A short-term assessment of the conservation status of *Tomistoma schlegelii* (Crocodylia: Crocodylidae) in Tanjung Puting National Park (Central Kalimantan, Indonesia)

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Cover photo (M. Auliya): The Sekonyer Kanan River, a "blackwater" river in the Tanjung Puting National Park, 2005.

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EXECUTIVE SUMMARY

This report describes the results of a nine-day visit (30 September-8 October 2005, the late dry season) to Tanjung Puting National Park, Central Kalimantan, to document preliminary information about the conservation status of *Tomistoma schlegelii* (the "Tomistoma" or "False Gharial").

The global population of the Sundaland freshwater crocodilian Tomistoma (*Tomistoma schlegelii)* is suffering an onward decline, due to a manifold severe human impact. Viable populations still exist in remnant peat swamp habitats on Sumatra and Borneo, however, these occur in scattered protected and non-protected localities, which are frequented by humans who (illegally) utilize an array of natural resources or practice unsustainable agricultural practices and pollute pristine habitats. *T. schlegelii* is listed under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Status surveys have been accorded a high priority for conservation of this species by the IUCN/CSG Tomistoma Task Force.

In 2002, observations of Tomistoma were made in Tanjung Puting National Park (Central Kalimantan) which indicated that high densities occur in the Sekonyer River systems (Simpson 2004). This 415,040 ha National Park represents one of the largest and most diverse protected examples of extensive coastal tropical heath and peat swamp forest in Borneo.

The aims of this survey were to document further information on the status of Tomistoma in Tanjung Puting National Park.

The core study area represented the most frequented locality of Tanjung Puting National Park due to the ecotourists and volunteers visiting and assisting Camp Leakey. The Sekonyer Kanan is a tributary of the Sekonyer River, marking the northwestern border of the National Park, and approximately 7.6 km in length. The distance between Pondok Ambung (S 02°44'478''; E 111°55'156'') and Camp Leakey (S 02°45'621''; E 111°56'559'') is 3.4 km, and river width during this study varied approx. between 8 and 18 m. The main Sekonyer River had a width of approximately ± 50 m. From the river mouth upriver, along a distance of 13.5 km *Nypa fruticans* framed the Sekonyer to both sides. While the Sekonyer Kanan is characteristically tea-coloured, the Sekonyer River was always turbid, a consequence of illegal gold mining activities upriver the Sekonyer.

Two boats used during this field survey were the long-boat and the speedboat and three local staff assisted the field survey. The majority of surveys conducted were spotlight surveys. The Sekonyer River, Sekonyer Kanan River, the parched Danau Bulut, the Sungai Bulin and the Sungai Buluh Kecil River were surveyed. Suitability of Tomistoma nesting habitat was evaluated and the total data-set was amended with several interviews. The dry season revealed relatively low humidity (< 60%) and high temperatures (± 30°C) during noon. Acidity of the water bodies was pH = ± 4. Dominant flora observed were the riverlining *Hanguana malayana* in part forming floating mats and *Pandanus* spp.

During a nine-day survey, 46 single observations of Tomistoma were recorded. Of these 38 specimens refer to observations made on the Sekonyer Kanan River and eight specimens to observations on the Sekonyer River. The former river was surveyed on seven occasions and latter on three. On 1 October, a spotlight survey resulted in nine Tomistoma of varying size classes (0.5-2.5 m total length). A rough estimate of the population size yielded 2.5 Tomistoma/km on a 3.5 km river passage (Pondok Ambung to Camp Leakey). The primary goal, to confirm the "high" density of *Tomistoma schlegelii* accompanied by varying size classes was therein achieved. During this time of the year the following was observed: immature and mature Tomistoma utilize different habitats, the former favouring smaller rivers with a lower current, the latter wider and faster flowing

rivers. Behavioural observations of juvenile *T. schlegelii* revealed excellent adaptions to its ecological niche. Basking sites included floating mats of *Hanguana* and emerged logs at the riverside.
Nesting sites in all likelihood, seem to be located beyond areas anthropogenically (regularly) disturbed.
A control survey trip to a far off river system, the Sungai Buluh Kecil River, revealed no crocodiles. This river was subject to several years of logging.
Coexistence with *Crocodylus porosus* is discussed due to one observation along the lower stretch of the Sekonyer River and a fatal encounter happened in Tomistoma habitat, 2002.
High observational records of Tomistoma at the main study site may represent the most viable and stable Tomistoma population of the entire National Park due to the conservation efforts of the Orangutan Foundation International (OFI).
However, the area is also exposed to significant threats, e.g., gold mining activities and increasing boat traffic.
Follow-up studies are urgently recommended in the near future, to assess the conservation status of *Tomistoma schlegelii* in the entire Tanjung Puting National Park.

RINGKASAN EKSEKUTIF

Laporan ini memberikan gambaran tentang hasil perjalanan selama sembilan hari (30 September-8 Oktober 2005, di akhir musim kemarau) ke Taman Nasional Tanjung Puting Kalimantan Tengah, untuk mengumpulkan informasi awal mengenai status konservasi *Tomistoma schlegelii* (Buaya Senyulong atau Buaya Supit).

Populasi global dari buaya air tawar asli daratan Sunda ini terus mengalami penurunan yang diakibatkan oleh tingginya kegiatan manusia. Populasi yang mampu mendukung keberlanjutan jenis ini masih ada di habitat yang tersisa di hutan rawa gambut Sumatra dan Borneo (Sabah, Sarawak, Brunei Darusalam dan Kalimantan, Indonesia), namun, populasi tersebut berada pada lokasi yang tersebar baik yang terlindungi (dalam kawasan konservasi) maupun di luar kawasan konservasi, yang secara keseluruhan berdampingan dengan manusia yang (secara illegal) memanfaatkan sumberdaya alam atau mempraktekkan pertanian yang tidak berkelanjutan serta membuat polusi di habitat yang masih asli. *T. schlegelii* termasuk dalam daftar Appendix-I Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Survai mengenai status jenis ini yang dilakukan oleh IUCN/CSG Tomistoma Task Force telah merekomendasikan bahwa jenis ini memerlukan prioritas tinggi untuk konservasinya.

Pada tahun 2002, observasi yang dilakukan di Taman Nasional Tanjung Puting (Kalimantan Tengah) mengindikasikan bahwa terdapat buaya ini dalam kerapatan (densitas) yang tinggi di Sungai Sekonyer (Simpson 2004). Taman Nasional yang luasnya 415,040 ha ini merupakan salah satu wakil dari contoh hutan kerangas pantai yang luas dan hutan gambut di Borneo yang terbesar dan yang paling beragam.

Tujuan survey ini adalah untuk mengetahui informasi lebih lanjut mengenai status Buaya Senyulong di Taman Nasional Tanjung Puting.

Daerah utama yang diteliti mewakili lokasi di dalam Taman Nasional yang paling sering dijumpai karena turis dan voluntir yang mengunjungi dan membantu di Camp Leakey. Sungai Sekonyer Kanan merupakan anak sungai dari Sungai Sekonyer, yang merupakan batas Taman nasional di sebelah barat laut, dengan panjang kira-kira 7,6 km. Jarak antara Pondok Ambung (02°44’478’’ LS; 111°55’156’’ BT) dan Camp Leakey (02°45’621’’LS; 111°56’559’’BT) kira-kira 3.4 km, dengan lebar sungai pada saat penelitian berkisar antara 8 dan 18 m. Sungai utama yaitu Sekonyer mempunyai lebar sekitar ± 50 m. Dari muara sungai kea rah hulu sepanjang 13,5 km *Nypa fruticans* memagari Sekonyer di dua sisinya. Sementara Sekonyer Kanan is dicirikan oleh warna menyerupai the, Sungai Sekonyer selalu keruh karena pertambangan emas illegal di hulu sungai Sekonyer.

Dalam survey lapangan kali ini dua kapal yang digunakan yaitu kapal panjang dan speed boat serta dibantu oleh tiga staf lokal. Survei secara umum menggunakan teknik *spotlight survey*. Daerah-daerah yang disurvey termasuk Sungai Sekonyer, Sekonyer Kanan, bagian Danau Bulut yang mongering dan dangkal, Sungai Bulin dan Sungai Buluh Kecil. Evaluasi dilakukan untuk kesesuaian habitat bertelur Buaya Senyulong serta untuk seluruh set data dilakukan perbaikan melalui beberapa wawancara. Musim kering menunjukkan relative rendahnya kelembaban udara (< 60%) dan tingginya temperatur (± 30°C) pada siang hari. Keasaman badan air adalah pH = ± 4. Flora yang mendominasi pinggiran sungai adalah *Hanguana malayana* yang di sebagian tempat seolah membentuk hamparan yang mengambang dan *Pandanus* spp.

