,* 2014). Two owners declared that their animals were bought at one month old and yet still older than some observed in the markets that still had eyes closed, aging them conservatively to less than two weeks since birth. It is expected that the mortality of young animals in the trade without their mother is likely to be very high. At over five months old, most civets purchased on average are of viable age though indications are that the vast majority of owners are principally male, in their 20s and first-time owners of their current civets and have them as pets. The survey monkey data records civet ages; 45.6% of them under 1 year old, rising to 95.3% under 5 years old; the maximum age recorded was 14 years. Only 20 civets were older than 5 years. It is suggested that the civet can live to 22 years old (Sanderson, *et al.,* 1955), could the loss of the majority of civets at a much younger age be due to the inexperience of new owners that have bought civets without underpinning knowledge of welfare, husbandry, diet, legislation and healthcare (Flevin, 1990; 2003; 2009; Lee, *et al.,* 2005; Nekaris, *et al.,* 2013; Carder, *et al.,* 2016; Janssen & Chng, 2017; Lewis-Whelan, *et al.,* in prep).

6.3.3. Diet and husbandry of civets in captivity

- *What are the husbandry practices provided for the Asian palm civets as exotic pets?*
- *What if any are the welfare issues identified for Asian palm civets in the pet trade?*
- *What national (Indonesian) and international legislation related to the trade, husbandry and welfare comes in to play and how?*

It was expected that owners would state that their civets' diet contained coffee fruits, yet only 3 of the 268 participants specifically mentioned coffee as a food item. Fruit was frequently given and not always specific types suggested. Owners may have thought that admitting to feeding civets coffee would yield them some negative response, therefore the universal omission of coffee in the survey may indicate that owners are aware of contentious issues in the media of kopi luwak and civet welfare. It is reassuring that captive diet of civets is reported as reasonably varied overall, though some inclusions

such as fruit cake, pork scratchings and soy sauce would be considered as wholly inappropriate. Like many areas of civet ecology their wild diet needs greater research so that captive diet can become more representative (Joshi, *et al.,* 1995; Jennings & Veron, 2011; Jothish, 2011; Peraturan Menteri Pertanian Republik Indonesia, 2015; Fung, 2016).

With nearly two thirds of respondents suggesting their civets' free roam around their owners' houses it suggests that the animals have a high degree of territoriality and are comfortable in presence of humans, supported by the eighteen respondents indicated their civets' are housed as both caged and free roaming at home; Thirty percent feel the need to cage their civets with one owner defining a cage size only suitable as a holding cage and not a permanent residence ($1.5m^3$), there is concern for the welfare of civets cages in environments that don't account for the animals natural behaviour (Peraturan Menteri Pertanian Republik Indonesia, 2015). Only one participant stated that their civet lives in a big cage with climbing logs and sleeps in its hammock. From market and plantation visits cages are typically barren with little or no enrichment, shelter or food (Figures 3, 22 and 24). Civets in captivity require an enclosure not a cage with enrichment to stimulate and allow their arboreal capability (Wemmer, 1977; Rozhnov & Rozhnov, 2003; Peraturan Menteri Pertanian Republik Indonesia, 2015). It has not been observed in any wild civet to sleep on the ground in full view (Rozhnov & Rozhnov, 2003; Spaan, *et al.,* 2014; Chutipong, *et al.*, 2015). In the markets they are often in the full sun with no shade; furthermore, there is no consideration for zoonotic or contagious diseases being spread between animals (Nijman, *et al.,* 2014). Welfare standards are wholly unacceptable and isn't subjected to just civets, cats, dogs, hamsters, rabbits, guinea pigs and various exotic pet species are subjected to similar conditions (Flevin, 1990; 2003; 2009; Peraturan Menteri Pertanian Republik Indonesia, 2015; Janssen & Chng, 2017). This can only be rectified by large scale drafting of new legislation and enforcement of specific higher animal welfare standards (Flevin, 1990; 2003; 2009; Lee, *et al.,* 2005; Pavlin, *et al.,* 2009). It is recommended that all owners of civets whether for pet or commercial use should be prepared to meet the minimum size and welfare requirements specified in Law 37 of 2015 (Chapter 7.1.4) (Peraturan Menteri Pertanian Republik Indonesia, 2015).

CIVET WELFARE AND THE ETHICS OF CIVET COFFEE PRODUCTION

7. CIVET WELFARE AND THE ETHICS OF CIVET COFFEE PRODUCTION

7.1 Introduction to Coffee and kopi luwak

7.1.1. Global Coffee Industry

Coffee is second only to oil as the world's most traded commodity, globally producing 112.5-123.4 million (60kg) bags per annum 2002-2008 (Roldán-Perez, *et al.,* 2009) raising 146.5 million bags in 2013 before reducing by 4 million bags in 2014 (Balan, Kilic & Ozekicioglu, 2018). Global coffee market equates to *circa* US$70 Billion (£45 Billion GBP) per annum (Fairtrade Foundation, 2012) and employs 25 million people (O'Brien & Kinnaird, 2003), with 80% of workers as smallholder producers (Jones, 2018). Coffee originates from Ethiopia (Koehler, 2017), and traded globally now uniting producers in Africa, Asia, Middle East, Europe and Americas (Cahill, 2017). Global consumers and producers total well over a billion people involved in the supply chain (Cahill, 2017) and is typically distributed via multinational corporations such as Nestle, Kraft, Sara Lee, Folger and Tchibo with collectively 47% of coffee produced (Roldán-Perez, *et al.,* 2009).

Coffee is grown between the Tropics of Capricorn and Cancer (23 degrees North to 23 degrees South) due to optimum conditions for the crop in respect to light, water and temperature (Jones, 2018). There are around 100 coffee plant species globally, though two predominate production (Jones, 2018), Arabica and Robusta (*Coffea arabica* and *C. canephora*). These grow best at different altitudes and both can be grown in Indonesia as the topography ranges from sea level around 5,000 masl. Abubakar, *et al.* (2011) states that Arabica needs to grow above 1,000 metres asl and requires richer quality soils. Siregar & Dewiyana (2016) suggests that Arabica was decimated in Indonesia by a leaf rust disease (*Hemileia vastatrix*) in 1876 and is additionally why Arabica is now only grown at higher altitudes where disease risk lessens. Robusta grows at lower altitudes on poorer quality soil yet despite this contains a greater amount of caffeine (Siregar & Dewiyana, 2016). Plants can be discriminated by Arabica having smaller leaves, larger fruit and bean and a shorter overall plant. Robusta is larger leaved, smaller fruit and bean and much taller plant than Arabica.

Wholesale prices per kilogram are US$0.60 - 0.75 (£0.38 - 0.47 GBP) for ordinary varieties rising to US$1.25 - 1.5 (£0.79 - 0.95 GBP) for specialist types. A *'coffee farmer receives 1% or less of the price of a cup of coffee sold in a café'* (Subagyo, 2007). In 1989, coffee reached a global high value however, suffered a subsequent seven-year crash in value so catastrophic that the price is, even though increasing, still worth less than at its peak with production. In the same period, production remained consistent, but farmers would have

found their income impacted by price fluctuations (Jaffee, 2014; Roldán-Perez, *et al.,* 2009).

7.1.2. Indonesian Coffee Production

- *How does the Indonesia coffee industry function and how was kopi luwak born from this?*

Coffee industry in Indonesia employs 1.5-2 million people (Subagyo, 2007; Neilson & Toth, 2016; Chairani, *et al.,* 2017), around 6% of global numbers employed in production. Indonesia has produced coffee since its introduction in the late 17th century (1696 in Jakarta, Java from Western Ghats, India; itself not an endemic crop) (Cahill, 2017; Chairani, *et al.,* 2017). Plants take six years of growth to become fruiting productive, despite this within ten years after introduction Java alone was producing 60 tons of coffee per year expanding to 4,000 ton by the close of the 19th Century (Cahill, 2017). To enable expansion, native forests and areas of existing farmland was cleared to dedicate to coffee monoculture (Cahill, 2017). Today, Indonesia ranks 4th in the world in overall coffee production behind Brazil, Vietnam and Columbia (Jones, 2018). In 2017-18 production was predicted to be 11 million 60kg bags of coffee (Jones, 2018) though poor weather reduced yields from both varieties (Rahmanulloh & McDonald, 2018). With improved weather conditions predicted for 2018-19 the estimate of coffee production in Indonesia is again 11 million bags predomininately Robusta variety, with over half to be exported (Rahmanulloh & McDonald, 2018). Nearly three quarters of coffee production in Indonesia is realised by the farmers of Sumatra alone and mostly in the south of the island (Neilson & Toth, 2016; Rahmanulloh & McDonald, 2018), so it seems peculiar that having a cup of coffee can be referred to as "*having a cup of Java*" when Java produces just 15% (Rahmanulloh & McDonald, 2018).

Indonesia supports 1,230,495ha of coffee plantations overall with most (69.1%) owned and managed by two million smallholder landowners with a mean of 0.6ha each (Neilson & Toth, 2016; Chairani, *et al.,* 2017) and collectively produces 6-7% (761kg/ha) of total coffee production exporting almost all (Mawardi, 2007; Fairtrade Foundation, 2012) though production is decreasing (Chairani, *et al.,* 2017). Vietnam for comparison produces nearly three times as much coffee per hectare at around 2,000kg/ha annually and according to Chairani, *et al.,* 2017, the lower expected production from Indonesia may be because production is largely by aforementioned smallholder farmers whom may therefore struggle from less supporting, rigorous and consistent chains of purchasers and processors. This type of supply needs a chain of intermediaries between farmers and processors leading to a lack of knowledge as to growing conditions, sustainability and quality. This arrangement expects also that farmers receive a lower market price for their produce (Neilson and Toth, 2016).

Around 70% of global coffee produced is the Arabica variety (*Coffea arabica*) (Chairani, *et al.,* 2017). In Indonesia however, the ratio of coffee varieties is reversed at 10:90 Arabica:Robusta and the Arabica production is largely for specialist coffees of which one product is *kopi luwak*, Robusta is of poorer quality and is typically used in lower cost instant coffees (Mawardi, 2009). The total land area dedicated to growth of Arabica covers 75,000ha (Mawardi, *et al.,* 1993) at altitudes of above 1,000 metres.a.s.l. (Roldán-Perez, *et al.,* 2009).

In Sumatra, there are schemes for certification of coffee to specific cooperatives, origins and certification organic status (Neilson & Toth, 2006). Certification is characteristically for Sumatra's Arabica production used in filter coffee brands and varieties (Neilson & Toth, 2006). Globally, 40% of coffee production is from certified sources (Neilson & Toth, 2006). Neilson & Toth (2006) further states that the creation of coordinated cooperatives and subsequent certification can promote socioeconomic wellbeing of villages and development of infrastructure and future local economic growth. Securing certification costs around US$50 per year per farmer but enables farmers to charge a higher price for coffee produced ($1.41 per pound ($3.10 per kg) for organic green coffee; US$1.26 ($2.77 per Kg) for non-organic retailing eventually for between US$7 and US$12 per pound (US$15.40 - US$26.40 per kg) in the USA when labelled as Fairtrade (Jaffee, 2014). Coffee was the first commodity to be traded as Fairtrade in 1988 in originating from a cooperative in Mexico; the movement expanded globally.

There are positives and negatives associated with greater joined up regional production of coffee, whilst growers may achieve more money for produce, supply is more direct to processors and extra money may help in village economics. Trade is likely to have a detrimental effect on the local environment in producing larger plantations by removing margins between plots and therefore losing wildlife corridors between endemic vegetation fragments. It potentially encourages farmers into monoculture and a lack of diversification may be good for focusing on making the one crop as productive as possible, though should poor growing season, poor weather, soil deterioration, disease, wildlife damage occurs or as highlighted previously, a global crop value crash; the sustainability of entire livelihoods of farmers could be destroyed (Jaffee, 2014). It is therefore recommended that cooperatives produce other crops such as rice, other fruits and vegetables for their own sustenance as well as a saleable commodity (Neilson & Toth, 2016). Coffee has been lucrative for the chains of coffee shops that are ever expanding around the world, though with seven-year price crash aforementioned; it may be considered as a potential volatile crop for small-holders in isolated locations. This may be one potential reason for increasing novelty coffees brands including kopi luwak that provides a higher wholesale income to farmers.

7.1.3. Kopi luwak overview

- *How does the Indonesia coffee industry function and how was kopi luwak born from this?*
- *What Indonesian legislation and religious code of practice is there related to kopi luwak production?*

Indonesia was formally a Dutch colony and the Dutch introduced coffee plants and production in 1696. Coffee was farmed by the poor for the rich of society to consume. Cahill (2017) provides the agreed chronology of the origins of kopi luwak, devised by the poor farmers whom were forbidden to procure crop for their own consumption were led to collect beans from the ground, from faeces of animals whom had consumed coffee cherries and defaecated the beans. To then wash and roast the resulting yield as normal. The resulting beverage was then subsequently discovered by the farmers' superiors and Dutch royalty thus raising the profile of Kopi luwak to a gourmet and luxury product from very humble origins. Latterly known to a global wealthy in Europe and America leading to its inclusion in the film The Bucket List (The Bucket List, 2007). Reportedly civet coffee is exceptional in unsurpassed flavour and quality akin to "*earthy, musty, syrupy, smooth, and rich with both jungle and chocolate overtones"* (Marcone, 2004; 2011), created by fermentation in acid and enzymes in the civets' digestive system and allegiedly also leads to substances in the coffee that possess medicinal properties (Marcone, 2004; Arief, 2009; Marcone, 2011).

There are now reports of other species used for producing 'gourmet' coffees within the same concept as kopi luwak. Animal species used in Indonesia and in other parts of the world include; small-toothed palm civet (*Arctogalidia trivirgata*), the masked palm civet (*Paguma larvata*), and binturong (*Arctictis binturong*), Asian Elephant (*Elephas maximus*), Coati (*Nasua nasua*), Jacu (*Penelope obscura*) and Rhesus Macaques (*Macaca mulatta*) (Milman, 2012; D'Cruze, *et al.,* 2014; Fleming, 2014; Aragon, 2015; Cahill, 2017; Malacarne *et al.,* 2017; Goodwin, 2018). Civet Coffee production occurs throughout Asia with different names in different countries including: *kopi luwak* (Indonesia, India and Malaysia); *Motit Coffee* or *Kape Alamid* (Philippines); *Kafé-Laku* (East Timor) and *Cà Phê Chồn* (Vietnam). In kopi luwak plantations in Bali it costs typically between IDR50,000 – IDR120,000 (£2.52 – £5.50 GBP; US$3.50 - $7.50) (pers. obs.). Cahill (2017) reports in less commercial areas of Indonesia, kopi luwak could cost as little as IDR10,000 per cup (£0.25 GBP; US$0.75) rising to IDR200,000 in parts of Bali (around £10 GBP; US$14). In the UK and USA a cup of kopi luwak retails at up to £60 (US$76) (Poulter, 2014). The opening of Origins Coffee Roasters house in Seattle on 11th May 2018 boasted a promotion of free kopi luwak to the first 100 customers, quoting the retail price per cup at US$40 (Hacienda, 2018). Harrods Department Store, London lists certified wild kopi luwak beans from Sumatra for sale via its website at a £250.00 per 125g pack (IDR 4.7 Million; US$336). This is the equivalent to £2,000 GBP (IDR38 Million; US$2,700) per Kilo. Harrods has reinstated the sale of kopi luwak after withdrawing it in 2014 following campaigns

from Tony Wild (*Cut the Crap*) and organisations such as *World Animal Protection* highlighting welfare concerns for caged civets involved in its production (Poulter, 2014).

Coffee beans are harvested from faeces of either free-ranging civets or captive animals (Carder, *et al.,* 2016). Civets are fed coffee fruit containing green beans, these pass through the digestive tract of the civet whole yet with altered composition of the chemistry of the beans that remains apparent after roasting (Marcone, 2004, 2011; Carder, *et al.,* 2016; Cahill, 2017). After collection, the bean packed faeces are washed to remove contaminants, then roasted for around 45 mins before grinding and packaging (Figure 26). Faeces from captive animals yields more green kopi luwak beans than wild civets due to greater quantities of coffee fruit in their diet over other fruit, small mammals, birds and invertebrates (Joshi, *et al.,* 1995; Krishnakumar & Balakrishnan, 2003; Nakashima, *et al.,* 2010; Nakabayashi, *et al.,* 2012). According to Cahill (2017) coffee beans procured from civets' faeces are easier to process as they lack the fruit pulp and skin of beans direct from coffee bushes and due higher market value of the end-product can be quite attractive to farmers at increasing financial rewards. As recently as 2006, the Indonesian government explored the expansion of kopi luwak production for the emerging market by intensifying caged civet kopi luwak using hundreds of caged animals (Cahill, 2017). This seems to be implemented with the formation of Kopi luwak production legislation in 2015 to promote standardisation (Peraturan Menteri Pertanian Republik Indonesia, 2015). In recent years, a number of companies where founded with brands described as '*Wild Kopi Luwak*' the assumed meaning that it is gathered from plantations by farmers after being deposited by free-roaming wild civets. There are issues with certification of wild kopi luwak however, as experts are convinced that kopi luwak is routinely branded as wild when it is actually from caged animals (Lynn & Rogers, 2013).

Issues with product integrity, certification and validation arises through difficulties of identification of green washed kopi luwak beans from other regular green washed beans. When collected and washed, kopi luwak beans are not distinctive enough to clearly identify fraudulent batches. To this end there have been a number of studies that have aimed to chemically analyse the composition of kopi luwak beans against regular coffees to lead to certification process that is reliable (Marcone, 2004; Jumhawan, *et al.,* 2013; Özdestan, *et al.,* 2013; Jumhawan, *et al.,* 2015; Suhandy & Yulia, 2017). In respect to the kopi luwak validation there is no regulation that states at what minimum percentage of a product should be in kopi luwak to be claimed as such. The 2015 Law no.37 (See Chapter 7.1.4) implies that it should be 100% kopi luwak to be called so, though it falls short of explicitly stating that. As kopi luwak yields higher prices, it must be tempting to dilute or substitute genuine kopi luwak with regular coffees. This lack of regulation, it is claimed by Cahill (2017) may also affect the mislabelling of coffee as Arabica when contents are the Robusta variety. Cahill further suggests that mislabelling may not be as commonplace in kopi luwak, though buyer beware that claims of "100%" and "wild civet coffee" may well be misleading as produce is rebranded and repackaged throughout the supply chain.

Figure 26: Process of manufacturing of kopi luwak. 1. Procure civets from the wild or markets. 2. Gather coffee berries from coffee bushes. 3. Provide civets with coffee berries to choose from or hand feed by use of a sharpened stick. 4. Collect bean encrusted faeces from civet cages. 5. Wash faeces away from beans and dry. 6. Roast and grind. 7. Create a menu. 8. Prepare for customer. 9. Sell other kopi luwak produced in plantation shop.

Further alleged false claims that follows production of kopi luwak is that only 127-700kg (typically 500kg) of kopi luwak is produced globally in any given year. This claim it typically reported characteristically by the coffee companies themselves, agro wisata, hotels and additionally stated regularly in news reports detailing the coffee (Taphanel, 2009; Kwok, 2013; Wild, 2013; D'Cruze, *et al.,* 2014). This alleged rarity value increases and maintains the market value of kopi luwak and attracts clientele to the variety. An indicator that the 500kg claim is bogus comes from an additional claim that 300kg per year originates from just one plantation in North Sumatra (Wulandari & Pardomuan, 2007) and 8 tons by one company in Java (BUMN, 2012). Cahill (2017) suggests that some plantations produce over a ton of kopi luwak each to supply tourism routes and destinations such as the island of Bali, Indonesia. The claim of quantities of production is address *in scripta* in results within this chapter.

Animal welfare campaign organisation, World Animal Protection formally known as the World Society for the Protection of Animals (WSPA) ranked the cruellest animal related tourism activities including riding Elephants, having photographs with drugged big cats, dancing bears and monkeys, snake charming and farming crocodiles. Ranked 8th on this list was visiting kopi luwak agro wisata (Hutchinson, 2016). Indications are that a diet of only coffee cherries results in malnutrition in captive civets and subsequently a premature death of individuals, never mind that animals are wild animals and the stress of being caged is another alleged precursor to mortality (Arief, 2009). Civets are naturally generalist omnivores, so whilst their diet may include coffee cherries, it is not exclusively. They can seemly consume a great quantity of food per day, Arief (2009) claims that civets can consume up to 3kg of coffee fruit in one night. The wild civet diet typically contains, other fruits, small mammals, birds, reptiles and amphibians and invertebrates (Bartels, 1964; Joshi, *et al.,* 1995; Krishnakumar & Balakrishnan, 2003; Su Su & Sale, 2007; Jothish, 2011). Again Law no.37 (2015) (see Chapter 7.1.4) requires the kopi luwak producers to feed a variety of foods from plants and animal sources, so feeding only coffee cherries to captive civets is prohibited. Providing captive civets with only a diet of coffee cherries raises purity levels in the eventual product as there is less necessity to extract prey remains of mammal fur and bone, bird feather and bone and insect exoskeletons during the washing stage before roasting. This washing stage is critical in not only removing contaminants from the green kopi luwak beans it is also necessary to satisfy the religious requirements in Islam. Washing multiple times (typically at least three) ensures purity and hygiene (Che Man & Sazili, 2010) according to Cahill (2017) however as kopi luwak's origins is from faeces it may be still considered as detestable under Halal/Haram rules.

This Chapter reports findings from investigations into Agro Wisata plantations that keep civets, produce and sell kopi luwak. Findings are reported on manufacture processes, health benefit claims and trade quantities of kopi luwak and the husbandry and welfare of civets.

7.1.4. Kopi luwak in Indonesian legislation

- *What Indonesian legislation and religious code of practice is there related to kopi luwak production?*

As well as the animal welfare legislation mentioned in previous chapters *in scripta*, there is also Law no.37 from 2015 (Peraturan Menteri Pertanian Republik Indonesia, 2015) produced with the intention of raising standards of civet welfare in the production of kopi luwak. This law, "*Cara Produksi kopi luwak Melalui Pemeliharaan Luwak Yang Memenuhi Prinsip Kesejahteraan Hewan*" includes the five animal needs and standards in housing, hygiene, mix of animals, biosecurity and feeding and watering requirements. The law denotes that kopi luwak meets requirements of Halal foods as the defaecated coffee beans retain their integrity and can even germinate following excretion. This is reinforced from Law no.18 (2009) as referred to in Chapter 6.1.2. With Halal guidelines prohibiting dirty foods, civets within production of kopi luwak should have prophylactic medication administered to prevent disease and especially endoparasites as stipulated by Law no.37. Sick animals should be isolated from others in the collection and any new animals entering the collection should be quarantined.

The civet housing and husbandry standards required for civets kept for kopi luwak under Law no.37 (2015) are:

- A location of cages away from noise and disturbance, therefore away from other species and not positioned adjacent to roads or industry.
- Three cage sizes are specified depending on circumstances: Individual civet cage at least 2x3x3 metres (18 metres^3) with wire walls and a double door entrance to prevent escape. Breeding cages should be at least 1.5x2x2 metres (6 metres^3) in size with heating connected to nest boxes. Enclosure for 5 communal civets (1 male and 4 females) should have dimensions of 7.5x10x3 metres (225 metres^3).
- Sleeping area should be provided consisting of a nest box that should be 2 metres from the floor (1.5 metres in a breeding cage).
- Built from non-toxic materials, that are easy to clean.
- Cage floors made of concrete or paved and with suitable drainage.
- Enrichment in the form of climbing branches to carry out normal behaviour.
- Suitable daily diet of mixed foods and fresh water given in a hygienic manner twice a day (Law suggests 0600 and 1700hrs) with meat, fruit, eggs, honey, insects and suitable supplements and vitamins. Coffee given no more than 3 times per week.
- Enclosure cleaned daily with use of disinfectant and not just water alone with minimal disturbance of the civet in the process.

- Rooves on quarantine cages and a minimum cage size of 1.5x3x3 metres in size (13.5 metres^3). No mention of the need for roof on regular housing.
- Young kept with mother until at least 8 weeks of age following weaning.
- Civet can only be kept for a maximum of 5 years before release to the wild or transfer to the pet trade. If released in to the wild, a period of observation post release is required to ensure health and successful transition.

The law continues through sections 4, 5 and 6 into the process and procedure for the preparing the coffee beans from excreta to the finished product. The law states that supervision is required for certification by suitable persons to ensure halal standards are met, food hygiene is acceptable, standards of sustainability and animal welfare are met and also that the coffee is not counterfeited or blended.

The assessment of the use of Asian palm civet in the production of kopi luwak (civet coffee) is urgently needed. Plantations (Agro Wisata) will be visited to assess the numbers of civets, to analyse the housing and welfare standards that are provided for the animals, to count the amount of kopi luwak for sale in shops and the also assess the standard of education provided by the plantations for their customers. The results from visits to kopi luwak Agro Wisata sites are presented in Chapter 7.2 and where plantations comply and violate the law is discussed in Chapter 7.3.

7.2. Results

7.2.1. Number of plantations and species observed within

- *What extent is kopi luwak produced and how many Asian palm civets are included within it?*

A total of 40 visits to Agro Wisata kopi luwak (Civet Coffee) plantations were carried out in Bali in 2013-14 and 2018 (6 in 2013-14 and 34 in 2018). This resulted in 6 and 34 plantations respectively being recorded. One in 2013-14 and 4 in 2018 seemed abandoned, with another (n=1) in 2018 seemly being built or extensively renovated. Totals civets recorded were 31 in 2013-14 and 125 in 2018 (means of 5.2 and 3.7 civets respectively). Carder, *et al.,* (2016) independently visited 16 plantations in 2013 and Lewis-Whelan, *et al.,* (in prep) visited 30 in 2018 (including 1 abandoned) and their data are incorporated in the results (Tables R, S and T). In the plantations that the author conducted in 2013-14 and 2018; only Asian palm civets were recorded (n=156; 100%). Carder *et al.* (2016) recorded all 48 animals as Asian palm civet (100%). Lewis-Whelan, *et al.,* (in prep) found four species of civets in plantations with 93.9% (n=123) being Asian palm civet, the remainder made up of masked palm civet (*Paguma larvata*), small-toothed civet (*Arctogalidia trivirgata*) and Malay civet (*Viverra tangalunga*) (n=8; 6.1%). Collectively 97.6% of animals in Kopi luwak plantations are Asian palm civets.

Overall, sixty-one plantations were visited totalling 86 visits (Table R), plantations were visited once (n=42), some twice (n=13) and others three times (n=6) (Tables R and T). Twelve plantations were visited twice by Carder, *et al.,* and thesis author in 2013-14 and 2018 yet, overall no difference in numbers were recorded (χ^2=9.1 P>0.01 Not Significant) (Table S). Nine plantations were visited by both the author (n=43 civets) and Whelan, *et al.,* (in prep) in 2018 (n=50 civets) (χ^2=0.04 P>0.01 Not Significant). Six plantations were visited by all contributors either in 2013-14 or 2018 (Recording n=28-26 civets); 3.6 civets per plantation (range: 3.0-4.3) (Tables R and T)) (χ^2=0.25 P>0.01 Not Significant). In 2013-14, 22 plantations visited by the author (n=6) and Carder, *et al.,* (2016) (n=16) and recorded 79 civets in residence (mean 3.6 civets per plantation; range 0-14). In author's 2018 visits; 125 civets were recorded (mean: 3.7; Range 0-20 civets). Lewis-Whelan, *et al.,* (in prep) recorded 131 civets (mean: 4.4; Range 0-32). Year 2018 recorded a combined 256 civets, from 58 visits (mean: 4.4 civets) (Tables R and T). Some plantations visited more than once may have recorded the same civet specimens in duplicate. Recorded civets are thus corrected to 218-248 civets (mean n=234), equating to 3.6-4.1 civets per plantation (mean: 3.8 civets) (Tables R and T). Excluding abandoned plantations from means adjusts them to 3.9 civets per plantation in 2013-14, 4.3 in 2018 and 4.5 civet in Lewis-Whelan, *et al.,* (in prep) (Tables R and T). Indications are that captive civet populations have increased in 61 plantations by 40 animals collectively from 2013 to 2018 from 229 (extrapolated from 21 plantations) to 269 civets (263-276), a mean of ten civets per year (0.14-0.19 civets per year per plantation), yet the increase is not significant (χ^2=0.024 P>0.01 Not Significant).

Table R: Number of civets recorded in visits to kopi luwak plantations. Yellow highlighted data are from Carder, *et al.*, 2016, orange are thesis authors own data, green are from Whelen-Lewis, *et al.,* (in prep).

Source / Name of Plantation	Number of civets in 2013 - 2014	Number of civets in Spring 2018	Number of civets in Summer 2018	Min civets recorded	Max civets recorded	Mean civets
Abian Kusuma Sari			3	3.0	3.0	3.0
Abian Luwus			1	1.0	1.0	1.0
Abian Sari	4	3		3.0	4.0	3.5
Alam Bali		2	2	2.0	2.0	2.0
Alam Sari			5	5.0	5.0	5.0
Alas Harum		10		10.0	10.0	10.0
Amertha Yoga	2	1	3	1.0	3.0	2.0
Asti Agro Tourism	3			3.0	3.0	3.0
Bahuana Asri		2		2.0	2.0	2.0
Bali As		3	2	2.0	3.0	2.5
Bas De Atayana		9		9.0	9.0	9.0
Basanta Agro			3	3.0	3.0	3.0
Batur Agro Wisata			32	32.0	32.0	32.0
Bhuana Asri			2	2.0	2.0	2.0
Buana Amerta Sari	5			5.0	5.0	5.0
Cantik	3	6	6	3.0	6.0	5.0
Dewi Agrowisata	2			2.0	2.0	2.0
Geo Bali		0		0.0	0.0	0.0
Goa Gaja Bali Agro			3	3.0	3.0	3.0
Hidden Garden		2		2.0	2.0	2.0
Intan Sari Luwak			2	2.0	2.0	2.0
Kabu Bali Agro	6			6.0	6.0	6.0
Kayu Manis	2			2.0	2.0	2.0
Kumulilir		3		3.0	3.0	3.0
Laksmi Bali	4	4	3	3.0	4.0	3.7
Lambung Amertha		0		0.0	0.0	0.0
Lebah Sari	0			0.0	0.0	0.0
Lembah Wangi			1	1.0	1.0	1.0
Lubak Bali		2		2.0	2.0	2.0
Lumbung Amertha	1			1.0	1.0	1.0
Lumbung Sari	3		6	3.0	6.0	4.5
Madu		0	0	0.0	0.0	0.0
Manik Abian		2	2	2.0	2.0	2.0
Mertha Sari		1		1.0	1.0	1.0
Negari Luwak		10	10	10.0	10.0	10.0
Nyepi		3		3.0	3.0	3.0
Oka	3	2	4	2.0	4.0	3.0
One Bali			4	4.0	4.0	4.0
Pandwana		0		0.0	0.0	0.0
Pulina	14	20		14.0	20.0	17.0
Pupuan-Tabanan			3	3.0	3.0	3.0
Santi	3	2	1	1.0	3.0	2.0
Sari Amerta Tanah			4	4.0	4.0	4.0
Satria Luwak	6	3	9	3.0	9.0	6.0
Sebatu	4			4.0	4.0	4.0
Segara Windhu		6	6	6.0	6.0	6.0
Silakarang		5		5.0	5.0	5.0
Subak Bali Agro		3		3.0	3.0	3.0
Suka		0		0.0	0.0	0.0
Taman Ayu			2	2.0	2.0	2.0
Taman Nadi	1			1.0	1.0	1.0
Tamen Sari	4			4.0	4.0	4.0
Teba Sari		7		7.0	7.0	7.0
Tegal Harum	1	0		0.0	1.0	0.5
Tegal Sari	5	4		4.0	5.0	4.5
Trisna	3	4		3.0	4.0	3.5
Ubud Sari		2	2	2.0	2.0	2.0
Una Pakel		4		4.0	4.0	4.0
Wedang Sari			2	2.0	2.0	2.0
Wild Coffee Luwak			4	4.0	4.0	4.0
Wisata Pertanian			4	4.0	4.0	4.0
Total civets	**79**	**125**	**131**	**218**	**248**	**234**
Mean civets/site	**3.6**	**3.7**	**4.4**	**3.6**	**4.1**	**3.9**

Table S: Repeated visits to 12 agro wisata plantations producing or selling kopi luwak (civet coffee) in Bali, Indonesia counting the number of civets on display (Yellow indicates data from Carder, *et al.,* (2016) and orange are authors own data.

Plantation Name	Number of civets in 2013 - 14	Number of civets in 2018	Difference	Mean civets per plantation
Abian Sari	4	3	-1	3.5
Amertha Yoga	2	1	-1	1.5
Cantik	3	6	3	4.5
Laksmi Bali	4	4	0	4.0
Lambung Amertha	1	0	-1	0.5
Oka	3	2	-1	2.5
Pulina	14	20	6	17.0
Santi	3	2	-1	2.5
Satria	6	3	-3	4.5
Tegal Harum	1	0	-1	0.5
Tegal Sari	5	4	-1	4.5
Trisna	3	4	1	3.5
Total civets recorded	**49**	**49**	**0**	**4.1**

Table T: Frequency of civets recorded at agro wisata plantations producing or selling Kopi luwak (Civet Coffee) in Bali, Indonesia from visits made in 2013-14 and 2018 showing authors own data combined with that of Carder, *et al.,* (2016) and Lewis-Whelan, *et al.,* (in prep). (A) shows all plantations visited including abandoned and renovated ones that contained no civets; (B) shows plantations visited excluding abandoned and renovated ones that contained no civets; (C) shows the data for plantations that were visited once, twice and three times.

A)	**All Plantations visited**	**2013-14**	**Spring 2018**	**Summer 2018**	**Totals**
	Number of civets	79	125	131	335
	Number of Plantations	22	34	30	86
	Mean civets per plantation	3.6	3.7	4.4	3.9
	Min number of civets	0	0	0	-
	Max number of civets	14	20	32	-

B)	**Excluding abandoned and renovated plantations**	**2013-14**	**Spring 2018**	**Summer 2018**	**Totals**
	Number of civets	79	125	131	335
	Number of Plantations	21	29	29	79
	Mean civets per plantation	3.8	4.3	4.5	4.2
	Min number of civets	1	0	0	-
	Max number of civets	14	20	32	-

C)	**Visits recorded in plantations**	**1 Visit**	**2 Visits**	**3 Visits**	**Totals**
	Number of plantations	42	13	6	61
	Number of visits	42	26	18	86
	Sum of civets recorded	154	116	65	335
	Mean of civets per plantation	3.7	4.5	3.6	3.9
	Min number of civets	0	0	1	-
	Max number of civets	32	20	9	-

Other species not related to Kopi luwak production were also recorded in Kopi luwak plantations the include: Large flying foxes (*Pteropus vampyrus*) [IUCN: Near Threatened] (n=3), Malayan Porcupine (*Hystrix brachyura*) [IUCN: Least Concern] (n=3), domestic cattle (*Bos taurus*) [IUCN: Not assessed] (n=4), Indian Muntjac Deer (*Muntiacus muntjak*) [IUCN: Least concern] (n=2) (Figure 27), leaf monkey aka Javan Lutung (*Trachypithecus auratus*) [IUCN: Vulnerable] (n=1), domestic rabbit (*Oryctolagus cuniculus*) [IUCN: Near Threatened] (n=1) and multiple caged birds and free roaming birds including: Oriental Pied Hornbill (*Anthracosceros albirostris*) [IUCN: Least Concern] (n=1), Common Hill Myna (*Gracula religiosa*) [IUCN: Least concern], Buffy fish owl (*Ketupa ketupu*) [IUCN: Least concern], a Green peafowl (*Pavo muticus*) [IUCN: Endangered] (Figure 27), and multiple chickens (*Gallus gallus domesticus*) [IUCN: Not assessed], domestic pigeons (*Columba livia domestica*) [IUCN: Not assessed] and Eclectus parrots (*Eclectus roratus*) [IUCN: Least concern]. No explanation was typically given was given for these additional species apart from one plantation that stated that they keep two cattle for fertiliser for crop plants on the plantation. Reasons for including other species other than civets is discussed in Chapter 7.3.