Selama survey sembilan hari tersebut, dapat dicatat 46 rekord observasi Buaya Senyulong. dari catatan tersebut 38 diantaranya merupakan specimen observasi yang dilakukan di Sungai Sekonyer kanan dan delapan specimen observasi di Sungai Sekonyer. Sungai Sekonyer Kanan disurvei dalam tujuh kali kesempatan, sedangkan Sekonyer dalam tiga kali kesempatan. Pada tanggal 1 Oktober

survei spotlight menemukan sembilan Buaya Senyulong berbagai kelas ukuran (0,5-2.5 m panjang badan total). Perkiraan kasar populasi Buaya Senyulong adalah 2,5 ekor/km pada bagian sungai sepanjang 3,5 km (Pondok Ambung sampai Camp Leakey). Survey ini telah berhasil sesuai dengan tujuan utama survey yaitu membuktikan bahwa *Tomistoma schlegelii* terdapat dalam kerapatan yang tinggi dengan berbagai kelas ukuran. Pada saat-saat seperti ini setiap tahunnya diketahui hal-hal sebagai berikut: Buaya Senyulong muda dan dewasa menggunakan habitat yang berbeda, dimana buaya muda cenderung lebih menyukai sungai-sungai kecil dengan arus yang lebih lemah, sedang pada yang tua lebih menyukai sungai lebar dengan aliran yang lebih kuat. Pengamatan tingkah laku pada anakan *T. schlegelii* menunjukkan bahwa anak-anak buaya tersebut beradaptasi dengan sangat baik terhadap niche ekologisnya. revealed excellent adaptations to its ecological niche. Anakan-anakan buaya tersebut dapat dengan tenang didup di tempat-tempat seperti hamparan mengambang *Hanguana* dan log yang muncul di tepi-tepi sungai.
Tempat-tempat bersarang nampak cenderung berada di daerah-daerah yang secara anthropogenik (umumnya) tidak terganggu.
Satu perjalanan survey sebagai kontrol ke sistem sungai yang agak jauha dari lokasi survey, yaitu Sungai Buluh Kecil, tidak menemukan adanya buaya. Sungai ini pernah mengalami pembalakan selama beberapa tahun.
Ko-eksistensi (hidup pada habitat yang sama) dengan *Crocodylus porosus* juga dibahas dalam studi ini karena sekali ditemukan sepanjang hilir Sungai Sekonyer, serta satu kejadian *C. porosus* ditemukan mati di habitat Buaya Senyulong pada tahun 2002.
Ditemukannya Buaya Senyulong dalam konsentrasi tinggi di lokasi penelitian utama mewakili populasi Buaya Senyulong yang paling viable dan stabil di seluruh kawasan Taman Nasional, karena adanya upaya-upaya konservasi yang dilakukan the Orangutan Foundation International (OFI) dan Balai Taman Nasional.
Namun demikian daerah ini juga terancam oleh beberapa kegiatan yang signifikan, seperti pertambangan emas dan meningkatnya lalu lintas perairan. Studi lanjutan sangat diperlukan segera untuk menilai status konservasi *Tomistoma schlegelii* di seluruh kawasan Taman Nasional Tanjung Puting.

1 RECOMMENDATIONS

Although this field study only lasted several days, valuable insights could be provided on the conservation status of *Tomistoma schlegelii*. Prior to the finalization of the study, it was recognized that follow-up studies must be established in the very near future, particularly taking current threats identified into consideration. This perception was not only gained from this ascertained globally significant population of Tomistoma but also through the excellent co-operation by the Orangutan Foundation which is well established in Tanjung Puting National Park. Hence the following recommendations need to be implemented as soon as possible:

1. Conduct baseline surveys in other regions of the park to assess the conservation status of Tomistoma and habitat quality in the entire park (not only close to Camp Leakey, where populations may be higher than other areas).

2. On the basis of survey results, identify sites and zones of high management priority for Tomistoma conservation.

3. Plan and implement follow-up activities with park management authorities and the Orangutan Foundation.

4. The IUCN/SSC CSG Tomistoma Task Force in cooperation with governmental and non-governmental organizations must actively promote local capacity building in the research sector and the public awareness (environmental education).

5. Implement a research programme on Tomistoma in Tanjung Puting National Park, e.g., for national and foreign Masters and Ph.D students, and in turn establish academic links with local universities and conservation groups.

During the compilation of this report fortunate circumstances solicited a MSc. student from the Graz University of Technology in Austria, conducting a "habitat assessment of *Tomistoma schlegelii* with satellite tracking and remote sensing methodologies, and furthermore a Ph.D student from the "Zoologisches Forschungsmuseum Alexander Koenig" of the University of Bonn, in Germany, studying the population ecology of Tomistoma, both in Tanjung Puting National Park. The Indonesian university counterpart of both students has been identified in the Department of Forest Resources Conservation & Ecotourism, Faculty of Forestry of the Bogor Agricultural University.

2 INTRODUCTION

2.1 Background

The Tomistoma or "False Gharial", *Tomistoma schlegelii*, is a large and taxonomically distinct freshwater crocodilian in South East Asia which shares various features with the Crocodylididae and the Gavialidae (cf. Harshman et al. 2003). However, it is distinct from both with an independent fossil record and is one of the least known crocodilians in the world, in terms of its population status and natural history.
It is internationally protected by virtue of being listed on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
Although the IUCN (World Conservation Union) considers the global population of Tomistoma "Endangered" (www.iucnredlist.org), defined as a species which is "facing a very high risk of extinction in the wild in the near future", to some extent, this reflects the paucity of data on the population status of Tomistoma in almost all parts of its range as well as the fact that the IUCN/SSC Crocodile Specialist Group is cautious about overstating risks.
To date, the global population of Tomistoma is apparently meeting the IUCN criteria "Critically Endangered" ("species facing an extremely high risk of extinction in the wild in the immediate future"). This assumption in turn requires the urgent and rapid collection of field data on the conservation status of Tomistoma in order to reassess the IUCN categories.
Tomistoma schlegelii is geographically restricted to the Indomalayan Realm (Sundaland) (cf. Figure 1), and to date has been reported from isolated locations in Peninsular (West) Malaysia and the Greater Sundas (Sumatra and Borneo). Tomistoma appears to be extinct in Thailand, and is represented by a very small remnant population in both Peninsular Malaysia and Java (cf. Stuebing et. al 2006).
Key threats to Tomistoma include the continuous loss of pristine habitat, particularly peat swamp forest which is subject to logging and conversion, to drained agro-ecosystems, combined with the reduction of the remaining isolated populations through human-induced mortality.
Morphological characteristics (an elongated narrow snout) and dietary habits of *Tomistoma schlegelii* (juvenile and subadult size classes are predominantly piscivorous) make the species vulnerable to incidental catch, as it gets attracted to and entangled with floundering fish in fishing nets (Auliya 2003, Bezuijen et al. 2001).

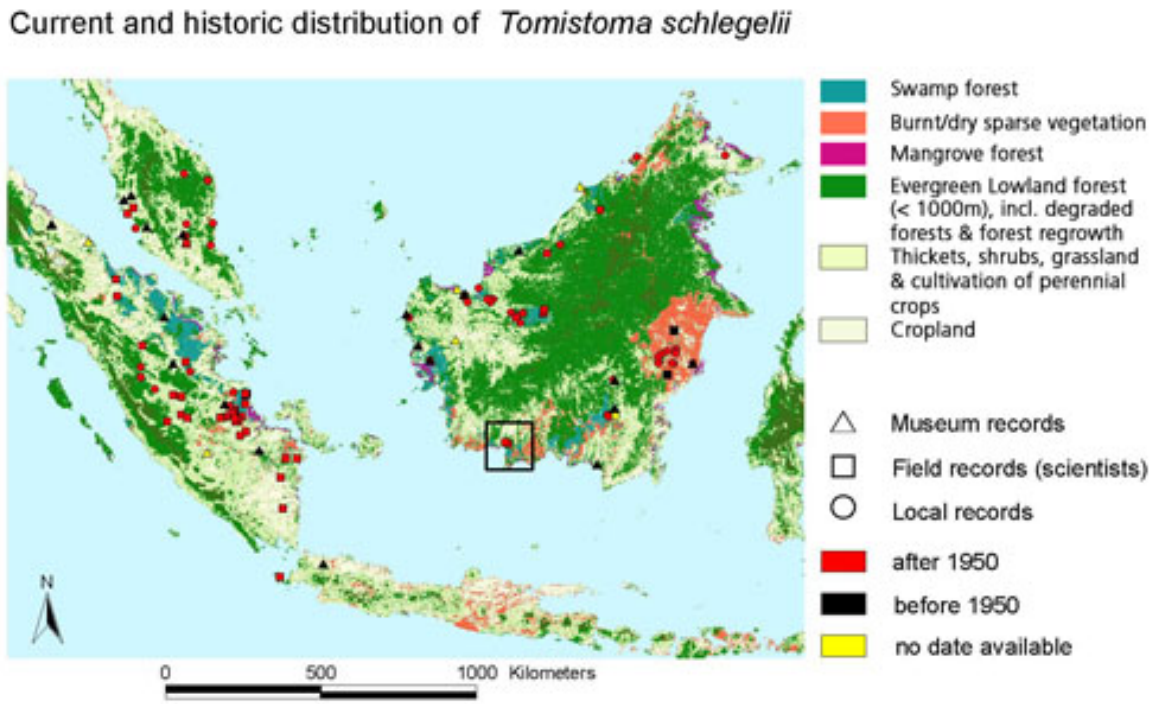

Figure 1. Current forested habitats remaining in the known range of Tomistoma, with some important locality records indicated. Square inset: Area of the Tanjung Puting National Park (see Fig. 2). Source: Stuebing et al. 2006.

At the 17th Working Meeting of the IUCN/SSC Crocodile Specialist Group in Darwin (Northern Territory, Australia), Boyd Simpson reported on a substantial population of *Tomistoma schlegelii* in Tanjung Puting National Park, in Central Kalimantan (Indonesian Borneo). These results were first published in the Proceedings of the 17th Working Meeting of the IUCN/SSC Crocodile Specialist Group, in Darwin, Australia in 2004. Tanjung Puting National Park is one of the largest and most diverse protected examples of extensive coastal tropical heath and peat swamp forest in Borneo (Galdikas & Shapiro 1994). The observational results obtained by B. Simpson in 2002, indicated that relatively high densities of Tomistoma may occur in the park, most certainly though in one specific area of the National Park, where the Orangutan Foundation International (OFI) has been active for over two decades (see below).

Simpson's promising findings confirmed former results of Frazier & Maturbongs (1990), who were the first to record a relative high density of Tomistoma at the Sekonyer Kanan River ("Simpan Kanan Creek") the core study site of this survey (also cf. below), and now in the light of "Priorities for Actions" for "False Gharial Conservation" formulated by the IUCN/SSC - CSG Tomistoma Task Force, status surveys in Indonesian Borneo (Kalimantan) were categorized as a "high priority task" (Bezuijen et al. 2003). Hence Simpson's results should trigger follow-up studies in the near future. A first step was made in late 2004, when the Tomistoma Task Force established contact with the OF, in order to conduct a short-term assessment of Tomistoma status in park.

2.2 A joint venture/co-operative initiative: "The IUCN/SSC Crocodile Specialist Group Tomistoma Task Force (TTF) and the Orangutan Foundation (UK)

Over the last decade, a considerable amount of new information on Tomistoma in the wild has been obtained through survey and research programmes facilitated mostly by the "IUCN/SSC Crocodile Specialist Group" (e.g., Bezuijen et al. 1995, 1997, 2001, 2002, 2005).
Surveys have shown that national and international efforts are urgently required to promote Tomistoma conservation. To this end, the IUCN/SSC CSG Tomistoma Task Force (TTF) was formally established by the IUCN/SSC Crocodile Specialist Group Steering Committee in February 2003.
The TTF is "dedicated to quantifying the population status of Tomistoma in the wild, identifying the threats to which they are exposed, and to promote such actions in co-operation with range states and others as may be deemed appropriate in order to achieve sustainable conservation".

The Orangutan Foundation (OF) is a UK-registered charity, established in 1991, and is a subunit of Orangutan Foundation International (OFI). OFI was founded in 1986 by Dr. Birute Galdikas, one of the world's formost experts on orangutans. The mission of OFI is to conserve the orangutan within its natural habitat, to promote research on these apes and increase public awareness (www.orangutan.org.uk). Logistics for the survey were coordinated by Stephen Brend, Senior Conservationist OF. Accommodation was provided by OF at Pondok Ambung, a tropical forest research station on the Sekonyer Kanan River. This research camp was recently refurbished by OF, and is used by national and international scientists.

2.3 Survey objectives

- One of the major goals was to reconfirm the observation records of varying size classes of Tomistoma in the river system opportunistically surveyed by B. Simpson in 2002. Positive results would therein prove the existence of a viable breeding and globally significant population of *Tomistoma schlegelii* since first reported 16 years, according to the published record.

- Knowledge gaps such as an estimate of the population density and information on the species autecology, population and behavioural ecology and coexistence with other crocodile species would further support and infer a more precise assessment of the conservation status of *T. schlegelii.* This baseline data would contribute to specific conservation measures and management plans by the IUCN/SSC Crocodile Specialist Group - TTF in co-operation with OF.

- Another goal is the assessment of habitat quality, and the identification of potential threats to the population under study.

3 MATERIALS and METHODS

This pioneer field survey on Tomistoma was conducted in the Tanjung Puting National Park. The survey was designed to adopt current recognized crocodile survey methods (e.g., Bayliss 1987, O' Brien 1990). However, the survey methods could not be fully implemented in the field for few reasons. Survey methods had to be evaluated and modified to local conditions upon arrival at the study area. Thus, decisions on the survey method modification were concluded on a daily basis. These were exemplified by the daily duration, types of boats, responsibilities and availability of staff and equipment. Despite the heterogeneity of the survey methodology applied, it was possible to provide sufficient data with respect to the project's goal.

3.1 Obligatory administrative work

Departure from Germany was 25th September 2005. In order to gain permission for the short-term field survey in Central Kalimantan, it was necessary to apply for a letter of recommendation ("research permit") at the "Departemen Kehutanan – Direktorat Jenderal Perlindungan Hutan dan Konservasi Alam" (PHKA) in Jakarta. After arrival at the Jakarta airport on 26th September, M. Auliya met Pak A. Susmianto following a personal agreement made at a meeting with him and Pak G. Saputra (Chair IRATA, Indonesian Reptile and Amphibian Trade Association) a few weeks before. This permit was received from Pak Herry Djoko Susilo (Subdirektorat Konservasi Jenis dan Genetik) on the same day and included three obligatory conditions, which were to be met by the applicant:

(1) the accompaniment of personnel from the local PHKA office,
(2) no specimen or sample of the species under study can be collected, and
(3) expenses incurred are to be covered by the researcher (see Appendix III).

From Jakarta via Semarang (Central Java), M. Auliya arrived in Pangkalan Bun (Central Kalimantan) on 29 September 2005. Mr. Jakir Udin (Pak Jak), the manager of Pondok Ambung, picked up M. Auliya and assisted with the collection of obligatory documents. At Pangkalan Bun's police headquarters the arrival of M. Auliya and his purpose to conduct a short-term field study on *Tomistoma schlegelii* in Tanjung Puting National Park was registered. With the receipt of the "Police Report Certificate" (see Appendix V), the admission letter of the Departement for Forest Protection and Nature Conservation (PHKA) office was obtained (see Appendix IV). The accompaniment of a PHKA employee during the entire survey was obligatory.

3.2 Study period

The study period selected was the end of the dry season with water levels relatively low. The entire stay at Pondok Ambung lasted from 29 September to 9 October 2005. Field data were obtained from 30 September to 8 October 2005. Daily activities are itemised in main points (see Appendix I).

3.3 Study area

The survey was conducted along the Sekonyer Kanan River in Tanjung Puting National Park, Central Kalimantan Province, Indonesian Borneo (Fig. 2). Tanjung Puting National Park is located between 2°35' and 3°35'S and 111°45' and 112°15'E in Kumai, Hanau, Danau Sembuluh and Seruyan Hilir Districts of the Kotawaringin Barat and Seruyan Regencies. The park was declared under Ministrial Forestry Decree No. 687/Kpts-II/1996, 25 October 1996 and has a total coverage of 415,040 ha or approximately 300,000 km².