7.2.2. Origins of the procurement of civets for kopi luwak plantations

All kopi luwak plantation's staff encountered (n=34) responded freely the questions about the source of animals, reporting that 96.2% (n=150) of civets were from wild sources (χ^2=85.2 P<0.01 Significant). One animal was sourced from captive bred origins in east Java, five others were born in plantation. With the quota set around 250 animals per year allowed to be harvested from the wild these plantations held up to 11.6% of the quota allowance in 2013 and 48.8% in 2018, should the animals have had all been trapped in a single year. Ages of civets were between less than 4 weeks (two still with their mother) to 15 years (average of 3.28 years), 93.6% (n=146); 5.1% juvenile (n=8) and 2 were neonates (1.3%) (χ^2=125.0 P<0.01 Significant). Adult had been kept for between 1 week (born in plantation) and the animal's whole life (15 years). Plantation guides reported a second facility in the Kintamani region of Bali where between 7 and 200 wild civets free roam and where their respected kopi luwak available in their shop is actually sourced, processed, packaged and supplied (n=7; 20.6%; total of 479 civets). Some other plantations (n=4; 11.8%) reported that that have an additional facility elsewhere in Bali where more caged animals (Range: 5-50 civets; total of 95 animals) supply their shop's product. One guide suggested that there may be 500 wild civets total in the whole of Bali. Implications of these numbers in the kopi luwak production in Bali is discussed in Chapter 7.3.

Figure 27: Selected images of other species recorded in agro wisata plantations producing or selling kopi luwak (civet coffee) in Bali, Indonesia from visits made in 2013-14 and 2018. Top row left to right: Malayan porcupine (*Hystrix brachyura*) [IUCN: Least Concern], Oriental pied hornbill (*Anthracosceros albirostris*) [IUCN: Least Concern], Muntjac deer (*Muntiacus muntjac*) [IUCN: Least Concern], Lower row left to right: Common Hill (*Gracula religiosa*) [IUCN: Least Concern], Buffy fish owl (*Ketupa ketupa*) [IUCN: Least Concern], Large flying fox (*Pteropus vampyrus*) [IUCN: Near Threatened], Green peafowl (*Pavo muticus*) [IUCN: Endangered].

7.2.3. Husbandry and welfare of civets in kopi luwak plantations in reference to the five animal needs

- *What Indonesian legislation and religious code of practice is there related to kopi luwak production?*
- *How are Asian palm civets procured and kept within kopi luwak production?*
- *What if any are the welfare issues identified for Asian palm civets in the kopi luwak production?*

The five animal needs (five freedoms) are listed as specific requirements in both Law no.18 and Law no.37 in Indonesia, the latter specifically pertaining to civets in captivity for kopi luwak production, the former referring to all captive vertebrate animals (Flevin 2009; Peraturan Menteri Pertanian Republik Indonesia, 2015).

a) Freedom from Hunger and Thirst

Food and water were absent in 70.6% and 52.9% of plantations respectively, in contravention of Law no.18 (2009) and Law no.37 (2015) (χ^2=17.0 P<0.01 Significant (χ^2=0.34 P>0.01 Not Significant respectively) (Table U) and despite the daily temperatures rising from 22 to 33 degrees Celsius (Figure 28). One plantation currently had no civets so was designated as not applicable (n/a) in relation to food and water. Of the 24 plantations with civets but without food there was some evidence of previous feeding in the way of recent faeces present in the cages in 13 (54.2%) (χ^2=0.71 P>0.01 Not Significant). A total of 8 (23.5%) plantations had no faeces and no food present at the time of visit suggesting that hygiene practices occurred that day (χ^2=28.1 P<0.01 Significant), food may have been scatterfed and fully consumed (Law no.37, 2015). Four plantations (11.8% overall; 44.4% of cages without food and water) presented no food in cages though guides explained that the reason was that they are fed in the evening, though to meet Law no.37, feeding and watering should be twice per day in the morning and the evening (Table V). Only 1 plantation (2.9%) presented water in cages that was in excellent hygienic state, notably extremely clean bowl with no debris evident in the water. Poorer hygiene scores were given to dirty bowls, floating and none floating matter in the water and a lack of water in the bowl indicating duration that it had been in the cage. Very poor would be given to plantations with water bowls that contain discoloured water or water bowls that evidently have not been cleaned for some time despite being refilled (Figure 29).

Five plantations had given food that day (14.7%) presumably prior to opening to the public (χ^2=49.8 P<0.01 Significant). All visits were made to plantations before between 9am and 2pm. No food (when it was present) was more than one day old and none was recorded as showing signs of decay or desiccation, though bowl hygiene was notably

Table U: Presence and absence of food and water visible in civet cages in 34 kopi luwak plantations visited in Bali, Indonesia during 2013-14 and 2018.

	Number of plantations with/without food available to civets (mean)	**Number of plantations with/without food available to civets (mean)**
Present	9 (26.5%)	15 (44.1%)
Absent	24 (70.6%)	18 (52.9%)
Not Applicable	1 (2.9%)	1 (2.9%)
Totals	**n=34**	**n=34**

Table V: Recorded food and water quality, quantity and hygiene present in civet cages in kopi luwak plantations visited in Bali, Indonesia during 2013-14 and 2018. Actual number of plantations recorded (percentage)

	Condition category of food and water (see Table C for key)							
Food and water	**0**	**1**	**2**	**3**	**4**	**5**	**n/a**	**Total Plantations**
Food Present	8 (23.5)	13 (38.2)	3 (8.8)	3 (8.8)	5 (14.7)	1 (2.9)	1 (2.9)	**n=34**
Number of Food	4 (11.8)	2 (5.9)	13 (38.2)	7 (20.6)	7 (20.6)	0 (0.0)	1 (2.9)	**n=34**
Freshness of Food	24 (70.6)	0 (0.0)	0 (0.0)	2 (5.9)	2 (5.9)	5 (14.7)	1 (2.9)	**n=34**
Hygiene of Food	24 (70.6)	0 (0.0)	3 (8.8)	4 (11.8)	2 (5.9)	0 (0.0)	1 (2.9)	**n=34**
Water Present	18 (52.9)	0 (0.0)	4 (11.8)	4 (11.8)	2 (5.9)	5 (14.7)	1 (2.9)	**n=34**
Hygiene of Water	18 (52.9)	2 (5.9)	5 (14.7)	4 (11.8)	3 (8.8)	1 (2.9)	1 (2.9)	**n=34**
Totals	**112 (54.9)**	**4 (2.0)**	**28 (13.7)**	**25 (12.3)**	**18 (8.8)**	**11 (5.4)**	**6 (2.9)**	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High °C	29	30	30	32	33	31	31	31	31	31	31	30
High °F	84	86	86	90	91	88	88	88	88	88	88	86
Low °C	23	22	23	22	23	22	22	22	22	23	23	23
Low °F	73	72	73	72	73	72	72	72	72	73	73	73

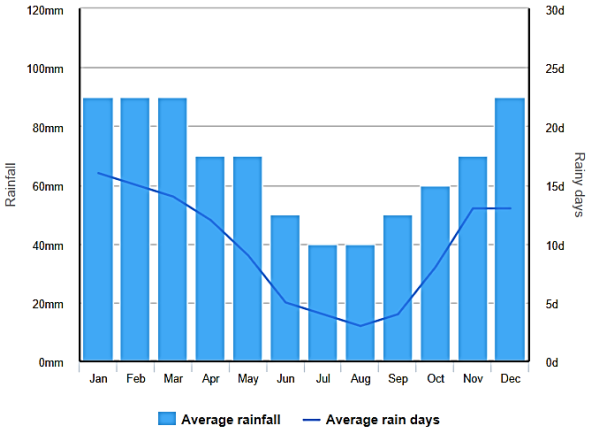


Figure 28: Average annual temperature and rainfall ranges for Bali, Indonesia [From: https://www.holiday-weather.com/bali/averages]

Figure 29: Two examples from two different plantations of poor hygiene in providing food and very poor hygiene in water provision in civet cages in kopi luwak plantations visited in Bali, Indonesia during 2018. Bowls show a general lack of cleaning leading to algae growth.

questionable (Figure 29). Three plantations (8.8%) provided only coffee berries to their animals, which in contravention to the requirements of a balanced varied diet in Laws 18 and 37 (Flevin, 2009; Peraturan Menteri Pertanian Republik Indonesia, 2015) (χ^2=67.9 P<0.01 Significant). When questioned, 13 staff (38.2%) (χ^2=5.6 P>0.01 Not Significant) referred only to plant-based sources of food in their civets' diet with 4 plantation staff members specifically referring to civets as "*vegetarian*" (31.8% of 13); 11.8% of 34). One staff member further explained that Bali civets are vegetarian but Javan ones do eat meat. Fourteen plantations (n=14; 41.2%) referred to foods that were from one or more plant and animal sources (7 plantations (20.6%) stating different foods but without any in cage; 7 with multiple foods that were also present in cages) (χ^2=34.6 P<0.01 Significant). No one gave extensive feeding regimes consisting of, in excess of 4 items from each of the plant and animal sources (Table V).

b) Freedom from Pain, Injury and Disease

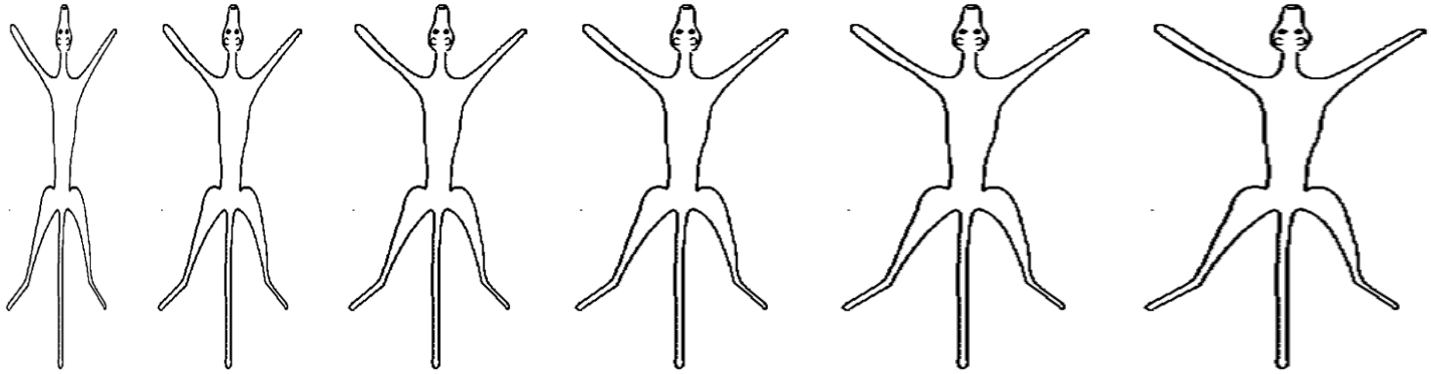
A visual health check was done on each of the 156 civets recorded in the 34 plantations visited. It was not possible to handle animals and carry out a more rigorous assessment of health and many animals were at least particially obscured by the place they were lying or the posture that they were lying in. Records taken were: a condition score given a numerical value of between zero and five, any signs of ectoparasites plus any signs of injuries and wounds.

The condition score is an assessment of body weight from severely emaciated (scored 0) through to morbidly obese (scored 5). An animals' ideal weight score would be scored as 3. For the 156 animals scored 94.2% were scored as at ideal weight, with 3.2% overweight (Score 4) and the remaining animals could not be assessed as they were not clear enough to see (n=4; 3%). No animals were recorded for condition scores of 0, 1, 2 and 5 (Table W). Other signs of health problems were the injuries present on civets were recorded in two plantations (n=3 animals; 1.9%) with a further two plantation's staff reporting rectal bleeding and death in civets previously if fed solely on coffee fruit (5.9%) and an additional case of infanticide (2.9%). Injuries observed appeared to be caused by fights between animals or self-harm located on limbs and tail (Figure 30 and Table X).

c) Freedom from Discomfort, Freedom from Fear and Distress and Freedom to Behave Naturally

The housing standard is specifically outlined in Law no.37 and *in scripta* is assessed in respect to build quality and materials, substrate and roofing standard. Additionally, examined is the standard of sleeping area provision and enrichment provided within

Table W: Condition scores and frequency for Asian palm civets (*Paradoxurus musangus*) observed in kopi luwak plantations in Bali, Indonesia during 2013-14 and 2018. Images for Dorsal view of animals adapted from Vogler, Goeritz, Hildebrandt and Dehnhard (2008). CNS = Could not see.



Condition Score	**0**	**1**	**2**	**3**	**4**	**5**	**CNS**	**Total**
Number of Animals	0	0	0	147	5	0	4	**156**
Mean	0.0	0.0	0.0	94.2	3.2	0.0	2.6	**100.0**

Figure 30: Injuries to limb and tail of Asian palm civets (*Paradoxurus musangus*) recorded in kopi luwak plantations visited in Bali, Indonesia during 2018. Left showing bite wounds to forelimb, the right picture showing loss of fur from halfway to tip of the tail (a frame from a video clip).

Table X: Health and welfare of civets in kopi luwak plantations visited in Bali, Indonesia during 2013-14 and 2018. Actual number of plantations recorded (percentage)

	Condition category of civet welfare (see Figure D for key)							
Welfare of civet	**0**	**1**	**2**	**3**	**4**	**5**	**n/a**	**Total Plantations**
Activity Pattern	1 (2.9)	1 (2.9)	8 (23.5)	10 (29.4)	5 (14.7)	8 (23.5)	1 (2.9)	**n=34**
Duration Kept	9 (26.5)	4 (11.8)	2 (5.9)	1 (2.9)	3 (8.8)	8 (23.5)	7 (20.6)	**n=34**
Signs of Injuries	0 (0.0)	0 (0.0)	1 (2.9)	1 (2.9)	0 (0.0)	31 (91.2)	1 (2.9)	**n=34**
Origins	0 (0.0)	29 (85.3)	0 (0.0)	3 (8.8)	2 (5.9)	0 (0.0)	0 (0.0)	**n=34**
Signs of Parasites	0 (0.0)	0 (0.0)	0 (0.0)	2 (5.9)	0 (0.0)	31 (91.2)	1 (2.9)	**n=34**
Stereotypic behaviour	2 (5.9)	0 (0.0)	6 (17.6)	1 (2.9)	1 (2.9)	23 (67.6)	1 (2.9)	**n=34**
Totals	**12 (5.9)**	**34 (16.7)**	**17 (8.3)**	**18 (8.8)**	**11 (5.4)**	**101 (49.5)**	**11(5.4)**	

housing. Cage size was assessed in line with catagories in Carder, *et al.,* (2016), meaning those stated as at or exceeding 1 metre^3 equals 85.7% (Table Y and Z), ranging from 1 metre^3 to 32 metres^3 yet remain in the same category. Carder, *et al.,* (2016) themselves recorded an enclosure in a plantation that was 150 metres^3 (10x5x3 metres) yet placed into the category for over 1 metre^3. One metre^3 is inferior to the legal requirement in Law 37 of 2x3x3 metres or 18 metres^3 for a single civet (Peraturan Menteri Pertanian Republik Indonesia, 2015). This thesis uses ten size categories rather than three to give greater clarity, yet six largest enclosures remain above the top category of 9 metres^3 (9 metres^3, 10 metres^3, 12 metres^3, 16 metres^3, 27 metres^3 and 32 metres^3) (Table Y and Z) with only two enclosures of the 42 sizes observed (4.8%) (χ^2=83.9 P<0.01 Significant) meet the legal standard for individual animals. Many cages however contain pairs of civets so could be considered breeding cages, (required to be 6 metres^3) then an additional 9 plantations are meeting the law on cage size (21.4%) (χ^2=32.7 P<0.01 Significant) (Peraturan Menteri Pertanian Republik Indonesia, 2015) (Table Z).

Law no.37 specifies that cages should be mesh walled and concrete based with good drainage, double door access and a roof is only required for quarantine cages. Cages were built of a multitude of materials from traditional bamboo, rendered concrete, wire mesh and high-quality metal kennel/aviary panels (Figure 3, 31 and 32) and lack the double door to prevent escape with sixteen plantations with cages with not so much as a padlock on the door (47.1%) (χ^2=36.7 P<0.01 Significant) (Table Y). Half of cages in plantations were built with concrete floors (50%) and 76.5% with wire mesh walls consistent with Law no.37 requirements (χ^2=45.0 P<0.01 Significant and χ^2=34.1 P<0.01 Significant respectively), though those with wire mesh cages and concrete floors combined were recorded in just 11 plantations (32.4%), 5 (14.7%) of these had large single doors for easier access for cleaning, 6 (17.6%) having small or very small doors that a person would struggle to or could not fit through (examples shown in Figure 3 and 31). The law is unclear to what extent the walls should be wire mesh, so data above only shows those with all four walls as mesh. The remaining cages between 1 and 3 walls of another material. Natural substrate floors came as second most common (20.6%) (χ^2=2.8 P>0.01 Not Significant). These are followed by unsuitable wire mesh floors and timber slats (17.6% and 8.8%) (χ^2=0.8 P<0.01 Significant and χ^2=2.1 P<0.01 Significant respectively) (Table Y). All types can be seen in the images in Figure 3 and 31.