Figure 2. Inset of Fig. 1. The interior within the white bordered line indicates the approximate range of the peninsulan Tanjung Puting National Park. Map source: Google Earth 2005.

The most comprehensive data on this National Park across-the-board still refers to "A Guidebook to Tanjung Puting National Park – Kalimantan Tengah (Central Borneo), Indonesia", published by Dr. Birutè Galdikas and Dr. Gary L. Shapiro in 1994. In the last 12 years, additional references describe Tanjung Puting National Park (e.g., Bennett & Gombek 1993, Stone 1994, MacKinnon et al. 1996, Cochrane & Cubitt 2000, Auliya 2006).

This National Park is internationally well reputed for its orang-utan rehabilitation centre, Camp Leakey, which regularly attracts visitors throughout the year. Since 1984, it has been declared a National Park, and due to its diverse and extensive lowland habitats, mainly characterized by heath and peat swamp forests, it reflects an extremely important refuge for much of Borneo's endangered wildlife.

As already outlined, the study area selected and to be surveyed basically reflects that B. Simpson opportunistically surveyed back in 2002. Before providing details on the core area surveyed, it is important to portray some of the park's geographical and biological features, in order to picture the singularity of Tanjung Puting National Park.

Tanjung Puting National Park is an overall low lying terrain marking the highest elevation with approximately 50 m a.s. Physiognomy of the landscape is distinctly shaped by the river and lake systems, particularly during the wet season. Three main rivers run through Tanjung Puting National Park, with its manifold networked patterned tributaries. Smaller tidal and slow-moving blackwater rivers drain Tanjung Puting National Park in the northern and central areas of the park. About 50% of the park's area can be flooded for a minimum of four months during the year.

The main terrain of Tanjung Puting National Park is alluvial of origin. The coastal plain was filled by alluvium and peat deposits from Tertiary formations after being submerged during the Pleistocene. The origin of the slightly elevated northern terrain may have evolved from sandstone deposits during the Tertiary.
The soils are generally characterized as acid and infertile, however the organic content increases in inland swamps. Three main topsoils occur, the river levee soils (clays), peats which have a thickness of up to 2 m in some occasions, and those at more elevated areas with a higher sand content.
Lying in the equatorial region, annual precipitation is high along with high humidity and temperatures. Borneo's climate is defined as ever-wet or tropical – equatorial. The dry season is marked from July to September, while the main wet season is distinct from October to April. Mean annual rainfall is recorded around 2,400 mm. Low water levels during the dry season in turn lead to the lowest night temperatures falling beyond 20°C. The maximal temperature recorded at Camp Leakey was 37.5°C. However, because of the geographical proximity to the equator, there is little seasonal variation in temperatures particularly in lowland habitats.
Tanjung Puting National Park supports the growth of a medium-sized forest, in contrast to the huge dipterocarp lowland forests famous for Borneo. However, there are occasional emergents such as *Alstonia* spp. of more than 50 m. Following are brief portraits of three of the park's major habitats.
Approximately one third of the park consists of heath forests, a tree community of low canopy characteristic in nutrient impoverished environments. This forest type varies across Borneo, but a common feature is that all heath forests are established on infertile soil associated with heavy rainfall but can not be drained due to a hard iron layer approx. 1m below the soil surface. In Central Kalimantan topsoils in heath forests ("kerapah") consist of podsolic and peat elements.
While the preservation of lowland dipterocarp and montane forests have always been a major focus, and the ecological importance of neighbouring habitats has been neglected, newer research activities have revealed that in particular the Southeast Asian peat swamp forests harbour a distinct and remarkable specialized flora and fauna. Tree diversity in peat swamp forests is not as depauperate as was long thought. The nutrient-poor and acidic soils allow the growth of many more wooden plants, comparable to tree diversity in forests established on mineral soils (Page 2002).
Though peat swamp forests are decreasing in extent, across Southeast Asia, they still remain the dominant habitat type in Tanjung Puting National Park (approx. 20% peat swamp habitat of the entire protected terrain). Peat swamp forests are rain-fed and thus reveal low fertile soils. The characteristic appearance of peat swamp forests are the so-called blackwaters and vegetation with various adaptive root systems in this waterlogged habitat, e.g. aerial and stilt roots. The tea colour of the water is derived from specific ingredients which are leached out from leaf litter. These toxic substances lead to a relative high acidity of 4,0 and below. Accordingly, only strongly adapted specialists in flora and fauna can withstand these harshest aquatic habitats with high concentrations of acids, sulphates and tannins.
The tree flora of the Tanjung Puting National Park basically reflects taxa which are adapted to periodical floods, e.g., *Campnosperma*, *Ganua* or *Shorea balangeran* or the Ramin *Gonystylus bancanus* (cf. Galdikas & Shapiro 1994, MacKinnon et al. 1996, www.nature-conservation.or.id/kalimantan.html.). To date the park harbours more than 600 tree species and 200 orchid species alongside with numerous species of pitcher plants in the under story. The most distinct vegetation pattern surrounding the Sekonyer River systems is a forest type with a lower canopy height and girth size, and the widespread riverlining weeds *Hanguana malayana* and *Pandanus* sp., of which former is more common in sun exposed patches and latter more common in canopy shaded river stretches (cf. Cover photo & Figs. 5,6).
Next to the orangutan, the National Park may sustain one of Borneo's largest populations of the endemic proboscis monkey (*Nasalis larvatus*). Other remarkable and endangered fauna native to this National Park is the highly-priced aquarium fish, the dragonfish or Arowana (*Scleropages formosus*), Swamp Toad (*Pseudobufo subasper*), the Irrawaddy dolphin (*Orcaella brevirostris*) and the Dugong (*Dugong dugon*). Conservation significance is also placed on one of the world's rarest

storks, the Wooly-necked Stork (*Ciconia episcopus*), and the Wandering Whistling Duck (*Dendrocygna arcuata*). Incidental records of the vertebrate fauna were compiled in Appendix VI.

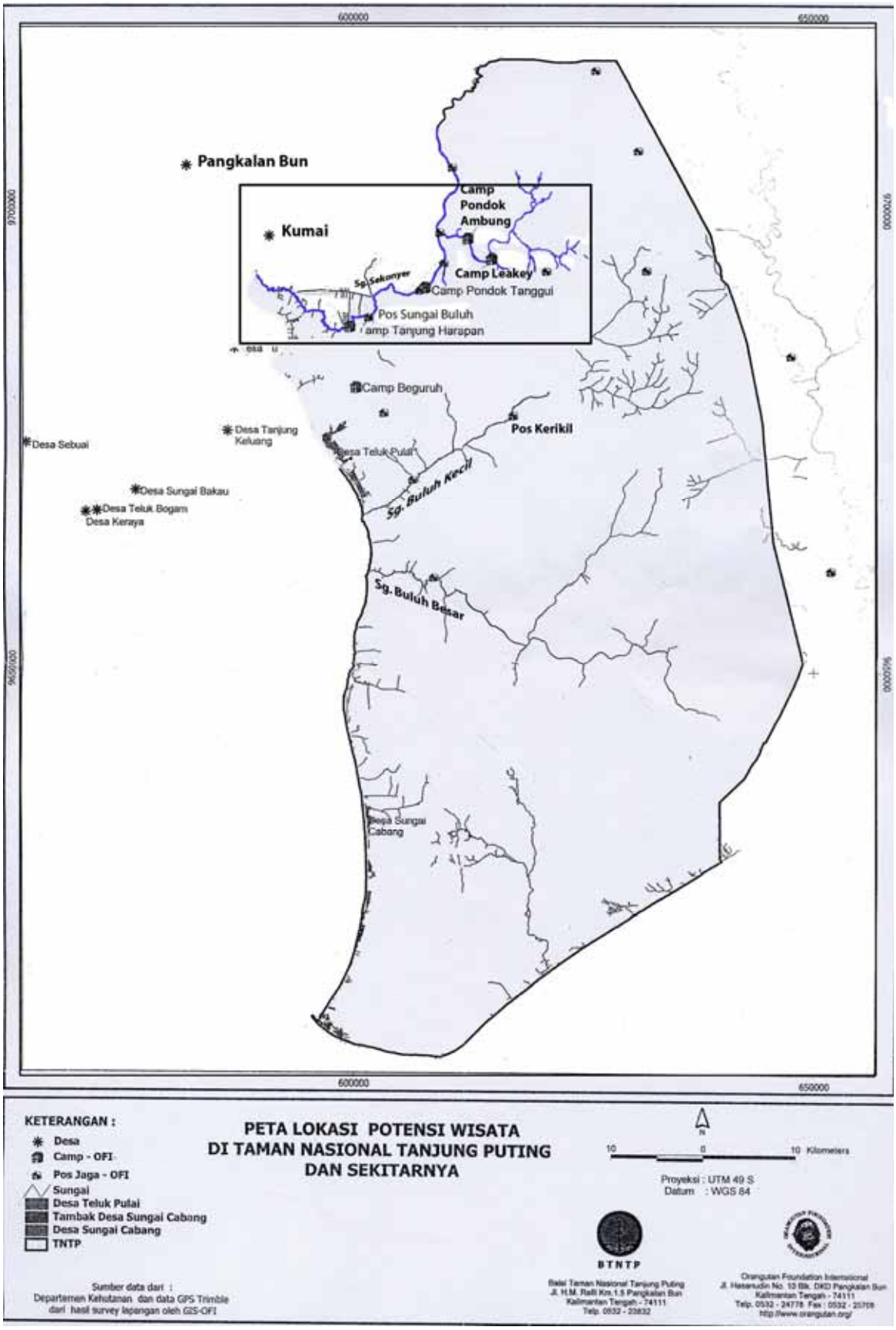

Figure 3. The Tanjung Puting National Park showing the main river systems. Inset square is illustrated in Fig. 4 and frames the study area. Source: PHKA, Pangkalan Bun.

Vertebrate communities of the blackwaters have received relatively little attention from field studies. Many unique stenotypic fish species occur. The freshwater crocodilian Tomistoma is one of two crocodilians found in the park, however, it is relatively new to science that *T. schlegelii* is a habitat-specialist, naturally associated with peat swamp forests (cf. Simpson et a. 1998, Stuebing et al. 1998, Bezuijen et al. 2001). Inventory lists of Tanjung Puting's flora and fauna can be viewed at (www.nature-conservation.or.id/kalimantan.html.).

The National Park is reached via Pangkalan Bun, where the airport is, and an approximately 15 km car ride to the old sea port Kumai. There are no roads in the park, all access is by boat. Camp Leakey, upriver the Sekonyer Kanan, is reached by either klotok (wooden boat) or speed boat in 4 or 1,5 hours, respectively. The Tropical Forest Research Station "Pondok Ambung" is located in the middle stretch of the Sekonyer Kanan River aproximately 3.4 km from Camp Leakey.

Core study area. This study site represents the most frequented locality of the Tanjung Puting National Park due to the ecotourists and volunteers regular visiting and assisting Camp Leakey. The Sekonyer Kanan is a tributary of the Sekonyer River and the junction of both rivers is marked by the "Pos Muara". These rivers mark the northwestern border of the National Park (Fig. 4). The Sekonyer Kanan is a river stretch of approximately 7.6 km, and the river distance between Pondok Ambung (S 02°44'478''; E 111°55'156'') and Camp Leakey (S 02°45'621''; E 111°56'559'') is 3.4 km (Fig.4). The river width of the Sekonyer Kanan during this study varied approx. between 8 and 18 m and was dominated by densely vegetated river-lining *Hanguana malayana* and *Pandanus* spp. (cf. Cover image & Figs. 5,6). The main Sekonyer River had a width of approximately ± 50 m. From the river mouth upriver, along a distance of 13.5 km *Nypa fruticans* framed the Sekonyer to both sides. While the Sekonyer Kanan is characteristically tea-coloured (due to tidal influences from the Sekonyer, turbid water entered the Sekonyer Kanan more or less up to the level of Pondok Ambung), the Sekonyer River was always turbid, a consequence of illegal gold mining activities upriver the Sekonyer (Figs. 5,6).

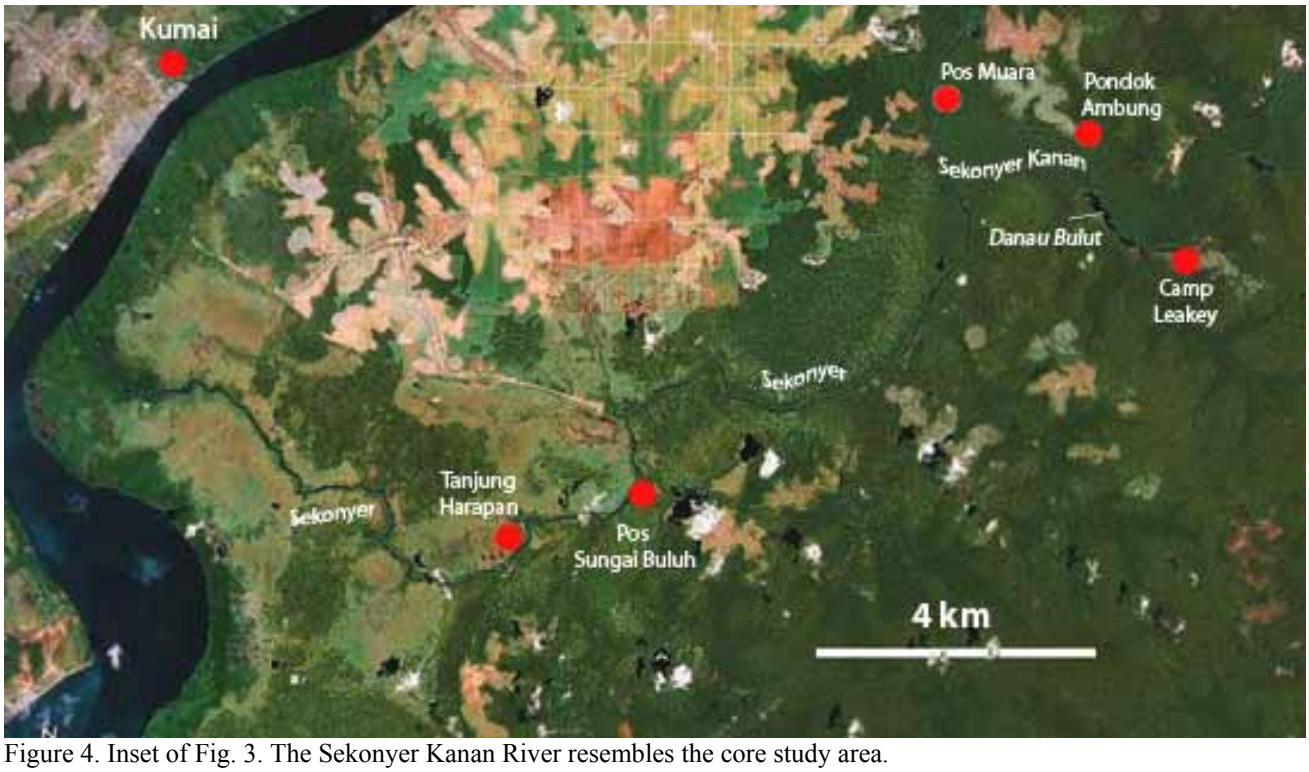

Figure 4. Inset of Fig. 3. The Sekonyer Kanan River resembles the core study area.


Figures 5,6. Left: The blackwaters of the Sekonyer Kanan River, Right: By longboat on the turbid Sekonyer River. Photos: left, M. Auliya, right, Arbain.

Sungai Buluh Kecil River. In order to check whether additional river systems in the Tanjung Puting National Park revealed similar high densities of Tomistoma as in the Sekonyer and Sekonyer Kanan River, the Sungai Buluh Kecil River was selected upon the recommendation of S. Brend and staff of Pondok Ambung. Entering the river mouth of the Sungai Buluh Kecil on 6 Oct, a GPS receiver measured the upriver distance of established *Nypa* palms to both sides of the river; 5.3 km from the river mouth. The chief difference between the Sungai Buluh Kecil River and the Sekonyer Kanan River was that almost the entire river stretch reflected logged area, often revealing entirely cleared habitat at both sides of the river. Occasionally, riverlining trees and dense patches with *Pandanus* sp. were present partly narrowing the river up to 2m. 8 km from the last post "Pos Kerikil" at the Sungai Buluh Kecil River, the widest river passage was approx. 15 m. Commonly coves with driftwood accumulations were concealed behind *Pandanus* sp. along the waterline, also revealing bare, peaty riverbanks and lower slopes.