Cages with rendered walls or concrete walls showed greater deterioration, the implications are discussed in Chapter 7.3 (Figures 31 and 32). Poor build quality or poor maintenance housing was recorded in 14.7% of plantations (χ^2=1.4 P>0.01 Not Significant) that could become worse in the next coming few months if renovations or rebuild were not carried out. It would be probably more cost effective to replace rather than repair these cages. In the current state the cages have a marked increase of causing injury or disease to the animals contained within. Other cages had fair (44.1%) (χ^2=29.0 P<0.01 Significant) to good (41.2%) (χ^2=22.5 P<0.01 Significant) construction of their housing standard that could be easier to maintain for a longer period.

Table Y: Recorded construction standards of civet cages in kopi luwak plantations visited in Bali, Indonesia during 2013-14 and 2018. Actual number of plantations recorded (percentage)

	Condition category of housing standard (see Table E for key)							
Construction Category	**0**	**1**	**2**	**3**	**4**	**5**	**n/a**	**Total Plantations**
Cage Size	2 (5.9)	3 (8.8)	3 (8.8)	2 (5.9)	4 (11.8)	20 (58.8)	0 (0.0)	**n=34**
Construction Standard	0 (0.0)	0 (0.0)	5 (14.7)	15 (44.1)	14 (41.2)	0 (0.0)	0 (0.0)	**n=34**
Enclosure Hygiene	0 (0.0)	6 (17.6)	6 (17.6)	13 (38.2)	9 (26.5)	0 (0.0)	0 (0.0)	**n=34**
Enrichment	2 (5.9)	21 (61.8)	8 (23.5)	3 (8.8)	0 (0.0)	0 (0.0)	0 (0.0)	**n=34**
Roof	0 (0.0)	3 (8.8)	2 (5.9)	12 (35.3)	17 (50.0)	0 (0.0)	0 (0.0)	**n=34**
Security	3 (8.8)	13 (38.2)	16 (47.1)	2 (5.9)	0 (0.0)	0 (0.0)	0 (0.0)	**n=34**
Shelter	1 (2.9)	1 (2.9)	12 (35.3)	2 (5.9)	18 (20.6)	0 (0.0)	0 (0.0)	**n=34**
Substrate Type	6 (17.6)	0 (0.0)	3 (8.8)	17 (50.0)	0 (0.0)	7 (20.6)	1 (2.9)	**n=34**
Walls	2 (5.9)	12 (35.3)	6 (17.6)	0 (0.0)	14 (41.2)	0 (0.0)	0 (0.0)	**n=34**
Totals	**16 (5.2)**	**59 (19.3)**	**61 (19.9)**	**66 (21.6)**	**76 (24.8)**	**27 (8.8)**	**1 (0.3)**	

Table Z: Approximate cage dimensions observed in kopi luwak plantations in Bali, Indonesia during 2013-14 and 2018 for housing Asian palm civets (*Paradoxurus musangus*). Suitability: B= Suitable as Breeding Cage, I=Suitable as a cage for Individual civets. (B) = suitable for breeding cage based on cubic capacity but one measurement is below that outlined in Law 37 (2015)

Length (m)	Width (m)	Height (m)	Floor Area (m^2)	Cubic Capacity (m^3)	n of Plantations (mean)	Suitability	Capacity (Individual civets)	Capacity (Breeding cage)
0.4	0.4	0.6	0.2	0.1	1 (2.4%)	-	0.01	0.02
0.6	0.4	0.6	0.2	0.1	1 (2.4%)	-	0.01	0.02
0.6	0.6	0.6	0.4	0.2	1 (2.4%)	-	0.01	0.03
0.6	0-.6	1.0	0.4	0.4	1 (2.4%)	-	0.02	0.07
1.0	0.6	0.6	0.6	0.4	1 (2.4%)	-	0.02	0.07
0.6	0.6	1.5	0.4	0.5	1 (2.4%)	-	0.03	0.08
1.0	1.0	1.0	1.0	1.0	1 (2.4%)	-	0.06	0.17
0.6	1.5	1.5	0.9	1.4	1 (2.4%)	-	0.08	0.23
1.0	1.0	1.5	1.0	1.5	2 (4.8%)	-	0.08	0.25
1.0	1.0	2.0	1.0	2.0	3 (7.1%)	-	0.11	0.33
2.0	1.0	1.0	2.0	2.0	1 (2.4%)	-	0.11	0.33
1.5	1.0	1.5	1.5	2.3	5 (11.9%)	-	0.13	0.38
1.0	1.5	2.0	1.5	3.0	1 (2.4%)	-	0.17	0.50
2.0	1.0	1.5	2.0	3.0	2 (4.8%)	-	0.17	0.50
1.5	1.5	1.5	2.3	3.4	2 (4.8%)	-	0.19	0.57
1.0	2.0	2.0	2.0	4.0	3 (7.1%)	-	0.22	0.67
1.5	1.5	2.0	2.3	4.5	1 (2.4%)	-	0.25	0.75
3.0	1.0	1.5	3.0	4.5	1 (2.4%)	-	0.25	0.75
2.5	1.5	1.5	3.8	5.6	1 (2.4%)	-	0.31	0.93
2.0	1.5	2.0	3.0	6.0	1 (2.4%)	B	0.33	1.00
3.0	1.5	1.5	4.5	6.8	1 (2.4%)	(B)	0.38	1.13
2.0	2.0	2.0	4.0	8.0	3 (7.1%)	B	0.44	1.33
3.0	1.5	2.0	4.5	9.0	2 (4.8%)	B	0.50	1.50
2.5	2.0	2.0	5.0	10.0	1 (2.4%)	B	0.56	1.67
3.0	2.0	2.0	6.0	12.0	1 (2.4%)	B	0.67	2.00
4.0	2.0	2.0	8.0	16.0	1 (2.4%)	B	0.89	2.67
3.0	3.0	3.0	9.0	27.0	1 (2.4%)	B, I	1.50	4.50
4.0	2.0	4.0	8.0	32.0	1 (2.4%)	B, I	1.78	5.33
				Total	**42**			

Figure 31: Selection of housing types observed for Asian palm civets (*Paradoxurus musangus*) in kopi luwak plantations in Bali, Indonesia during 2013-14 and 2018.

Figure 32: Two examples of poor civet housing in kopi luwak plantations in Bali, Indonesia showing deterioration of materials and housing standard.

Nine plantations (26.5%) (χ^2=2.1 P>0.01 Not Significant) showed signs of cleaned cages on visit day, one plantation was still cleaning with a water hose while visitors were present. There was however no evidence of the use of detergents or disinfectants in any plantation as specified in Law no.37 (Peraturan Menteri Pertanian Republik Indonesia, 2015). Only floors seemed to be cleaned, cage furniture, walls and enrichment was typically discoloured with scent marks and urine or had presence of faeces that was not fresh on them. This cage (Figure 33) along with 5 other plantation's cages rated poor on hygiene (17.6%) (χ^2=0.3 P>0.01 Not Significant), equally a further 17.6% (χ^2=0.3 P>0.01 Not Significant) showed some lack of cleaning but for no more than one day. Most cages in plantations rated good with only fresh faeces present, though it is not known how long that faeces would remain before being removed.

Enrichment was entirely lacking in the cages of two plantations (5.9%) (χ^2=9.9 P<0.01 Significant) with 61.8% containing only a single branch or platform for the civet to exercise on (χ^2=87.4 P<0.01 Significant). One plantation had live trees within the crudely built large enclosure, though the trees were far taller that the enclosure so only trunks were inside. The substrate was bare earth with little or no understorey vegetation. The legal standard however is for a concrete base to the enclosure/cage so any live plants would need to in containers (Table Y). Civets resident in these plantations are subject to the challenges of being on public view and exposure to the Balinese weather cycles of dry and wet seasons and tropical temperatures (Figure 28). To promote good welfare for captive animals, housing should have shelter that protects the animals from weather conditions and also allows animals to escape public view. Shelter assessed constitutes two types:

i) The roof structure on top of the entire cage/enclosure (Figure 31).
ii) The standard of nest box/sleeping area provided (Figures 29 and 31).

Rooves offer good shelter from the weather, either heat or precipitation. No roof on any enclosure was immaculate, though 50% of plantations had cages or enclosures with full rooves in a good state of repair though typically in need of some light maintenance (χ^2=45.0 P<0.01 Significant). An additional 35.3% of plantations had cages or enclosures with full rooves that needed more extensive cleaning or maintenance, these typically starting to look shabby or had growths of moss or algae on them (χ^2=11.7 P<0.01 Significant) (Table Y and Figure 31). Five plantations had cages or enclosures with partial covering rooves of good standard (n=2; 5.9%) or in need some repairs or maintenance (n=3; 8.8%) (χ^2=9.9 P<0.01 Significant and (χ^2=6.3 P<0.01 Significant respectively). The lack of gutters and drainage in all cages could lead to flooding in ground level cages. The issues towards the welfare of the animals is discussed in Chapter 7.3.

At the times of day of the visits, civets being nocturnal animals (Figure 10) should be asleep in their cages or enclosures, yet in many of the plantations (73.5%) some if not all

Figure 33: An Asian palm civet (*Paradoxurus musangus*) resident in a kopi luwak Plantation in Bali, Indonesia seemly disgusted by its own desiccated and discoloured faeces present on a platform where the animal sleeps.

of the civets in residence were awake with two plantations animal's all awake and distressed exhibiting stereotypic pacing behaviour (χ^2=40.0 P<0.01 Significant). Most sleeping areas and nest boxes were raised off the ground (n=30; 88.2%) (χ^2=66.0 P<0.01 Significant) and could promote natural behaviour in the animals. Yet none were also either the legal requirement of 2 metres off the ground, most were at average eyeline height meaning around 1.5 metres. Plus, even the best next boxes were open at the side towards the public onlookers at eye-level (n=18; 52.9%) (χ^2=54.3 P<0.01 Significant). Only one plantation had no box or platform of any kind for the animals in their cages (see 4th image from left, 2nd row in Figure 31). The issues towards the welfare of the animals is discussed in Chapter 7.3.

7.2.4. Information, education and facilities available to the customers in kopi luwak plantations

- *What Indonesian legislation and religious code of practice is there related to kopi luwak production?*

All kopi luwak plantations (n=34) provided a free tour and verbal presentation from staff present within the establishments. All guides spoke English, though 23.5% seemed to rush their scripted presentation (χ^2=0.1 P>0.01 Not Significant). Accuracy issues arose in some information provided and due to some limited English, not many additional questions could be asked beyond the script. Most presenters (76.5%) gave guidance at a good pace that was largely or completely accurate (χ^2=59.8 P<0.01 Significant). Only one presenter provided not only excellent English but also excellent customer service with only one statement of inaccuracy related to the civets' natural diet. This guide, among 13 guides that referred to civets as "*vegetarian*" (38.2%) (χ^2=16.6 P<0.01 Significant) (Table AA) though as her establishment didn't have any civets at the time of the visit, it can be assumed that she had chosen to compensate with customer service. Guides also referred to civets as sleeping in the daytime (and one even saying they sleep with their eyes open) and that they let out at night and return to their cages in the morning where staff then lock them in.

Education gained from plantations was mostly or entirely focused on guides knowledge and presentations. There were typically an absence of written warning and educational signs related to customer safety (absent in 82.4% of plantations) and origins of kopi luwak, with 64.7% of plantations with no information at all (Table AA) (χ^2=29.6 P<0.01 Significant). Simple signs in one language were represented 35.3% and always in English (χ^2=23.0 P<0.01 Significant). Plantations provided written education in the coffee shop areas and represents expected clientele, these paragraphs in the menus were either in English (38.2%) (χ^2=16.6 P<0.01 Significant) or in combinations of English along with Russian, Chinese, French, Dutch and/or German (44.1%) (χ^2=20.6 P<0.01 Significant) (Table AA). None of the coffee shop information was in more than these languages, six

Table AA: Information provided to customers in civet cages in kopi luwak plantations visited in Bali, Indonesia during 2013-14 and 2018. Actual number of plantations recorded (percentage)

	Category of Information available to the public (see Table F for key)							
Information Category	**0**	**1**	**2**	**3**	**4**	**5**	**n/a**	**Total Plantations**
Details on civets	6 (17.6)	10 (29.4)	13 (38.2)	3 (8.8)	2 (5.9)	0 (0.0)	0 (0.0)	**n=34**
Education Signs	22 (64.7)	0 (0.0)	2 (5.9)	10 (29.4)	0 (0.0)	0 (0.0)	0 (0.0)	**n=34**
Quality of Guide information and Customer Service	0 (0.0)	0 (0.0)	8 (23.5)	19 (55.9)	6 (17.6)	1 (2.9)	0 (0.0)	**n=34**
Warning Signs	28 (41.2)	0 (0.0)	2 (5.9)	4 (11.8)	0 (0.0)	0 (0.0)	0 (0.0)	**n=34**
Totals	**56 (41.2)**	**10 (7.4)**	**25 (18.4)**	**36 (26.5)**	**8 (5.9)**	**1 (0.7)**	**0 (0.0)**	

plantations had no information of this type at all (17.6%) (χ^2=0.3 P>0.01 Not Significant). Most information only explained Kopi luwak's origins, characteristics or alleged medicinal qualities (67.6%) (χ^2=21.1 P<0.01 Significant) with 14.7% including additional basic information about the Asian palm civet (χ^2=0.3 P>0.01 Not Significant) (Figure 34). One plantation went further with their information on the alleged medicinal qualities of Kopi luwak with a four page (English only) itemised literature review (Figure 35).

7.2.5. Quantities of Kopi Luwak for Sale in Agro Wisata

- *What extent is kopi luwak produced and how many Asian palm civets are included within it?*

One fundamental marketing myths that surrounds kopi luwak is its rarity (see Chapter 7.1.3) (Taphanel, 2009; Kwok, 2013; Wild, 2013; D'Cruze, *et al.,* 2014). Law no.37 implies that only 100% pure kopi luwak can be named such, so we can assume what is on sale as kopi luwak has not been diluted (Peraturan Menteri Pertanian Republik Indonesia, 2015). The onsite shops (n=34) were assessed for kopi luwak quantity on sale. Each shop contained own brand own label kopi luwak from single serving sachets through to one-kilogram foiled bags. Kopi luwak quantity in 2013-14 totalled 109.9 kilograms (average of 18.3kg per shop; n=6). In 2018, the average content was 13.1 kilograms (range 0 to 54 kilograms; n=29 shops) overall yielding 446.4 kilograms. Shop content (year 2018) represents between 63.8% to 351.5% of the annual production of kopi luwak claimed (Taphanel, 2009; Kwok, 2013; Wild, 2013; D'Cruze, *et al.,* 2014). Extrapolating 2013-14s higher average results to the same as 2018 results in 593.2 kilograms of kopi luwak or 84.7 to 467.1% of the claimed annual output (Taphanel, 2009; Kwok, 2013; Wild, 2013; D'Cruze, *et al.,* 2014). Kopi luwak is common in Bali and there are at least 61 plantations on the island. Extrapolating quantity of kopi luwak to 61 plantations yields between 801 kilograms (114.4% to 630.7% of the claimed annual yield) and 1,116.8 Kilograms (159.5% to 879.4%). Plantation staff were asked how much kopi luwak their plantation produces per year, this accumulated yields 8,651 Kilograms (298.3kg per plantation per year) (range: 10-2,922kg per year). The average per civet calculates to 69.2 kilograms per year or 189.5 grams per day. The quantity of kopi luwak in the shops would make between 29,000 to 39,000 cups of kopi luwak with an Indonesian value of IDR 1,488,133,33 to 1,977,300,000 (around £80,500 to £106,800). In Europe or USA and sold for £50 (US$65) per cup the value is massively increased to £1.6 to £2.1 million (US$2.0-2.7 million).

Figure 34 has been removed from this version of the thesis due to copyright restrictions

Figure 34: Education materials examples within a coffee shop menu in kopi luwak Plantations in Bali, Indonesia, .

Figure 35 has been removed from this version of the thesis due to copyright restrictions

Figure 35: Education materials with emphasis on the alleged medicinal qualities of kopi luwak within a coffee shop menu in kopi luwak Plantations in Bali, Indonesia, .

7.3. Discussion

- *How does the Indonesia coffee industry function and how was kopi luwak born from this?*
- *What Indonesian legislation and religious code of practice is there related to kopi luwak production?*
- *What extent is kopi luwak produced and how many Asian palm civets are included within it?*
- *How are Asian palm civets procured and kept within kopi luwak production?*
- *What if any are the welfare issues identified for Asian palm civets in the kopi luwak production?*

7.3.1. Standards of housing and husbandry in Kopi luwak plantations

Kopi luwak plantations are in principle zoological establishments where the focus of the business is in a single species, although many plantations house other species additional to civets (Figure 27). Zoo Reach describes this type of facility "*fauna parks*" (Zooreach.org, n.d.) and links their obligation to contribute to conservation efforts, welfare improvements, research and education. Specifically referenced is a decree of the minister of forestry and plantation, number 479/Kpts-11/1998; the section of particular interest is Article 4 and translates as follows (Kutilang, 2011):

The criteria for being able to be designated as a Zoo are as follows:

a. as an ex-situ conservation institution that carries out maintenance and maintenance business collection of various protected and unprotected species of animals' laws and or CITES (Convention International on Trade) provisions Endangered Flora and Fauna Species) in the context of conservation efforts.
b. breeding wild species in conservation efforts, in particular for endangered species.
c. *as a means of protection and conservation of nature, education, development of science knowledge and research, as well as healthy recreational facilities.*

In 2015, Indonesia introduced Law 37 legislation for the regulation of the roadside tourist sites known as Agro Wisata and the wider kopi luwak industry to set standards of animal welfare under pinned by the five animal needs (five freedoms). This is further backed up by the older laws for harvesting species from the wild, animal welfare in relation to food production and (Flevin, 2003; 2009; Peraturan Menteri Pertanian Republik Indonesia, 2015). Despite the legislative structure providing standards for keeping civets for kopi luwak production, none of the Agro Wisata surveyed met all legal requirements (Flevin, 2003; 2009; Peraturan Menteri Pertanian Republik Indonesia, 2015). Main infringements of legal kopi luwak production requirements were in provision of housing that meets or exceeds the 18 metres^3 specified, with a enclosed shelter at 2 metres high, has a concrete base to a wire cage with double door access, with drainage and the

provision of suitable hygiene programme and nutritional provision (Peraturan Menteri Pertanian Republik Indonesia, 2015). The cage sizes stated by Carder, *et al.,* 2016 (visited in 2013) and also 6 plantations *in scripta* also visited in 2013-14, predates Law 37's authority yet visits in 2018 also found that the majority of housing remained under legal size requirement. Using the size categories set from Carder, *et al.,* (2016) suggests 58.8% are a suitable size, this isn't now the case as now up to 95% of civet cages observed are too small. No cages were large enough for the communal size (225 metres^3) stated in Law 37 (Peraturan Menteri Pertanian Republik Indonesia, 2015). It can also be said here that the law requires a cage one third of the size for a breeding pair than for a single animal and it is believed that cages containing more animals should be larger than those containing singles (Young, 2003; Kleiman, Thompson & Kirk Baer, 2010). Rozhnov & Rozhnov, (2003) utilised cages from 7.1m^3 for single civets, 14.3m^3 for paired animals and 72m^3 for groups up to 3 civets. Whilst the small cages probably don't allow the promotion of fuller behavioural repertoire and wouldn't be legal if used in Indonesia, the largest cages are a significant improvement on those in Kopi luwak plantations.

The wire mesh and timber slat floors also are the most likely to cause entrapment, abraision or laceration injuries to the animals and therefore are not recommended for use (Carder, *et al*., 2016). The concrete whilst legal requirement and more hygienic, rates second to the natural substrate for promotion of natural behaviours in the animals and naturalising enclosures with live vegetation (Young, 2003; Kleiman, Thompson & Kirk Baer, 2010). Hygiene could have been mitigated using a disposable natural absorbent bedding on top of the concrete floor that could have contributed also to hygiene and husbandry practices however though was not recorded in any plantations (Young, 2003; Kleiman, Thompson & Kirk Baer, 2010; Carder, *et al*., 2016). Legislation (Peraturan Menteri Pertanian Republik Indonesia, 2015) states that rooves on enclosures need only be required on quarantine/isolation facilities yet nearly all observed enclosures recorded had at least partial plastic rooves through to higher standard metal or thatched rooves. The provision of the roof will mitigate some of the discomfort from most weather conditions and afforded by the lack of standards in the remainder of the housing, though as a rule the poor standard of housing and enrichment is detrimental to the health and welfare for the civets within. Rain could flood ground level cages due to lack of channelled drainage from the rooves and could lead to injuries to animal's feet and increased disease risk. Rain falling on metal or plastic sheeting rooves may be noisy and disturbing to the animals in the cages beneath, therefore a pitched tiled roof would be preferable versus metal or plastic sheeting (Young, 2003; Kleiman, Thompson & Kirk Baer, 2010; Carder, *et al*., 2016).

The lack of behavioural and environmental enrichment in all housing observed, the inadequate amount of space with in enclosure, the lack of arboreal enrichment equipment and the lack of suitable shelter for sleep away from public view means that the animals are significantly more prone to develop stereotypical behaviours such as pacing and looping, being awake abnormally during the day and developing behaviours resulting in self-harm (Clubb & Mason, 2007; Peraturan Menteri Pertanian Republik

Indonesia, 2015; Carder, *et al*., 2016; Rose, 2017). As shown *in scripta* cages that are barrien and too small will cause detrimental affects on animals' wellbeing, welfare and, where animals are housed together, will likely cause conflict between individuals resulting in stress and injuries observed in kopi luwak plantations and also reported in musang lovers facebook pages (see figures 22 and 30 *in scripta*) (Young, 2003; Kleiman, Thompson & Kirk Baer, 2010). Poor environmental conditions are likely to lead to poor health, reproductive success and earlier death (Carder, *et al*., 2016; Clubb & Mason, 2017). It is well documented set of problems in the kopi luwak plantations (Carder, *et al.,* 2016; Topsfield, 2016; Cahill, 2017) and observed in the visits here too. Cahill (2017) claims that trappers whom source civets for kopi luwak believe they are saving the animals from death at the hands of farmers whom consider the animals as crop pests and that captivity is beneficial, on the contrary, captivity causes zoochosis in civets (Wild, 2013; Carder, *et al.,* 2016; Clubb & Mason, 2017).

Single spot check visits to kopi luwak plantations as conducted will not indicate consistency in routine husbandry like cleaning and feeding practices. There were some indications that cleaning was not carried out thoroughly on a daily basis and also that feeding and watering of the animals was neither hygienic or varied as required by the legislation (Peraturan Menteri Pertanian Republik Indonesia, 2015). A simple failing would be the lack of availability of an *ad-libitum* supply of fresh water to the animals, a fundamental minimal essential and was also consistent with the findings of Carder, *et al.,* (2016) and Lewis-Whelan, *et al.,* (in prep), showing that this failing was commonplace. The lack of food in enclosures could be as a consequence of total consumption by the animals since morning or previous evening feeding. As none of the animals were condition scored at any score lower than 3 (the ideal), it does suggest that they are fed adequately in quantity. What is unknown however is whether the diet is balanced and promotes long term health or whether diet regime is focused on producing kopi luwak to the detriment of the animals' nutrition (Flevin, 2003; 2009; Peraturan Menteri Pertanian Republik Indonesia, 2015; Carder, *et al.,* 2016; Lewis-Whelan, *et al.,* in prep). Feeding can promote normal foraging behaviours in animals, and by being active in feeding enrichment endeavour can reduce occurrences of stereotypic behaviour (Young, 2003; Kleiman, Thompson & Kirk Baer, 2010; Carder, *et al.,* 2016; Wagman, *et al.,* 2018). With the cage design, lack of enrichment and poor hygiene, the feeding for excellence in welfare cannot occur. The issues with diet are also exacerbated by the apparent knowledge of guides in the plantations in either not providing enough depth to their clients or in too many cases, providing information about civets' natural diet that is inaccurate, especially referring to civets as vegetarian when diet plans that are in the legislation clearly eludes to the species being omnivorous (Peraturan Menteri Pertanian Republik Indonesia, 2015; Carder, *et al.,* 2016) as does several other literature sources (Bartels, 1964; Joshi, *et al.,* 1995; Jothish, 2011; Zaki, 2018). Indications could suggest that the reason several guides believe that the civet is herbivore is that the animals in these plantations do not receive meat in their captive diet. If this is the case it is contrary to the legal requirements (Peraturan Menteri Pertanian Republik Indonesia, 2015). Another infringement is the duration that civets are kept for in captivity for Kopi luwak production. Law no.37 states that civets should be released after 5 years via soft release in to wild or transferred to the pet trade (Peraturan Menteri Pertanian Republik Indonesia, 2015). Guides claim that many civets are kept for their entire lives of around 15 years whilst

Tony Wild identifies incidences where civet's restricted captive diet in producing kopi luwak has a detrimental affect on the health and longevity of the civets. It is unlikely that civets suffering malnutrition would survive to an age where they could be rehomed or released. More training of staff is highly recommended to mitigate inaccurate civet welfare knowledge and lead to legislative compliance (Carder, *et al.,* 2016).

In respect to the general animal welfare and husbandry standard on display in kopi luwak plantations, it may not be enough to legislate standards for plantations to meet voluntarily (Thiermann & Babcock, 2005). It may be necessary to introduce a licencing scheme as enforcement for plantation standards and to promote excellence in animal welfare. Carder, *et al.,* (2016) called for an international regulatory body for the inspection and sanction of the kopi luwak Industry, yet this also needs be on a national level also and also throughout Asia followed by globally for the other species used in animal digested coffees (Thiermann & Babcock, 2005). Enforcement should take the guise of periodic inspections of facilities by suitably qualified persons with the authority to enforce the replacement of substandard housing and training of staff both caring for the animals directly and providing education to the public. Plus, inspectors should possess authority to close facilities and seize animals that are either not cared for in the correct manner or where plantations are procuring animals from wild rather than captive bred sources and exceeding numbers that they are authorised to keep. Furthermore, checks should be able to determine whether producers are misleading consumers by labelling kopi luwak from wild civets, when the source is from caged animals (Thiermann & Babcock, 2005). Once the local standards are in place then certification can follow and umbrella regulatory bodies so that consumers have confidence that the products purchased are high welfare, high quality and traceable (Thiermann & Babcock, 2005). The UTZ and Rainforest Alliance both have certification scheme frameworks that could modified to rollout to certify kopi luwak across Asia (UTZ, 2017). Perhaps the World Association of Zoos and Aquariums (WAZA) could provide animal welfare policy framework.

Education of the public is an intrinsic part of a modern animal collection not just recreation (Young, 2003). EAZA states that education is key to informing and enthusing people about species and their conservation (Kleiman, Thompson & Kirk Baer, 2010). Educational materials can take many forms in an establishment including written materials such as signage and displays, leaflets, banners; audiovisual presentations can inform visitors with recorded images and speech. Other verbal means of education includes guidance and presentations from trained staff and animal keepers. The focus of education by definition to inform and enlighten to remove confusion and mystic about a topic, in this instance the behaviour and ecology of the Asian palm civet and origins of kopi luwak (Young, 2003; Kleiman, Thompson & Kirk Baer, 2010; Carder, *et al.,* 2016). The institutions also have the opportunity to (as Law no.479 states) to offer "*protection and preservation of nature, education, development of science knowledge and research, as well as healthy recreational facilities*". It has been shown that Kopi luwak plantations fail in the responsibility to provide accurate and detailed education of the public as well as contributing positively towards

conservation efforts, in actual fact, practices towards sourcing of animals for Kopi Luwak plantations is doing harm to individual animals and is likely to be harming wild populations (Carder, *et al.,* 2016; Lewis-Whelan, *et al.,* in prep).

7.3.2. Conservation of civets in the wild

As reported in 7.4.3. caged civet populations in Agro Wisata are sourced from the wild in more than 96% of cases and the numbers of civets in Bali's kopi luwak trade could be around 25% of all the Asian palm civets wild in Bali. Depletion of the wild population in localised areas or on an island could cause disruption to ecological processes and biodiversity. It is clear from the results here that the quota for harvest of wild civets is also disregarded by the kopi luwak industry as it is with the trade for pets. Whilst relatively small numbers of civets are housed in the plantations surveyed individually there are high numbers of plantations particularly in Bali (n=61 at least). There are suggestions by plantation staff that there are other facilities that are not open to the public and these facilities are actually producing the kopi luwak available in plantations and not the plantations themselves. The industry is likely to be causing detrimental harm to the local populations of civets in Bali, Java and Sumatra particularly, though the kopi luwak industry is more likely to be damaging to Balinese civets owing to the smaller population on a smaller island. Trapping civets for kopi luwak if left unregulated is unsustainable and a threat to the civet population density in Bali that may lead to extinction of the species on the island. The extent of depletion of populations and the threshold at which civets might become endangered and therefore struggle to recover is unknown (Carder, *et al.,* 2016). As also some Kopi luwak producers are also unseen by the public, the housing standards that the animals kept in and the husbandry and welfare of the animals is even more likely to be substandard and in contravention of law 37.

Shepherd (2008) indicates that biologists have recorded ten species of civet in Indonesia. In the pet trade of Viverridae in Indonesia presented in Chapter 6 showed five species of civet and two further Viverridae that all could be species kept also for the production of kopi luwak (should they partake in a, at least partially, frugivorous diet), yet the study *in scripta* here only shows Asian palm civet in the Agro Wisata plantations in Bali, Indonesia and no other viverrid species is represented. Why this is the case may be due the lower availability of the other species in Bali. Unlike the pet trade that is starting to breed its own population in captivity to contribute to the specimens procured from the wild, the kopi luwak plantations almost exclusively are capturing wild civets. According to the IUCN red list data only the Asian palm civet and small Indian civets have populations on Bali, the other species occurring on other islands west of Bali (Choudhury *et al.,* 2015; Duckworth, Mathai, Chutipong, *et al.*, 2016; Duckworth, Mathai, Wilting *et al.,* 2016; Duckworth, *et al.,* 2016c; Duckworth, Timmins, Chutipong, *et al.*, 2016; Willcox, Chutipong, *et al.*, 2016; Willcox, Duckworth, *et al.,* 2016). It can be said that the Balinese kopi luwak production is localised and only utilises the species that are readily available. It is likely that the other species could be utilised in Java and Sumatra where wild populations of the other species can be resourced.

Despite being available to kopi luwak plantations in Bali, the small Indian civet is not recorded in any of the forty visits made to plantations *in scripta*. Perhaps the small Indian civet is less frugivorous than Asian palm civets therefore less productive and viable in producing kopi luwak. An additional reason why they are potentially underutilised is that there is probably a lower population density for small Indian civets akin to findings *in scripta* in Java, therefore the ability to trap them is less than for Asian palm civet. In the IUCN accounts for each of the seven viverrid species found in the pet trade (Chapter 6) only binturong and Asian palm civet are indicated as used in the kopi luwak production whilst small Indian civet, Asian palm civet, small-toothed palm civet and binturong are stated as traded (and potentially threatened) as exotic pets (Choudhury *et al.,* 2015; Duckworth, Mathai, Chutipong, *et al.,* 2016; Duckworth, Mathai, Wilting, *et al.,* 2016; Duckworth, *et al.,* 2016c; Duckworth, Timmins, Chutipong, *et al.,* 2016; Willcox, Chutipong, *et al.,* 2016; Willcox, Duckworth, *et al.,* 2016). Cahill (2017) states that the small-toothed palm civet (*Arctogalidia trivirgata*), the masked palm civet (*Paguma larvata*), and the binturong (*Arctictis binturong*) are used by coffee producers to make kopi luwak, though does not suggest in which specific locations. Kopi luwak production is common in Bali, Java and Sumatra and what extent the trade here is also threatening wild civet and other small carnivore populations is yet to be determined and requires prioritisation. It has been discussed within this thesis and within other studies that civets are important seed dispersers, prey species, and predator so removal of them from habitats is likely to damage overall biodiversity (Rabinowitz, 1991; Pin & Tiong, 2008; Nakashima, *et al.,* 2010; Jothish, 2011; Nakabayashi, *et al.,* 2012; Fung, 2016; Zaki, 2018).

7.3.3. Kopi luwak as an employer

Agro Wisata and the wider production of kopi luwak in Indonesia especially in Bali offers a route into tourism related employment for local people (Cukier-Snow & Wall, 1994). Whilst no specific data was taken on the number employees work in each plantation though it is likely to be between two to twenty, even more for those plantations that are resorts and also incorporate a hotel and other amenities (Tripadvisor, 2016; Ijen plateau, 2020). There is a wider supply chain also indicated by guides who suggested that the kopi luwak in their shops within the plantations was produced by civets in other facilities in Bali and not open to the public. It is estimated in Bali that the kopi luwak industry provides direct employment for up to around a thousand people as guides, animal carers and baristas. There are likely to be significant additional links to hotels and tour providers around Bali that create excursions to the plantations. The plantation staff already possess very good skills in more than one language that should be applauded. It is expected that employment in kopi luwak related roles in Java and Sumatra are likely to at least equal if not exceed that in Bali due to the islands being much larger. Expanding the research on kopi luwak to more areas is needed to ascertain its extent and to understand how many people the industry supports (see Chapter 9). The plantations have a fantastic opportunity to provide education materials to their clients concerning civet ecology, animal welfare and kopi luwak. The difficulty arises in the range of languages which the tourists likely speak. Educational material by definition should

be prepared to advance knowledge and understanding of a subject therefore each plantation should hold materials in different languages that explains what a civet is, its distribution, diet, its general ecology, threats and uses. There should be details about the animals' captive environment and why its important and then details about the history and ethos of kopi luwak as a product. Only the details of kopi luwak to any degree of consistency was recorded, many with much the same wording. As the animal housing is substandard it is understandable that materials do not exist for this (Carder, *et al.,* 2016). Details of civets in the plantations is weak and lacking in any depth. More advancements are needed urgently in these areas to inform the public of the behavioural ecology of the species and to inform about the conservation value of the Asian palm civets (Carder, *et al.,* 2016).