3.4 Study equipment and local staff

Study equipment. Long distances in the National Park can only be covered by means of a boat. In doing so, the cooperation of OF again proved indispensable. Four boat types were avalaible, (1) a small wooden canoe-like boat called "sampan" or "jukung", (2) a long boat ("klotok") motorized by a diesel engine, (3) a tourist houseboat (" klotok turis"), and (4) a speedboat, motorized by an outboard engineer. For the purpose of a crocodile survey, the most appropriate boat should be easy to handle and have a quiet engine. The two boats used during this field survey were the long-boat and the speedboat. Further study equipment included waterproof torchlights and bags as well as nylon cords for incidental captures, and various measuring tools to determine specific environmental variables (a measuring tape, a thermometer and hygrometer (were measured regularly at the Pondok Ambung Research Station), a portable salinometer and pH-meter with an electrode). All these variables were recorded by the senior author. Microhabitats, flora and fauna were additionally documented with a pair of binoculars plus a digital and analogous reflex camera.

Local staff. People who assisted with this survey were Mr. Jakirudin, Manager of Pondok Ambung, Mr. Arbain of the Research Station's field assistants, who is himself a very experienced local naturalist, and Mr. Agus Lelono, a PHKA staff member. During night time (spotlight) and daytime surveys, all three assistants accompanied M. Auliya, as more eyes can naturally record more crocodile observations.



Figures 7,8. Left: A. Leiman and S. Brend in a speed boat aside a long-boat beyond the jetty of Pondok Ambung. Right: Assistants and the senior author planning the next survey at Pondok Ambung. Photos: left, M. Auliya, Right, Desy.

3.5 Survey methods

Surveys in general included diurnal and nocturnal surveys at different times, however the main focus was spotlight surveys conducted by boat. Rivers surveyed were the Sekonyer River, Sekonyer Kanan River, the parched Danau (lake) Bulut next to the Sekonyer Kanan (cf. Figure 4), the Sungai Bulin and the Sungai Buluh Kecil River (cf. Figure 3). Every person was furnished with one torchlight, and the waterline was scanned on both sides at generally very low speeds (Fig. 9). The most silent way to survey the rivers was by paddling. This locomotion method was tested and compared in its efficacy with the much louder motorized boat survey. If (crocodile) eyeshine was observed and the situation allowed, the team attempted to approach the individual(s) as closely as possible. In field data sheets, all observational data was filled in (see below). In some instances, in close proximity to Tomistoma specimens, behavioural observations could be recorded. Specific river stretches (transects) were repeatedly surveyed. Due to the limited study period and finances, the transect from the Pondok Ambung Tropical Forest Research Station to Camp Leakey on the Sekonyer Kanan River proved to be the most convenient to survey (cf. Figure 4). At daytime, the riparian zone was observed by boat, particularly searching for suitable basking sites and active or basking Tomistoma (Fig. 10). GPS data could also mark locality records of individual Tomistoma on the Sekonyer River. On two occasions, potential nesting sites were surveyed by foot amid densely vegetated and stilt-rooted swamp forests.



Figures 9,10. Left: Spotlight survey, at 7:30 p.m., 7. X. 2005. Right: Inspection of a river bank (S 02°44’567’’; E 111°55’282’’), a potential basking site aside the Sekonyer Kanan River during the end of the dry season, usually submerged in the wet season. Photos: Arbain.

3.6 Habitat survey

Macro- and micro-habitats were documented in detail by observation and photographs. Eyecatching and dominant vegetation was recorded, as was the habitat in which, or adjacent to which, Tomistoma individuals were observed. This information is essential to understand and describe autecological traits of Tomistoma.
Plant species recorded may also represent indicator species in the habitat requirements of Tomistoma. Equally, the accompanying fauna, if encountered accidentally, was recorded, contributing to an overall better understanding of (specialized) life communities of peat swamp forests. Additionally the habitat survey also documented the anthropogenic induced habitats (tourist activities, logged areas, grassland and cultivation).

3.7 Field data sheets

Specific data sheets were created only for recording of observational data on crocodilians (see Appendix II). Because populations of the Saltwater Crocodile (*Crocodylus porosus*) also inhabit the Tanjung Puting National Park, the data sheet allowed for observations of both species.

3.8 Community interviews

Interviews with local communities were conducted with at least 6 local residents in the park, working either for the Orangutan Foundation or the PHKA. Information provided by these is referenced by names and the additive "personal comment" abbreviated as "pers. comm.".

4 RESULTS

4.1 Abiotic data

At the Pondok Ambung Tropical Research Station a thermometer and a hygrometer were attached to a wooden wall of the sleeping accommodation. Due to the irregularly timed boat surveys, it was not possible to record a continuous data-set of weather variables. However, some data recorded has been summarized (see Table 1).
Apart from temperature and relative humidity (%) values the acidity recorded of the Sekonyer Kanan was pH = 4.2, at the level of the Danau Bulut (3 Oct) and at the jetty of Pondok Ambung (4 Oct). At the jetty of "Pos Kerikil" aside the Sungai Buluh Kecil, acidity was measured at pH = 3.92 (7 Oct). On 4 Oct. the first two heavy rain showers were recorded after the dry season (Bain, pers. comm.).

Table 1. Temperature and relative humidity (%) values measured at the Pondok Ambung Tropical Forest Research station, October 2005.

	4 Oct.	5 Oct.	5 Oct.	6 Oct.	8 Oct.	8 Oct.	8 Oct.	8 Oct.	9 Oct.	9 Oct.
a.m.		6:15			7:40				6:15	7:45
p.m.	10:45		3:45	4:30		3:35	6:45	8:30		
°C	23.9	23.4	28.3	25.1	27	30.4	27.3	26.4	24.2	27.1
% (rel. hum.)	72	76	55	69	68	57	55	60	71	69

4.2 Observations of *Tomistoma schlegelii*

The following results describe absolute data on the number of crocodiles recorded in the varying waterways surveyed during different daytimes. Individual observations are commented in more detail in Table 3.

Crocodile surveys were conducted in three rivers: Sekonyer River, Sekonyer Kanan River and Sungai Buluh Kecil River. The small tributary Sungai Bulin of the Sekonyer River could not be penetrated beyond 50m due to several logs blocking the thoroughfare.

Tomistoma schlegelii was observed in the Sekonyer River and the Sekonyer Kanan River, none were recorded in the remaining watercourses surveyed. The Sekonyer Kanan River was surveyed seven times and the Sekonyer River three times.

Forty-six observations of Tomistoma were recorded in nine days: 38 in the Sekonyer Kanan River and eight in the Sekonyer River (Table 2). Autecological and ethological information was documented from 14 Tomistoma specimens on data sheets, together with one single observation of *C. porosus* and a find of a Tomistoma carcass (cf. Table 4).

Table 2. Observational data of *Tomistoma schlegelii* in the Sekonyer River and the Sekonyer Kanan River, Sept.-Oct. 2005. PA = Pondok Ambung; CL= Camp Leakey. Grey shaded data mark all observations not documented in data sheets. Each row refers to one survey! Columns indicating two numbers of Tomistoma observed also indicate the observational record made during the way back to the point of departure.

Date	Time	No. Tomistoma observed	Distance covered (km)	Localities/river stretch	Type of boat utilized	Remarks
30 Sept.	≈ 6:45 p.m. to 7:30 p.m.	3	3.4	PA - CL	long-boat with engine	recorded on data sheets!
1 Oct.	7:30 a.m to 9:30 a.m.	4	2.1	PA directing to CL	long-boat with paddles	recorded on data sheets!
	6:45 p.m. to 8:10 p.m.	9	3.5	PA beyond CL	long-boat, engine and paddles	not recorded on data sheets! (cf. Table 3)
2 Oct.	10:00 a.m. 11:45 a.m.	5	≈ 10	Sekonyer R. (Pos Sungai Bulin to Pos Sungai Buluh Sekonyer)	long-boat (with engine!)	recorded on data sheets!, one dead find (Fig. 20)!
	8:30 p.m. to 10:30 p.m.	3	≈ 2	Sekonyer Kanan heading towards junction of Sekonyer R.,	long-boat with paddles	not recorded on data sheets!
3 Oct.	8 p.m.	1	-	opposite of Pondok Ambung jetty, Sekonyer Kanan R.	-	-
4 Oct.	7 p.m. to 8:30 p.m.	8, 4	6.8	PA to CL, CL to PA	speedboat (low speed), speedboat (higher speed)	no data sheets available! Behavioural observations! One capture!
5 Oct.	12:45 p.m. 12:50 p.m.	2	≈ 12	Tanjung Harapan to Pos Muara	speedboat (high speed)	recorded on data sheets!
7 Oct.	11:10 a.m.	1		Sekonyer R.	speedboat	recorded on data sheet!
	7:45 p.m. to 9 p.m.	3, 3	≈ 1.8 x 2	PA to level of the lake "Danau Bulut", Danau Bulut to PA	long-boat with paddles	not recorded on data sheets!