7.3.4. Exploding the myth about production

One of the key mythologies that is part of the Kopi luwak brand is that there is a significantly low production annually of the coffee of between 127-700kg (Taphanel, 2009; Kwok, 2013; Wild, 2013; D'Cruze, *et al.,* 2014). Despite consideration that some estimates made by staff in Kopi luwak plantations may be a little exaggerated, it can be declared that the actual production of kopi luwak globally is far higher than what is claimed in the marketing mythology as claimed quantities are exceeded just from Bali alone (up to 1,116.8 Kilograms from Bali alone, *in scripta*), nevermind production in other countries and islands of Southeast Asia. Sumatra's production of kopi luwak is likely to be greater than Bali's. Whilst kopi luwak production may have been very low around 10 years ago the industrialisation of the product and the process has hugely increased productivity. There are reportedly larger plantations in Java as research on the online indicates there are as many as 300 civets captive in a kopi luwak plantation and breeding centre in North of Bandung (Tripadvisor, 2016) and another 20 and 80 in a hotel/plantation and factory in Blawan, Ijen plateau in Java (Ijen Plateau, 2020), plantations in Bali often reported facilities in Kintamani that hold up to 500 civets for the production of civet coffee (*in scripta*). There are around 200 civets in a company called PT Perkebunan Nusantara XII that claims 200 civets producing 8 tons of Kopi luwak per annum (realised in 2011 and projected for 2012) (BUMN, 2012). The myth cannot be supported on a local level never mind a global scale, and the claim should be debunked. With a greater production of kopi luwak than originally claimed the resulting price that the coffee can be marketed at must be reduced. The implication from a lower market price may subsequently cause some of the plantations to go out of business, inherently there is a saturation point of kopi luwak businesses that will cause production to plateaux. It will be certainly higher however than the claimed maximum currently of 700kg per annum, whether the myth will be amended remains to be seen, yet maintaining it means that customers are knowingly deceived as they are also with the mislabelling as wild kopi luwak when it is invariably from caged animals (Thiermann & Babcock, 2005; Peraturan Menteri Pertanian Republik Indonesia, 2015). Without enforcement of laws, standards, welfare codes of practice, species conservation and transparent ethical trade regulations, kopi luwak should not have the high value status that it does and therefore certification and validation is null and void.

GENERAL DISCUSSION AND CONCLUSIONS

8. GENERAL DISCUSSIONS AND CONCLUSIONS

The frequency of occurrence of species in camera trap images may well explain in part why densities of different carnivore species in the trade and kopi luwak producers are also biased towards Asian palm civet (Shepherd, 2008; Shepherd, 2012; Shepherd & Shepherd, 2010; Jennings & Veron, 2011; Nijman, *et al.,* 2014; Rode-Margono, *et al.,* 2014; Carder, *et al.,* 2016; Lewis-Whelan, *et al.,* in prep). The Asian palm civet was neither rare in the wild, in *Musang Lovers* photos, in survey or in markets or plantations (*in scripta*). Throughout Indonesia, the pet trade, deforestation and other anthropogenic changes to habitat is damaging populations of the rarer mesocarnivore species (Eaton, *et al.,* 2008; Rode-Margono, *et al.,* 2014; Ross, *et al.,* 2015; Chutipong, *et al.,* 2016; Duckworth, *et al.,* 2016a-d; Willcox, *et al.,* 2016). The trade as pets and for Kopi Luwak are significantly high with Asian palm civet more than any other carnivore probably reflected by populations in the wild (Shepherd, 2008; Shepherd, 2012; Shepherd & Shepherd, 2010; Nijman, *et al.,* 2014; Rode-Margono, *et al.,* 2014; Carder, *et al.,* 2016; Chutipong, *et al.,* 2016; Willcox, *et al.,* 2016a-b; Lewis-Whelan, *et al.,* in prep). Even though the Asian palm civet is considered common throughout its distribution, there is currently so much demand from the pet trade and from kopi luwak plantations that it cannot be believed that populations are not being reduced particularly in Java and Bali and almost certainly Sumatra also (*in scripta;* Shepherd, 2008; Shepherd & Shepherd, 2010; Shepherd, 2012; Nijman, *et al.,* 2014; Carder, *et al.,* 2016; Duckworth, *et al.,* 2016a-d; Lewis-Whelan, *et al.,* in prep). In their wild state and owing to civets omnivorous, largely frugivorous, natural diet; civets could hold a substantial role in regeneration of Indonesia's native forests through dispersal of viable seeds excreted (Joshi, *et al*, 1995; Roberts, *et al.,* 2007; Jothish, 2011; Fung, 2016). Removal of civets from the wild for use in the kopi luwak trade and as exotic pets may harm future biodiversity (and densities of the rarer mesocarnivores also) in native landscapes resulting in a lower resistance to: anthropogenic change, regeneration following timber harvesting, changes of use, burning and deforestation (Rode-Margono, *et al.,* 2014; Chutipong, *et al.,* 2016; Fung, 2016).

It needs to be noted here also that according to the IUCN Red list, the masked palm civet (Duckworth, *et al.,* 2016d) is not present and the small-toothed palm civet (Willcox, *et al.,* 2016b) is extremely localised in the wild in Java though it is regularly present in the pet trade on this island. If these animals are traded from wild capture in Java it indicates that they are transported regularly from island to island. It is unknown how much animal's mortality rate is affected by trapping, trade and translocation practices. It has been shown that the Javan landscape can and does support multiple species of small carnivores, alongside primates and larger carnivores too (Nijman, 2005; Rode-Margono, *et al.,* 2014; Nekaris, *et al.,* 2017). It is believed that coexistence is attained via separation of niche by at least temporal means, yet communication occurs interspefically and intraspecifically by scent marking of mutual used deposition sites (Wemmer, 1977; Ralls, 1971; Gorman & Mills, 1984; Kruuk, 1992; Sillero-Zubiri & Macdonald, 1998; Rozhnov & Rozhnov, 2003; Zala, *et al.,* 2004; Roberts, *et al.,* 2007; Müller & Mancer, 2008; Kean, *et al.,* 2011; Soso, *et al.,* 2014). It is unknown how these social scent marks are perceived by species, though as on no

occasion there were two different species on scent marking sites together, its probably that scent marks are perceived by species to displace them from an area when scent marks are fresh, though when scent marks degrade scent mark is renewed (Ralls, 1971; Gorman & Mills, 1984; Kruuk, 1992; Sillero-Zubiri & Macdonald, 1998; Rozhnov & Rozhnov, 2003; Zala, *et al.,* 2004; Roberts, *et al.,* 2007; Müller & Mancer, 2008; Kean*, et al.,* 2011; Soso, *et al.,* 2014). As the slow loris and Asian palm civet often use overhead waterlines to navigate around home ranges and that useage has shown to be as little as 5 minutes apart it can be assumed that there is little or no threat displayed between the two species (Spaan, *et al.,* 2014). It potentially cannot be said for the yellow throated marten however, despite having arboreal capability akin to civets, these the marten was never recorded on the waterlines. As the marten occurred much less frequently on camera trap images than the Asian palm civet, the lack of waterline images could be due to a general lack of density of the marten compared to the civet or the civet could be more dominant a species than the yellow throated marten and therefore displacing them. It has been determined from the camera trap images that the civet is nocturnal and the marten crepuscular; so, the need for the civet to displace the Marten is reduced. The low density of the yellow throated marten could be explained by a less suitability of the habitat for the species and the Asian palm civet being more adaptable to various habitat types that the marten and other small carnivores (Chutipong, *et al.,* 2016; Hon, *et al.,* 2016).

On the outset of research, the Asian palm civet was believed to be primarily threatened by the kopi luwak trade in Indonesia and that the pet trade in the species was secondary to this. The two trades are now believed to be even more extensive than originally supposed and is still increasing and potentially threatening to localised populations of civets especially in Java and Bali (Nijman, *et al.,* 2014; Carder, *et al.,* 2016; Lewis-Whelan, *et al.,* in prep). The recent reclassfication of Javan and Baliese Asian plam civet from *P. hermaphroditus* to *P. musangus (*Patou, *et al.,* 2010; Veron, *et al.,* 2014*)* has resulted in decreasing the distribution thus population density available to the kopi luwak and pet trades, therefore removing individuals from the wild at the current extent will now have an even greater affect on the continuity and viability of populations. Major growth areas of trade appear to be via social media especially Facebook and continues to be significant in animal markets (*in scripta*). Furthermore, (and consistent to the findings of Shepherd (2008; 2012); Shepherd & Shepherd, 2010) the pet trade in Indonesia is highly likely to be threatening towards populations of several other species of small carnivores including: small Indian civet (*Viverricula indica*), small-toothed civet (*Arctogalidia trivirgata*), masked palm civet (*Paguma larvata*), Malay civet (*Viverra tangalunga*), banded linsang (*Prionodon linsang*), binturong (*Arctictis binturong*), leopard cat (*Prionailurus bengalensis*), Javan mongoose (*Herpestes javanicus*), Asian short clawed otter (*Aonyx cinereus*), yellow throated marten (*Martes flavigula*) and Javan ferret badger (*Melogale orientalis*) as all of these were either recorded in the animal markets or in posted images from *Musang Lovers* sites (*in scripta*). Trade in all these species, like their wild ecologies and population densities, is little known and research is very much needed so mitigation measures can be developed should they need protection (Nijman, *et al.,* 2014; Carder, *et al.,* 2016; Lewis-Whelan, *et al.,* in prep).

It is also now believed that the kopi luwak and pet trades are largely separate entities that independently harvest individual civets from free roaming wild civet populations, the kopi luwak trade harvesting directly and the pet trade harvesting via the markets into private ownership (*in scripta;* Shepherd, 2008; Shepherd & Shepherd, 2010; Shepherd, 2012; Nijman, *et al.,* 2014; Carder, *et al.,* 2016; Duckworth, *et al.,* 2016a-d; Lewis-Whelan, *et al.,* in prep). The kopi luwak trade in Bali at least seems predominantly interested in the use of Asian palm civet, despite other frugivorous civets being not only available but also reportedly used elsewhere (Carder, *et al.,* 2016; Cahill, 2017; Lewis-Whelan, *et al.,* in prep). The other species mentioned above are not typically included in the kopi luwak plantations, neither data *in scripta* or Carder, *et al.,* (2016) recorded any species other than Asian palm civet, only Lewis-Whelen, *et al.,* (in press) found three other civet species. Additionally, Cahill (2017) discusses the use of bintourong in production of Kopi luwak. There is no evidence *in scripta* for the use of Sunda stink badger (*Mydaeus javanesis*), otters, Javan mongoose and yellow throated marten in production of Kopi luwak y*et al*l but the Sunda stink badger have been recorded in the pet trade. Otters such as Asian short clawed otters (*Aonyx cinereus*) are speculated as increasingly common as pets yet the IUCN lists threats as mainly due to poaching, skins, and anthropogenic changes to habitats (Wright, *et al.,* 2015).

Trade was largely either directly from the wild or has moved to captive breeding and trade between members of owners' clubs at club meetings or via internet sales (*in scripta*). As shown *in scripta* domestication has begun in Asian palm civets that is not seen in other species so trade in captive bred animals has been likely occurring for longer than other species. It is likely that emerging domesticated breeds yield a higher retail price than wild type pelages. The wild trade however is still significant and rising to meet demand, contrary to restrictions set out in the harvest quotas (see Table I *in scripta*). The notable exponential increase in *Musang Lovers* clubs and membership over recent years shows that the Asian palm civet is now a popular, mainstream and widespread exotic pet in Indonesia, fuelling the demand (see Table L *in scripta*). In 2016 it was reported that around 10,000 civets are in pet ownership in Indonesia (Arshad, 2016), with the huge increase in popularity, more *Musang Lovers* clubs and consequently more members, today's captive population is considered very much higher, even over 1 million animals. Evidence are that owners regularly meet to show specimens for prizes under categories such as best of breed, age brackets and best in show for example (see Figure 20 *in scripta*). Showed species include: Asian palm civet, small Indian civet, small toothed civet and masked palm civet. Also, there is now formulated civet specific foods available (See Figure 25 *in scripta*) meaning that the pet food companies have identified this as profitable market themselves. Surely this would not be the case if there were still just a few tens of thousands of civets as pets?

Conditions of husbandry, housing and enrichment in animal markets, pet trade and kopi luwak plantations all require review, standardisation, improvement and legalisities enforcing with a matter of urgency otherwise should be forced to cease trading. Current standards of welfare for keeping exotic pets in Indonesia promotes poor housing, poor diet regimes for animals, poor hygiene and has a negative effect on the behavioural repertoire of species leading to cage related psychosis and likely premature death (*in scripta;* Shepherd,

2008; Shepherd & Shepherd, 2010; Shepherd, 2012; Nijman, *et al.,* 2014; Carder, *et al.,* 2016; Lewis-Whelan, *et al.,* in prep). Part of the issue surrounding the trade and care of animals is that many owners appear to be first time owners of the species and few guidance and educational materials available to advise prospective owners on husbandry, minimal standards and owners' responsibilities. The *Musang Lovers* pages on Facebook will aid with processes of dissemination of information, though equally misinformation could just as quickly be spread. There is likely to be a much more significant trade in animals in Indonesia via the internet and especially via social media pages such as *Musang Lovers*. This is near impossible to sufficiently monitor and legislate and just as difficult to evaluate extent and the impact of founding rules (Nijman, 2010).

Animal markets in Indonesia are establishments liable for the vectoring of disease and parasites intraspecifically and interspecifically and possibly also zoonotically (Kan, *et al.,* 2005; Roberton, *et al.,* 2006; Moutou & Pastoret, 2010; Clark, 2012). The lack of suitable housing standards in these establishments provides limited or no barrier to proliferation thus a threat to animal and human health alike (Nijman, *et al.,* 2014). In addition, not all of the five animal needs are consistently met and often are completely disregarded (Nijman, *et al.,* 2014). As before there are animal welfare laws in existence that outline standards specifically in reference to the five needs as detailed in results *in scripta.* As before however, little or no enforcement of the law to drive to higher welfare standards and nor enforcement of trade restrictions and conservation legislations. The result being the continued existence of appalling, inhumane and often illegal markets that openly trade in not only traditional pet species but also in wild animals as exotic pets regardless of origin, health and condition of animals, viability of age of specimens, conservation status or legal quotas meant to govern the numbers being traded (see Tables L and Q *in scripta*).

What is greatly apparent from images on Facebook, from visits to kopi luwak plantations and from surveys in animal markets that the cage dimensions used to house civets are fundamentally unsuitable for housing civets and other similarly sized carnivores. Any owner considering purchasing a civet as a pet should or for kopi luwak be prepared to house their animals in cages that meet the minimum dimensions set out in Law no.37 (Peraturan Menteri Pertanian Republik Indonesia, 2015) of at least 18 metres^2 (2 metres x 3 metres x 3 metres) for single animals, that these cages should be cleaned and disinfected daily and for cages to be enriched with multiple branches and platforms for climbing with a fully enclosed nest box at 2 metres above the ground and other vegetation in aid to reduce the promotion of stereotypic behaviour in the animals and allow the animals to exhibit their nocturnal activity period as confirmed in wild civets (*in scripta*). No cages should have wire or timber slates for the floor. Nest boxes should be lined with soft absorbant bedding materials that can be readily disposed of daily as a means of promoting good hygiene. Materials suggested are hay, straw or the leaves of banana plants or bamboo for example. If the animals live in outdoor enclosures these should be roofed with pitched thatch or tile to channel rainwater into drainpipes and guttering (Peraturan Menteri Pertanian Republik Indonesia, 2015).

Animals should be fed twice daily on a varied diet regime from both animal and plant sources and have this provided to them along with water in hygienic containers. Animals should be monitored at least weekly for signs of disease, disorders, parasites and for body condition (Peraturan Menteri Pertanian Republik Indonesia, 2015). Transport housing could utilise cages typically used for domestic cats or small domestic dogs, though animals should only be temporarily housed in these and not, as would appear from Facebook, housed in them full-time. The animal welfare legislation and kopi luwak legislation exists to be able to administer these standards though enforcement is entirely incapable, unwilling or unaware of its responsibilities (Flevin, 2009; Peraturan Menteri Pertanian Republik Indonesia, 2015).

There are copious brands and varieties of coffee globally that are both delicious with several rare types that allow the wealthy to exercise elitest desires to possess exclusive coffees out of financial reach of others. Kopi luwak is one such (branded as rare type) of coffee that in it manufacture however involves subjecting animals to husbandry that does not demand and promote excellence in welfare (Abebe, 2003; Wild, 2013; Carder, *et al.,* 2016; Topsfield & Rosa, 2016; Cahill, 2017; Lewis-Whelan, *et al.,* in prep). As a luxury product kopi luwak is inheritantly unnecessary and even the involvement of the civets in its production is now obsolete as research has determined alternatives in bathing green beans in artificial gastric juice (Marcone, 2004). What is more appealing; coffee that has been bathed in chemicals to ferment it and alter its flavour, or the same process and additionally to have been excreted by an animal? Kopi luwak may lose its novelty value eventually though the trade in civets as pets will remain as a threat with greater longevity and greater capacity for destroying wild populations of civets with currently unknown detrimental effects on ecology and biodiversity (Abebe, 2003; Wild, 2013; Carder, *et al.,* 2016; Topsfield & Rosa, 2016; Cahill, 2017; Lewis-Whelan, *et al.,* in prep).

RECOMMENDATIONS FOR FUTURE RESEARCH AND POLICIES

9. RECOMMENDATIONS FOR FUTURE RESEARCH AND POLICIES

Population densities of civets and their sympatric carnivores are not well known despite being one of the worlds most widespread carnivore species. Some home ranges have been calculated in localised areas that suggests that civets occur at densities of up to 31.5 individuals per kilometre square (lower in anthropogenically changed habitats) (Heydon & Bulloh, 1996). Even less is known about the densities of the sympatric species that occur alongside the civets in the wild. It is therefore recommended to:

1) Conduct a multi-site programme of study to identify carnivore species *in situ* and to monitor and calculate home range sizes, identifying limits to habitat preferences and responses to disturbance for multiple species and population densities. It is recommended to select habitats and locations throughout Indonesia incorporating areas of higher and lesser human population density, natural and anthropogenically changed habitats and urbanised areas and to examine the effect of topography and climate. The IUCN red list entry for *Paradoxurus hermaphroditus* (Duckworth, *et al.,* 2016c) states that the population is Least concern but decreasing yet no definitive widespread population density estimates seem to be available (Heydon and Bulloh, 1996; Parikesit, Withaningsih & Prastiwi, 2019). Initially, the deployment of camera traps would identify species present and provide some details on habitat use, preferences, behaviour and temporal placement of species (as *in scripta*). This would provide the necessary resolution to select sites for traps to be set for a capture-mark-release-recapture programme to be implemented. Technology now enables detailed and accurate less invasive monitoring via neck worn collars with global position system tracking meaning the only invasive part of a study would be to capture, anaesthetise and fit the collars to specimens (Evans, Guerrero-Sanchez, *et al*., 2016). At this time there is the opportunity to take other data such as morphometrics, weight, samples for DNA analysis and scent samples from dermal exocrine glands. Marking animals on capture will aid in the identification of individuals (that are not collared) in camera trap images. Such marking technique could be ear tags as used by Seymour, *et al.*, (2017).
2) Utilising the GPS locations of specimens derived from collars would allow investigation of niche separation and overlap by exploring the territoriality and scent marking behaviours of different carnivore species. This will determine if there is any dominant species that displaces others and whether the habitat available and preferences for them determines the spatial and temporal ecologies of species.
3) Transects in habitats and locations of animals determined through camera traps and collars would aid in locating faecal material from focal species. These samples can then be assessed for diet content to define whether any further convergence or divergence of niche occurs between carnivore species.
4) The aforementioned scent gland samples should be assessed for chemical composition using Gas Chromatography Mass Spectrometry (GC-MS) analysis for different species that show mutual use of scent marking sites to ascertain whether communication occurs intra and interspecifically and what may be being conveyed. Speculation suggests that scent informs of animals' health status, hierarchical standing and reproductive receptivity. Use of GC-MS has almost exclusively been

used on kopi luwak with the aim to identify key markers that can be used to confirm provenance of coffees on the market as genuinely civet coffee. Research in this one area alone contributes a significant amount of civet related research (Marcone, 2004; Jumhawan, *et al.,* 2013; Özdestan, *et al.,* 2013; Jumhawan, *et al.,* 2015; Suhandy & Yulia, 2017). At this stage there is more concern for the conservation, welfare and husbandry of civets producing the coffee than for determining criminality in kopi luwak trade descriptions.

It is hugely apparent that the pet trade in civets and other small carnivores is on the increase and more urgent study is required to monitor animals in markets throughout Indonesia. Recommendations and priorities in this area are:

5) To determine if the estimations for the extent of civet pet trade within this thesis can be authenticated. There are many towns and cities in Indonesia that have not yet had their animal markets assessed. The pet trade in civets is also present in other areas of Asia and the wider world and this needs to be quantified also.
6) Once civet pet trade has been monitored for a wider amount of Indonesia it can be be shown with stronger evidence that the annual harvest quotas are disregarded, and that consultation needs to occur with government officials to propose and implement enforcement of conservation strategies across Indonesia. This cannot be done until the numbers of civets and other carnivores in markets are known and what the numbers are that are left in the wild. Current quota levels are both unachievable and unrealistic and urgently requires revision.
7) The runaway wildlife trade in Indonesia is a likely source of zoonotic disease reservoirs and vectors, with outbreaks such as SARS and Corona virus linked to wildlife sources (BBC, 2020; Guo, *et al.,* 2020; Moutou & Pastoret, 2010; Clark, 2012), more enforcement of hygiene, husbandry, biosecurity and quarantine is necessary. This would require significant input from governments, government agencies, epidemiologists and the world health organisation, with significant inputs from researchers and universities studying wildlife trade. Animal markets in Asia need immediate closure and need to be entirely and significantly redesigned, shop keepers licenced, and inspections implemented. One such model for pet trade licencing could be the Pet Animals Act (1951) from the United Kingdom. Which restricts species sold, conditions kept in and to who animals can be sold.

The kopi luwak trade is also on the increase particularly in tourist areas in Indonesia and throughout Asia. Like with the pet trade, the extent to which the industry is likely affecting the civets' wild populations is not known enough and density models are needed to be determined to then open dialogue with authorities about excess harvest of animals from the wild and standards of animal welfare. Both the pet trade and kopi luwak trades provide significant employment for local people and any changes in policies and structures should ideally not decrease employment prospects for people. Measures for improvement of the kopi luwak industry could be:

8) Like with the animal markets, standards of hygiene, housing, welfare, conservation and biosecurity in kopi luwak plantations (agrowisata) needs addressing urgently. It

has become apparent through research that the standard of animal welfare is inadequate and poor care is widespread. Poor animal husbandry is extant in trade in kopi luwak. Despite laws already in existence for high standards of animal husbandry that includes the five animal needs that relate to pet animals, animals as food and specifically, it is decernable that enforcement of high animal welfare standards throughout the trade in civets and other carnivores is highly inadequate or even not in existence. Agrowisata need urgent orders to raise standards to meet or preferably exceed legislative requirements as outlined in Law 37 (2015). Failure to meet these requirements and show consistency in welfare and standards over time to be demonstrated to inspectors appointed by the government and local authorities. Any plantation/facility failing to meet requirements should be closed and animals seized.

9) Where jobs are lost through agrowisata closure, equally as many can be created by increasing the number of roles in monitoring and enforcement, education and in coffee certification roles. Staff from within the Industry probably know the industry the best and could be utilised in developing policies and education programmes for example. The current deception in the kopi luwak industry towards education of the public in respect to quantities of kopi luwak produced, medicinal properties and source (caged or wild) needs to end through Indonesia's own trade descriptions legislation and law 37 (2015).
10) There seems to be a lack of literature that provides an understanding of standards required and literature in the form of a care manual could be a means for prospective civet farmers, owners and existing owners to prepare suitable: housing, diet regimes, hygiene regimes, health care plans and enrichment that promotes natural behaviour in the animals in their care. Subsequent manuals can be sold in animal markets, pet shops, in breed shows and at *Musang Lovers* meetings as well as provided to owners of kopi luwak plantations to promote the significant increase of standards. The book published should be available in multiple versions to acknowledge the requirements of the various dialects and languages across Indonesia. It can then also be modified into other languages within Asia and to also represent animal welfare legislation in different countries.

Civets and other carnivores in all areas of captivity need to be provided with housing that enables and promotes normal behaviour, balanced diet, health care, natural activity patterns and husbandry that reduces fear, distress and reduces discomfort. This needs to be obligatory and enforced via the existing legislation. Further legislation may even be required towards licencing of businesses utilising civets and other carnivores (i.e. Kopi luwak plantations and animal market purveyors) to ensure that the animals' welfare is met consistently, hygiene is of high standard and that customers are guaranteed 'certified' Kopi luwak. If significantly higher standards are not enforced for the whole pet trade and markets, kopi luwak production, harvesting and for the animals in the wild, then carers and conservationists would be failing in their fundamental responsibilities. The result would be abject suffering in captive animals, and instability of ecosystems consequently leading to the reduction of wild biodiversity in Indonesia. Significant work needs to be done in Indonesia to raise awareness and enforce all of the national and international animal welfare and conservation legislation. National strategies and policies need to be disseminated locally and implemented with a matter of urgency to start to reduce the damage being caused and

the suffering at animals are experiencing. The dissemination needs to not only be for those people in authority but needs to filter down to the grassroots of Indonesian society.

11) Such legislation that is required (or needs potential modification) or needs enforcement includes:
    - Pet shop licencing and monitoring
    - Kopi luwak agro wisata licencing and monitoring
    - Kopi luwak trade legislation (exists in Indonesia since 2015; but unknown in other countries of Asia).
    - Trade legislation for greater management and regulation of pet trade via online sources.
    - Exotic pet ownership, possibly limiting ownership of wild animals without registration and monitoring of housing, husbandry and welfare standards.

Indonesia has recently legalised restricting research on its biodiversity and conservation to promote Indonesian students and researchers over non-nationals and prevent theft of samples and what Indonesia refers to as biopiracy (Rochmyaningsih, 2019). Non-native students that fail to seek appropriate permits could face fines and a prison sentence. This new law may restrict research being completed at all meaning that the intellectual property that Indonesia is attempting to protect is not created at all. Though it aims to create official acknowledgement of formal procedures for establishing collaborations between Indonesian and international researchers and institutions like exists in other countries (Rochmyaningsih, 2019). It means in at least in the short term as a response to pending punishments that reesarchers may be discouraged from proposing research programmes in Indoensia and therefore threats to wildlife, conservation, welfare, habitats and populations may not be highlighted in sufficient time to implement recovery measures. It seems that permits can only be sourced once researchers are already in Indonesia and that this process is time consuming, eating into available timescales for research to be completed. A potential amendment to this could be if:

12) Permits for research in Indonesia by non-nationals could be sort via Indonesian embassies in researchers home country who provide a liaison between researcher and authorities in Indonesia (e.g. Indonesian Institute of Sciences (LIPI)). This will mitigate the researchers taking the risk to conduct programmes in Indonesia without the collaborations and permits, improve the efficiency of research and reduce the concerns of institutions within Indonesia that they will be unable to establish international collaborations due to the new law (Rochmyaningsih, 2019).

Indonesia has a rich and highly biodiverse landscape with high degrees of areas of outstanding natural beauty, high endemism of species and areas with populations of some species (e.g. Javan and Sumatran Rhino, Bornean and Sumatran Orangutan, and Sumatran tiger) that exist no where else (Van Strien, Manullang, *et al.,* 2008; Van Strien, Steinmetz, *et al.,* 2008; Goodrich, *et al.,* 2015; Ancrenaz, *et al.,* 2016; Singleton, *et al.,* 2017). The mesocarnivores are seemly of lesser concern for the creation of protected areas but benefit from their foundation, nonetheless. It is therefore recommended that:

13) Further areas of Indonesia are identified as containing either habitat types, species composition or an aesthetic of value to biodiversity, maintaining species richness and/or tourism, making these areas reserves or national parks limiting the degradation of the habitats available. Yet employment opportunities are necessary for communities adjacent or even within protected involving the protected area (e.g. tour guides, hoteliers, caterers, rangers and countryside managers for example) to prevent loss of trees for timber and animal species through unregulated and prohibited harvesting plus prevention of conversion of habitats from native to monocultural agriculture for such as palm oil (Sodhi, *et al.,* 2010a; Sodhi, *et al.,* 2010b). This would be enacting law no.5 (1990) and law 447 (2003) into these selected areas (Flevin, 1990; 2003). It is not to say that some farming and wild harvesting cannot be carried out by local people as biodiversity can often be improved by removal of some invasive, fast reproducing and dominating species. Connectivity between protected areas through green corridors would allow species to maintain viable populations in animal species that require larger home ranges such as Javan Leopard (Spaan, *et al.,* 2014; Yuliastuti, *et al.,* 2017; Jakarta Post, 2019) and allow dispersal routes for other animals.

CITATIONS

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10. CITATIONS

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APPENDICES

11.1 Appendix One - An overview of the Islands of Bali and Java, Indonesia

Bali and Java like much of Indonesia is mountainous with highest altitude on Java at 3,676 metres above sea level and Bali at 2,276 metres above sea level (UNEP, 1998). Habitats are similar on Bali and Java with much the same verdant hillsides, mountains and forests with expanding agricultural land producing rice, tea and coffee (Ardli & Wolff, 2009) with analogous animal and plant species assemblages. Notably neighbouring Bali to the East is the Wallace Line through the Lombok Strait that divides Bali from Lombok (Brodie, *et al.,* 2018). Species assemblages on these two islands of Indonesia are different due to the islands' origins further away from each other and brought together through plate tectonics (Brodie, *et al.,* 2018). Differences in species include placental mammals on Bali and marsupial mammals on Lombok among many other taxonomic groups (Metcalfe, *et al.,* 2001. Metcalfe, *et al.* (2001) cite many species including civets that probably were introduced by people in prehistory and have since become naturalised (Duckworth, *et al.,* 2016c).

There are six major religions in Indonesia (Islam, Protestantism, Catholicism, Hinduism, Buddhism and Confucianism) with Muslim given for 87.2% of the population (Van der Schaar Investments, 2015a). The national language is Bahasa Indonesia with 40 Million speakers with around 700 regional dialects (Inlingua, 2015). In 1996, Bahasa Indonesia ranked 31st most common language in the world, with Bahasa Sunda at 35th with 27 Million speakers, though Javanese spoken by 75.5 Million people ranked 12th (Photius Coutsoukis, 2000).

The national currency of Indonesia is the Indonesia Rupiah with approximately 18,250 Rupiah to 1 British Pounds Sterling (www.xe.com/convert; Prices on 20th April 2019). Indonesia has a national minimum wage that varies between regions (1,660,000 – 3,940,973 IDR per month in 2019) (£91 - 214 GBP per month) (Van der Schaar Investments, 2014; Indonesia Investments, 2019). Despite low income of workers, Indonesia's economy is the 5th highest in Asia generating the equivalent to £715 Billion GBP Gross Domestic Product (GDP) in 2016 which is an all-time high (Trading Economics, 2018). Agriculture in 2010 made up 15% of GDP, though the greatest sector is Industry with 47% of GDP including mining for gold, coal and oil and manufacturing automobiles, textiles and furniture (Van Der Schaar Investments, 2015b). The Service Sector makes up 37% of GDP (Van Der Schaar Investments, 2015b) and Bali particularly is very popular with tourists for its beaches and scuba diving sites. Tourism in Indonesia is vital to the economy, in 2013 tourism produced the equivilient to $7.9 Billion GBP (World Bank Group, 2015d). Though has been greatly impacted in the last few years by a number of natural disasters caused by Indonesia's natural geology and geography.

Indonesia is also seismically active poses natural disaster threats from volcanoes, earthquakes and tsunamis. This either causing the death directly of animal populations, or

parts of the food web causing starvation of remaining animals or causing damage to habitat to species no longer have resources needed. With debris and pollution caused by natural disasters there is the potential of secondary disease outbreaks. Volcanic eruptions and earthquakes are commonplace throughout Indonesia including eruptions of Krakatoa in 1883 (killed 36,000 people and reduced global temperatures), the Boxing Day Tsunami of 2004 (killed 230,000 people, 170,000 from Indonesia) and two eruptions of Mount Agung in 1963 (killed 1,100 people) and 2017 (Osbourne, 2014; Hughes, 2018). Recent disasters have hit Lombok and Sulawesi with earthquakes and eruption and partial collapse of Anak Krakatoa in 2018 leading to a tsunami that affected neighbouring islands (Lonely Planet, 2011; Krippner, 2017; BBC, 2018). The volcano had since regrown in to Anak Krakatoa (the child of Krakatoa) and again partially collapsed in 2018 causing another destructive tsumani on neighbouring islands (Bagley, 2017; BBC, 2018). The wild civet study site was overlooked by an active volcano named Gunung Papandayan with its own history of eruption and destruction (7°19'S 107°44'E) (see Chapter 3). The threat of natural disasters affecting habitats throughout Indonesia is a constant and present danger. There is scant evidence of animal deaths though stories suggest that many animals may have sensed the danger before disaster struck and moved to higher ground prior to areas being hit by the wave (Mott, 2005).

11.2. Appendix Two – Taxonomic and nomenclature status and reassessments of the Asian palm civet (*Paradoxurus musangus*)

As briefly mentioned in Chapter 2, the classification of the Asian palm civet has undergone numerous reclassifications over the years. It is currently gaining acceptance that the Asian palm civet resident in Indonesia are designated as *Paradoxurus musangus* and are distinct from other civets elsewhere is Asia. Under the species' former scientific name of *P. hermaphroditus* it was considered a widespread species throughout Asia (Figure 5) (Patou, *et al.,* 2010; Stevens, *et al.,* 2011; Duckworth, *et al.,* 2016c). The Asian palm civet consequently has a multitude of other common names dependant on country of origin, for example: *Alamid*, *Musang* or *Motit* [Philippines], *Punugu Pilli* [India], *Laku* [East Timor] and *Cầy vòi hương* [Vietnam], *Bhondar* [Bengal], and *Lakati*, *Khatas*, *Jhar Ka Kutta* or *Menuri* [subcontinental India]. *Musang*, *Luwak* and *Careuh* are all names are derived from Indonesian and Malay dialects and languages and typically used in the online forums for '*Musang Lovers*' clubs (Chapter 6) across Indonesia and in reference to 'kopi luwak' or civet coffee and its various brands for which the animal is now best known (Chapter 7).

The English names: civet Cat or Toddy Cat is as aforementioned an incongruity that wrongly associates kinship to Felidae, they once were members of the Felidae family but since reclassified by John Edward Gray in the viverrid family (Viverridae), due to distinctive divergent traits, to be akin to linsang, binturong, genets, and African civet (Gaubert *et al.,* 2004). There are several behavioural and physical characteristics of Viverridae that are mutual to Felids also and likely indicate to a shared taxonomic ancestry (Chapter 2 and Table BB). Despite designated of the Order: Carnivora; the term "toddy" in Toddy Cat is in reference to civets' penchant for consuming fermented sap of palms that some endemic peoples use to produce the sweet toddy liquor (Sanderson, *et al.,* 1955; Joshi, *et al.,* 1995). It is suggested in literature that the civet has a generalist approach to diet, including frugivorous, carnivorous, Insectivorous and detritivorous sources (Joshi, *et al.,* 1995; Krishnakumar & Balakrishnan, 2003; Nakashima, *et al.,* 2010; Nakabayashi, *et al.,* 2012). To be Felidae the civet would need to be an obligate carnivore though it is clearly omnivorous (Rabinowitz, 1991; Nakashima, *et al.,* 2010; Jothish, 2011; Nakabayashi, *et al.,* 2012; Fung, 2016).