Several Tomistoma specimens observed and not considered in data sheets could be size-estimated during approach:

- Additional data of the nine Tomistoma observed on 1 Oct from Pondok Ambung beyond Camp Leakey are compiled in Table 3.
- The three Tomistoma observed on 2 Oct (Table 2) from Pondok Ambung heading to Pos Muara at the junction to the Sekonyer River, had estimated total lengths between 1 and 1,5 m. This river stretch was dominated by stands of *Pandanus*. On the Sekonyer River a distance of approximately 1km was covered with paddles, and in two instances eyeshine was recorded, but these originated from the Swamp Toad (*Pseudobufo subasper*).
- The eight Tomistoma recorded on 4 Oct (Table 2) on the distance Pondok Ambung to Camp Leakey between 7 and 8:30 p.m. could be approached to estimate total lengths. Two specimens ranged between 1,6 - 2 m, four specimens between 1-1,3 m and two specimens between 0,8 and 0,9 m. Specimen No. 8 could be captured. After approaching this specimen in proximity of approx. 1m, the slender snout was cautiously grabbed. Morphometrics of

this specimen resulted in a head length of 12cm, snout-vent length of 34 cm and tail length of 36 cm. Accordingly, the total length was 80 cm (Fig. 11).

- The three Tomistoma observed on 7 Oct (Table 2) from Pondok Ambung to the level of "Danau Bulut" could be approached close enough to estimate their total lengths which ranged between 0,9 m and 1,3 m. Way back to Pondok Ambung using the engine, again three Tomistoma were observed.

Figure 11. The juvenile Tomistoma captured on 4 Oct 2005, with a total length of 0,8m (cf. text). Photo: M. Auliya.

Table 3. Nine Tomistoma observations on 1 October between 6:45 p.m. and 8:05 p.m. on the Sekonyer Kanan River. (cf. Table 2). Size estimates of only eyeshine records refer to the grade of movements in the water. These records therefore can not unequivocally refer to Tomistoma.

Time (p.m.)	6:45	6:50	6:52	7:10	7:30	7:53	7:55	8:02
Estimated total size	> 1m	1 - 1,2 m	≈ 1-1.5m	0,60-0,7m	2-2,5 m	approx. 2m	< 0,5-0,6 m	≈1- 1,5 m
Remarks	-	-	only eyeshine!	approached to 1m, then swiftly submerged	among driftwood and logs, slowly submerged	-	2 juveniles, beyond Camp Leakey	only eyeshine!

Of all 46 Tomistoma observations, 34 Tomistoma were detected during spotlight surveys and 12 (incl. the carcass find) during daytime. All observational records made during daytime were recorded in data-sheets (Table 4).

Due to reasons outlined above, this short-term "visual encounter survey" can not permute these field observations into a statistical design. Despite the categorizing in size-classes, it is not feasible to identify the number of individual Tomistoma and those specimens observed on more than one occasion, to in turn provide an estimate of the relative abundance and local population density of *T. schlegelii*. However, the number of total Tomistoma observations made in combination with the different ascertained size classes clearly reveals the existence of a viable population of *Tomistoma schlegelii* restricted to the study area investigated. Transect counts along a known distance provide a rough estimate. In a distance of 3.5 km, from Pondok Ambung slightly beyond the jetty of Camp Leakey, a maximum of nine Tomistoma ranging from approx. 0.5 m to a maximum of approx. 2.5 m in total length, were recorded (Table 3). As additional surveys also recorded Tomistoma along

the same transect, it is legitimate to proceed on the assumption, that more than nine specimens may frequent this river passage. Regardless, to proceed on the assumption that nine specimens were recorded on a 3.5 km river passage, results in a relative density of 2.5 Tomistoma/km.

In spite of this time-constrained investigation, it was possible to increase the insight on Tomistoma habitat and abundance by conducting a survey in a remote river system of the Tanjung Puting National Park. Furthermore, it was possible to collect behavioural and ecological data on Tomistoma which will be tentatively described in the following chapters.

Table 4. Compilation of all crocodile observations recorded on data sheets (see Appendix II). T = *T. schlegelii*; P = *C. porosus*; juv. = juvenile; CL = Camp Leakey; PA = Pondok Ambung.

No.	Date	Time	Species	approx. age class	approx. total length	Locality (River)	Position in water	approx. distance to human presence; (geographic) position	Habitat characteristics	Behaviour during encounter	Observation by /remarks
1	30.09.05	≈ 7 p.m.	T	juv.	≈ 1 m	Sekonyer Kanan	floating at riverside	between CL and PA	among a stand of *Hanguana malayana*	did not submerge while passing by motorized long boat	Auliya
2	30.09.05	7:10 p.m.	T	juv.	< 1 m	Sekonyer Kanan	floating at riverside	between CL and PA	among a stand of *Hanguana malayana*	see 1)	Jak, Agus, Bain
3	30.09.05	≈ 7:20 p.m.	T	subad.	≈ 1,50 m	Sekonyer Kanan	1.5 m from riverside, head emerging, body submerged	between CL and PA	submerged logs, branches overhanging riverside	resting with hindlegs on submerged logs, could be approached to 2 m, specimen submerged and dived towards the middle of river	Auliya, Bain, Agus
4	01.10.05	8:40 a.m.	T	subadult /adult	≈ 2,50m	Sekonyer Kanan	resting on *Hanguana*	between CL and PA	among a stand of *Hanguana malayana*	specimen was previously basking, approached to 5-6 m, escaped swiftly into the river	Auliya, Bain, Agus/ photo of basking site
5	01.10.05	9:20 a.m.	T	juv.	≈ 0,9 m	Sekonyer Kanan	dense vegetated riverside	between CL and PA	in riverlining *Hanguana*	swiftly submerged	Auliya, Bain
6	01.10.05	9:45 a.m.	T	juv.	≈ 100 cm	Sekonyer Kanan	dense vegetated riverside	between CL and PA	in a pool aside the river framed with *Hanguana*	submerged loudly	Bain
7	01.10.05	≈ 10:25 a.m.	T	subadult	≈ 1,50 m	Sekonyer Kanan	dense vegetated riverside	between CL and PA	amid *Hanguana malayana*	quietly submerged	Bain
8	02.10.05	10:50 a.m.	T	adult	≈ 2,8m	Sekonyer River	dead specimen, hide lying overturned on a log	S02°45'116''; E111°53'675''	turbid, 25-30 m wide, aside swamp forest	-	Carcass approx. 1 week old, photo
9	02.10.05	≈ 11 a.m.	T	adult	≈ 4m	Sekonyer River	approx. 3-4m from riverside, only head emerged	S02°46'424"";E111°53' 292'', near "Pos Sungai Ulin"	turbid water, riverside bordering logged area, outside the National Park	head quietly submerged,	Auliya et al. , pH = 4.63, water temperatue 10 cm below surface 27°C
10	02.10.05	12:02 p.m.	T	adult	≈ 2,8-3 m	Sekonyer River	basking on a log, hindfeet and tail submerged	S02°47'047''; E111°50'566''	turbid water, basking site next to the waterline, stands of Pandanus nearby	did not escape into the water while passing by long-boat	Auliya et al.
11	02.10.05	2:05 p.m.	T	adult	≈ 2,8 – 3 m	Sekonyer River	only head emerged,	S02°46'861'': E111°53'100''	turbid water, stands of	head slowly submerged beneath water surface	Jak, Agus, Bain

							approx. 30 cm, close to the waterline		Pandanus, nearby troop of Proboscis monkeys		
12	02.10.05	≈ 2:10 p.m.	T	subadult	≈ 1,8m	Sekonyer River	approx. 1m adjacent waterline	near 4m specimen, way back from "Pos Sungai Buluh"	driftwood	submerged swiftly	Bain
13	05.10.05	≈ 12:40 p.m.	P	adult	≈ 2,4 m	Sekonyer River	basking on muddy river bank	S02°49'368''; E111°46'670''	turbid water, among riverlining stands of Nypa palms	could be approached to 3m, did not escape into the water but tried to penetrate through the Nypa shoots	Auliya et al.
14	05.10.05	≈ 12:45 p.m.	T	adult	≈ 2,8 m	Sekonyer River	approx. 4 m from waterline, swimming upstream	approx. 3 km before junction to Sekonyer Kanan	turbid water, stands of Pandanus intermingled with riparian shrubs	after approach, slowly submerged into the water	Auliya et al.
15	05.10.05	≈ 12:50 p.m.	T	adult	≈ 3,5-3,8 m	Sekonyer River	basking in shallow water on the river edge	approx. 2.5 km before junction to Sekonyer Kanan	turbid water, among *Hanguana* and low riparian shrubs	after approach it slowly slipped into deeper water	Auliya et al., photograph (Figure 19)
16	07.10.05	11:10 a.m.	T	adult	> 3 m	Sekonyer River	resting in shallow water on the river edge	S 02°47'047''; E 111°52'576''	turbid water, basking among a stand of *Hanguana*	observed while passing by speedboat, after returning to the site it slowly submerged and dived downstream near to the river edge, indicated by a line of bubbles	Auliya et al.

Figure 12. Sekonyer River with six red GPS locality marks of crocodiles. Mark Nr. 13 (the most left) shows the locality record of *C. porosus*, while the five marks to the right all indicate adult Tomistoma records.

4.3 Preliminary behavioural observations of *Tomistoma schlegelii*

Juvenile *Tomistoma schlegelii*. During the spotlight surveys, juvenile specimens revealed some characteristic behaviour. All had their jaws gaping a few centimetres and several could be approached up to 1-3 m. The most common escape behaviour was to submerge and dive only a few metres towards deeper river sections where they halted and rested on the river bottom. This has also been observed in wild Tomistoma in peat swamp forests in Sumatra (Bezuijen, pers. comm.). Those specimens approached near stands of *Hanguana malayana* or other riparian vegetation, demonstrated extraordinary and agile body movements in the mode to escape. The entire body escaped eel-like with left and right turns between the submerged water plants.

Niche partitioning between age classes of *Tomistoma schlegelii*. Interestingly, and most obvious were the observational records of size classes of Tomistoma comparatively of both major rivers surveyed, the Sekonyer River and the Sekonyer Kanan River. 30 specimens observed and size–estimated on the Sekonyer Kanan River ranged approx. between 0,5 and 2.5 m in total length, whereas nine specimens observed and size-estimated on the Sekonyer River ranged approx. between 1.8 to 4 m in total length. These distinct disparities may provide some hint on specific and separated habitat utilization of immature to that of mature individuals. Thus, the immature individuals may favour smaller and slow-flowing waterbodies, mature Tomistoma on the other hand faster flowing and wider water bodies (assumingly in the non-reproductive season).

Potential basking and nesting sites of *Tomistoma schlegelii*. On three occasions walks on land were undertaken to investigate habitat conditions for potential nesting sites. On 30 Sept riverine swamp forest along the Sekonyer Kanan was surveyed by foot from Pondok Ambung towards Camp Leakey. The end of the dry season revealed river banks which may potentially be used as basking sites (cf. Figure 10). However, during the sunny morning hours no direct or indirect signs of crocodiles were recorded either on sun-exposed river banks or in the riparian swamp forest. The

flooding regime of these low-to medium sized peat swamp forests may last several months annually, revealing diverse stilt-rooted trees, with uplifted or emerged root systems functioning as obstacles for driftwood and other floating organic debris. The water level during the wet season may be 1-2 metres higher. These experiences make it at first difficult to detect the actual waterline in the wet season during the high dry season. At least three specimens were observed basking between noon and 1 p.m. Basking sites included the shallow water amid riparian vegetaton, logs and muddy river banks (cf. Figs. 13, 14).

Figure 13. Subadult *Tomistoma schlegelii* basking at the Sekonyer Kanan. Photo displayed in the education center at Camp Leakey. Photo: OF (UK).

On 2 Oct the Sungai Bulin, a small tributary of the Sekonyer River was investigated for Tomistoma nesting sites. The five to seven metre-wide rivulet was framed by a closed canopy resulting in a dark forested habitat. These abiotic conditions did not allow the growth of river-lining weeds or shrubs, e.g., *Pandanus* sp. or *Hanguana malayana*, instead plenty of driftwood accumulations and logs described this microhabitat, avoiding the thoroughfare after 50 m. This highly inaccessible habitat may represent Tomistoma retreats or suitable nesting sites in upriver locations. Similar tributaries of the Sekonyer River (side of the National park) should be investigated in follow-up studies.

On 8 Oct the parched seasonal lake "Danau Bulut" was inspected on foot. The lake was separated by a dense 5-8 m stretch of *Pandanus* sp. and *H. malayana* to the waterline. The question arises whether and how Tomistoma utilize a pure *Pandanus* habitat? The fringing vegetation of the lake was surveyed heading towards Camp Leakey through riverine swamp forest. Stilt-roots filled with soil and foliage, *Pandanus* seedlings and driftwood characterized this habitat. It seemed suitable for Tomistoma nesting sites, however, the area is obviously to close to Camp Leakey and therefore predisposed to human disturbances. Also indirect signs of Bearded pigs (*Sus barbatus*) were present, which roam the catchment area of Camp Leakey. Nesting sites of Tomistoma must be located in more remote areas isolated from all Camp Leakey-oriented tourist activities. At Camp

Figure 14. Subadult *Tomistoma schlegelii* basking on Sekonyer Kanan, approximately 500m upstream from Pondok Ambung, 11 August 2006 at mid-day. Photo: S. Brend.

Leakey, Pak Satri, staff of Camp Leakey, reported that he had found crocodile eggs beyond Camp Leakey following the Sekonyer Kanan River. Unfortunately he could not provide any further data, concerning the number of eggs, distance to the water edge, etc. Remoteness is pre-existing here and with rising water levels during the wet season, Tomistoma can penetrate into more isolated areas suitable for nesting activities. Overall, no Tomistoma nesting activities could be recorded by either direct or indirect signs during the survey.

4.4 The Sungai Buluh Kecil

The habitat and the occurrence of crocodiles were first investigated during daytime upriver the Sungai Buluh Kecil River to the last post " Pos Kerikil" (also cf. methods). No crocodiles were recorded.
A spotlight survey of a 20 km stretch of the Sungai Buloh Kecil River on the same day did not result in any observation of crocodiles. The next day, the team left the Sungai Buloh Kecil River back to Pondok Ambung- Along this entire waterway until the river mouth, no crocodiles were observed. Pak Bambang of the first post "Pos Jagu Sungai Buluh Kecil" was interviewed on the occurrence of crocodiles particularly that of Tomistoma in this river. Generally he reported on Saltwater crocodiles feeding on pigs and monkeys along the riverlining *Nypa* palms.
During the daytime survey, rising bubbles were commonly observed, however these could not be unequivocally referred to crocodiles. According to Pak Idul from the "Pos Kerikil" the Southeast Asian Softshell Turtle (*Amyda cartilaginea*) also frequents this river. In 2005, Pak Idul observed a Saltwater crocodile near the "Pos Kerikil" in the Sungai Lopo Kanan, a sidearm of the Sungai Buluh Kecil, attacking a wild boar, and in 2004 he said that he strongly believes in having seen a Tomistoma in the Sungai Lopo Kiri, opposite of the Sungai Lopo Kanan.

Figures 15, 16. The Sungai Buluh Kecil showing logged area and remaining Tomistoma suitable habitat. Photos: M. Auliya.

4.5 Threats

Extensive illegal logging activities mirror habitat degradation across the National Park. Significant threats are also posed through gold mining activities and increasing boat traffic. Additionally Bearded pig populations roam the area and take advantage as commensals from human facilities, e.g., Camp Leakey. Wild pigs pose a threat to the eggs and hatchlings of Tomistoma (cf. Bezuijen et al. 1997), and Water