In terms of scientific nomenclature, the original name of *Paradoxurus hermaphroditus* was coined to reflect anatomists' puzzlement, as early descriptions of the taxon designated specimens paradoxically as simultaneously both male and female as the perineal gland resembles additional female genitalia in the male specimens (Pocock, 1915; Rozhnov & Rozhnov, 2003). In fact, the species is separately male and female and there are no known hermaphrodites, forgiving any developmental intersex anomalies that may occur. Viverridae lack anal glands so, the perineal gland is likely to be their alternative producer of scent for use in olfactory communications (Ralls, 1971). The role of the perineal gland is likely utilised in scent marking objects in their home range; as discussed *in scripta* in Chapter 5. To this

end civets have a number of dermal exocrine glands secreting scent from the flanks, the jawline and the perineal gland.

The name 'civet' derives from Arabic lexicographical origins according to Macdonald (2001) and refers to the fluid (*Civetone*) produced from glands on the perineum. Civetone has been traditionally extracted from captive African and Asian civets and used in high-end perfumes including Chanel no.5. It is believed that civetone bonds to artificial scents in the perfume and helps to maintain them for a longer duration than perfumes without civetone (Whitten, 1969). Many perfumes are now manufactured with synthetic civetone (Macdonald, 2001). Macdonald (2001) also suggests that civetone may also have aphrodisiac properties, also medicinal properties as an antiperspirant and to alleviate skin conditions. The scent of a civet has a distinctly buttered popcorn odour with added overtones of musk (Macdonald, 2001) and also likened to the scent of the Pandan plant (*Pandanus amaryllifolius*) used in Asian cooking and baking (Cahill, 2017). Within the '*Musang Lovers*' clubs there is also reference to Asian palm civet as *Musang Pandan* that is in reference to the plant (Cahill, 2017).

The Asian Viverridae diverged from the Felid branch of phylogeny prior to 33.3 million years ago (Gaubert & Veron, 2003). The similarities of Felidae and Viverridae are expressed in the latter group's taxonomy containing a suborder entitled Feliformia or cat-shaped (Table BB; Figure 4). Patou *et al.* (2010) further suggests that *Paradoxurus* spp*.* diverged as a whole from kin Viverridae around 2.8 – 5.7 million years ago from which three distinct radiations occurred likely caused by development of natural barriers (i.e. stretches of open water between islands and landmasses) resulted in at least three distinct species; namely the golden palm civet (*Paradoxurus zeylonensis* Schreber, 1778), of Sri Lanka; the brown palm civet, (*P. jerdoni* Blanford, 1885), endemic to the Indian Western Ghats; and the Asian palm civet (*P. hermaphroditus* Pallas, 1777) distribution map in Figure 5.

Asian palm civets were first described by Peter Simon Pallas in 1777; though along with genets in Africa were classified as a Felid until the creation of the viverrid group by John Edward Gray in 1821 and genus *Paradoxurus* in the same year by Frédéric Cuvier (Wozencraft, 2005). Wozencraft (2005) states that Viverridae comprise of approximately 33 species within 15 genera, though different sources suggest numbers between 30-38 (Table CC represents 34 species). Genetic research in to the viverrid family has resulted already received several realignments of associations, distribution and taxonomy have already occurred (Gaubert, *et al.,* 2002; Gaubert, 2003; Gaubert, Fernandes, *et al.,* 2003; Gaubert, Tranier, *et al.,* 2003; Gaubert & Veron, 2003; Gaubert *et al.,* 2004; Gaubert, Taylor, Fernandes, *et al.,* 2005; Gaubert, Taylor & Veron, 2005; Veron, *et al.,* 2014).

In 1934, Thomas Horsfield directed that the Javan and Balinese populations of Asian palm civet is distinct from other populations, therefore a subspecies of its own designation as subsequently named *Paradoxurus hermaphroditus javanica* and *P. h. bondar* respectively.

Table BB: Taxonomic classification for the Asian palm civet (*Paradoxurus hermaphroditus* Pallas 1777) with definitions at each level. [Adapted from Duckworth, *et al.,* 2008].

Taxonomy Category	**Taxonomic Designation**	**Definition**
Kingdom:	Animalia	Akin to all animals.
Phylum:	Chordata	In possession of a notochord.
Class:	Mammalia	Furred, homoeothermic, viviparous lactating animals.
Order:	Carnivora	Consumer of other animals, possessor of adaptations to dental configuration, alimentary tract and endocrine systems to consume other animals.
Suborder:	Feliformia	Shape of feline.
Family:	Viverridae	Akin to other civets, genets, linsangs and binturong.
Genus:	*Paradoxurus*	Relating to confusing or impossible states.
Species:	*hermaphroditus*	Appearing to possess the characteristics of both male and female in each specimen.

Table CC: Current thirty-four Viverridae species with Common and Scientific binomial nomenclature and the 15 Genera that they belong (adapted from Wozencraft, 2005).

Common nomenclature	**Scientific binomial nomenclature**
Binturong	*Arctictis binturong*
Small-toothed palm civet	*Arctogalidia trivirgata*
Owston's civet	*Chrotogale owstoni*
African civet	*civettictis civetta*
otter civet	*Cynogale bennettii*
Hose's palm civet	*Diplogale hosei*
Aquatic genet	*Genetta piscivora*
Abyssinian genet	*Genetta abyssinica*
Angolan genet	*Genetta angolensis*
Bourlon's genet	*Genetta bourloni*
Crested servaline genet	*Genetta cristata*
Common genet	*Genetta genetta*
Johnston's genet	*Genetta johnstoni*
Rusty-spotted genet	*Genetta maculata*
Pardine genet	*Genetta pardina*
King genet	*Genetta poensis*
Servaline genet	*Genetta servalina*
Haussa genet	*Genetta thierryi*
Cape large-spotted genet	*Genetta tigrina*
Giant forest genet	*Genetta victoriae*
Banded palm civet	*Hemigalus derbyanus*
Sulawesi palm civet	*Macrogalidia musschenbroekii*
Masked palm civet	*Paguma larvata*
Asian palm civet	*Paradoxurus hermaphroditus* (from which *P. musangus* is set to be added after Patou, *et al.,* 2010 and Veron, *et al.,* 2014).
Golden palm civet	*Paradoxurus zeylonensis*
Jerdon's palm civet	*Paradoxurus jerdoni*
Leighton's linsang	*Poiana leightoni*
African linsang	*Poiana richardsonii*
Malabar civet	*Viverra civettina*
Large-spotted civet	*Viverra megaspila*
Malayan civet	*Viverra tangalunga*
Large Indian civet	*Viverra zibetha*
Small Indian civet	*Viverricula indica*

Prasetiyo (2017), supported this by identifying subpopulations in Balinese Asian palm civets (Chapter 7). It is likely that the Sumatran population is also distinct however Wozencraft (2005) does not state what subspecies this is though Duckworth, *et al.* (2016) suggests *P. h. musanga* (Table DD). Molecular insights by Veron, *et al.* (2014) has indicated taxonomic affinities and division within *Paradoxurus*. Of the three-species studied (*Paradoxurus hermaphroditus*, *P. jerdoni* and *P. zeylonensis*) consisting of 128 specimens; *Paradoxurus hermaphroditus* indicated just three subspecific divisions rather than 30. Veron *et al.,* (2014) recommended the following nomenclature: *P. hermaphroditus* (Indian and Indochinese regions), *Paradoxurus musangus* (mainland Southeast Asia, Sumatra, Java and other small Indonesian islands) and *Paradoxurus philippinensis* (Mentawai Islands, Borneo and the Philippines) (Figure 5). Patou, *et al.,* (2010) also suggests three similar centres of expansion of distribution:

1. In the subcontinent of India through south China and Hainan plus areas in altitude above 200 m in Indochina.
2. Malaysia, Java, Sumatra and in areas in Indochina below 200 metres altitude.
3. In Borneo, the Philippines and the Mentawai archipelago.

Patou, *et al.,* (2010) and Veron, *et al.* (2014) both suggest that Asian palm civet needs distributions remapping. Of note related also is that the Javanese and Balinese populations of civets have their own distinct subspecies with the new given name of *Paradoxurus musangus javanicus* and *P. m. musangus* respectively. *P. hermaphroditus* will be converted to hold the name of *Paradoxurus musangus in scripta*. The original name of *P. hermaphroditus* will be used *in scripta* for Asian palm civets from other countries or where the papers referring to the species were written prior to the Veron, *et al.,* (2014).

Under the name of *P. hermaphroditus*, the species was considered common and widespread therefore at lower priority and therefore overlooked by wildlife researchers or conservation strategies. The reduced distribution range may mean that *P. musangus* is also at a greater threat from exploitation and threats caused by humans especially in South East Asia. The affect of anthropogenic changes on the ecology *P. musangus*, the influences of trade and harvesting and production of kopi luwak warrant greater prioritisation than would have been considered. Estimates of population sizes remain needed for all civet species. These reassessments also mean that species, subspecies and distributions given in Table DD now require full and comprehensive revision.

No IUCN status has yet been derived for *P. musangus.* The most recent conservation status by the IUCN of the Asian palm civet (as *P. hermaphroditus*) in 2012 designated it as "*Least Concern*" (Duckworth, *et al.,* 2008; Schipper, *et al.,* 2008) due to populations inhabiting most countries in central, south and south eastern Asia. There are no population estimates for the species across their range though they are projected as decreasing but not yet fragmented (Duckworth, *et al.,* 2016c). Of the various studies referred to in Duckworth, *et*

al., (2008); these civets are not the focus and/or discuss other areas of behaviour or ecology rather than identifying population trends. Duckworth, *et al.* (2008) lists twenty-one countries and their islands of origin for *P. hermaphroditus*. Countries of endemism as: Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia (Java, Kalimantan, Lesser Sunda Island), Lao People's Democratic Republic, Malaysia (Peninsular Malaysia, Sabah, Sarawak), Myanmar, Nepal, Philippines, Singapore, Sri Lanka, Thailand and Vietnam. It is suspected when the IUCN assess *P. musangus* the species will be listed as Near Threatened (Nekaris, *pers comm*).

Table DD: A list of the subspecies of the Asian palm civet (*Paradoxurus hermaphroditus*), originating countries and by whom they were designated by and date (Data sourced from Wozencraft, 2005; Patou, *et al.,* 2010) and http://www.gbif.org/species/2434708 [accessed 20th June 2015]. *P. h. javanica, P. h. bondar and P. h. musanga* are the species grouped together under *P. musangus* (Veron *et al.,* 2014).

Subspecies	Originating Countries	Designated by and date
hermaphroditus	India	Schreber, 1777
balicus	Undefined	Sody, 1933
bondar	Bali, Indonesia	Undefined
canescens	Undefined	Lyon, 1907
canus	Afghanistan	Miller, 1913
cochinensis	Undefined	Schwarz, 1911
dongfangensis	Undefined	Corbet & Hill, 1992
enganus	Undefined	Lyon, 1916
exitus	Undefined	Schwarz, 1911
javanica	Java, Indonesia	Horsfield, 1824
kangeanus	Kangean Island	Thomas, 1910
laotum	Lao, Vietnam, Thailand, Myanmar	Gyldenstolpe, 1917
lignicolor	Mentawai Island, Indonesia	Miller, 1903
milleri	Undefined	Kloss, 1908
minor	Singapore	Bonhote, 1903
musanga	Borneo, Malaysia, and west Indonesia	Raffles, 1821
nictitans	Undefined	Taylor, 1891
pallasii	India	Gray, 1832
pallens	Undefined	Miller, 1913
parvus	Undefined	Miller, 1913
philippinensis	Philippines	Jourdan, 1837
pugnax	Undefined	Miller, 1913
pulcher	Undefined	Miller, 1913
sacer	Undefined	Miller, 1913
scindiae	Undefined	Pocock, 1934
senex	Undefined	Miller, 1913
setosus	Undefined	Jacquinot & Pucheran, 1853
simplex	Undefined	Miller, 1913
sumbanus	Sumba Island	Schwarz, 1910
vellerosus	Undefined	Pocock, 1934

11.3. Appendix Three – CITES records for other carnivore species that are recorded in the wild study area or the animal markets.

In addition to the CITES records for Asian palm civet, there are records for other mammals traded as pets and for other purposes (Table EE). Most stiking of these numbers is the trade of 1,134,326 leopard cats in 2,056 records over 40 years (1976-2016) with 86 importing countries and 60 exporting countries. Animal destinations and departure point is recorded for 638,364 leopard cats with a significant and major exporter of leopard cats is China exporting 578,378 (90.6%) animals between 1976 and 2017. Most animals were not alive, 70.5% are stated as skins in the records, just 0.3% as live specimens, the remainder as items of clothing goods and trophies (Table EE). A major importers of leopard cat are Italy with 136,437 (21.4%) and Japan with 214,733 (33.6%) animals between 1976 and 2017. The Yellow throated marten in the trade (n=6,228 martens) shows a peak in 1989 and 2002 with movement of 3,177 (51%) and 2,402 (38.6%) animals respectively. The 1989 movement was likely skins and other derivatives though the records states unknown for all of these. In 2002 only 2 were live specimens, the remainder were skins and derivatives (Table EE). The major importers of Yellow throated marten are Germany (24.5%) and the United States (22.6%) and exporter is Russia (39.6%). Three hundred and six masked palm civets were recorded with 42% Imported to France and 48.4% exported from the United States. Twelve occurrences recorded masked palm civets being moved from the US to France (a total of 26 animals). One further import/export relationship saw 212 captive bred live masked palm civets moved in 2008 from Korea to the United States (69.3% of all masked palm civets traded) (Table EE).

Over ninety six percent (96.1%) of the small Indian civet trade is recorded as living specimens and 66.4% of these animals (Table EE) were exported from Madasgacar to the United States of America between 2003-2005 but mostly in 2005. Binturongs are captive bred (74.3%) and traded alive around the world (86.4%) (Table EE), importers are led by the USA with 16.7% of trade and a range of exporters are recorded near equally to each other, Philippines (16%), Cuba (15.3%), USA (13.8%), Singapore (12.8%) and Malaysia (11.6%). The Banded Linsang are only either not specified about their source (55%) or are stated as wild caught (45%) and 91% as live specimens (Table EE). Trade in banded linsang is not common in records as over 40 years there has been a mere 89 animals traded. Germany has been the largest importer (40.4%) with Malaysia the largest exporter (40.4%). Trade in linsang been these two countries alone was 30 animals in 2010 (33.7%).

The Asian short clawed otter is suspected as being the otter kept as an exotic pet in Indonesia, though is also common globally in zoological parks. Identification of which species is the pet still needs to be done, therefore is it is only included in Table EE tentatively. The records of leopard (*Panthera pardus*) do not discriminate between Asian and African subspecific origins, therefore sensible conclusions of trade of Javan leopard specifically cannot be drawn here, overall trade constitutes 13,220 records over 42 years (1975-2017) with a total of 172,285 animals with only 2.5% as live animals, 45.3% listed as derivatives, 23.7% as trophies, 12.2% as specimens and 7.3% as skins (Table EE). China

highly significant as the major exporter of leopard (90.2%), exporting to such countries as Japan (39.4%), Italy (24.9%) and Great Britain (14%). No CITES records could be found for the small-tooth palm civet, Malay civet, Javan ferret badger and Sunda stink badger.

Table EE: Records of trade in selected Indonesian carnivores between 1976 and 2017 as recorded by CITES and extracted via the CITES trade database (https://trade.cites.org/) [Accessed 19/01/2019].

Species	No. of records	First Date	Latest Date	Years	No. of Importers	No. of Exporters	Total Specimens (of which Live Animals)	Mean of Records	Mean per Year (of which Live)
Leopard cat	2,056	1976	2016	40	86	60	1,134,326 (1,597)	551.7	28,358.1 (39.9)
Yellow throated marten	53	1989	2016	27	17	15	6,228 (51)	117.5	230.7 (1.9)
Javan mongoose	18	1992	2017	25	5	7	3,174 (1)	176.3	127.0 (0.04)
Asian short clawed otter	467	1977	2017	40	51	39	2,043 (1,936)	4.4	51.1 (48.4)
Small Indian civet	45	1992	2014	22	11	14	876 (18)	19.5	39.8 (0.8)
Asian palm civet	84	1990	2016	26	14	20	701 (579)	8.3	27.0 (22.3)
Binturong	143	1989	2016	27	30	22	413 (359)	2.9	15.3 (13.3)
Masked palm civet	31	1991	2015	24	8	9	306 (267)	9.9	12.8 (11.1)
Banded Linsang	17	1977	2012	35	4	6	89 (45)	5.2	2.5 (1.3)

11.4. Appendix Four – Country codes as used in CITES records within this thesis

Table FF: Transcription of Country Codes as used by CITES in Table K within this thesis for the countries recorded in Trading in Asian Palm Civet as either Importer or Exporter

BR	Brazil
CM	Cameroon
CN	China
CZ	Czech Republic-
DE	Germany
FR	France
HR	Croatia
ID	Indonesia
IT	Italy
JP	Japan
KR	Korea
NL	Netherlands
QA	Qatar
SG	Singapore
US	United States of America
DD	Former East Germany
CH	Switzerland
ES	Spain
HU	Hungary
LA	The Lao People's Democratic Republic
MM	Myanmar
MY	Malaysia
PH	Philippines
VN	Vietnam
ZA	South Africa
ZC	Former Czecholovakia

11.5. Appendix Five

The datasets, files and images are contained in the DVD attached below: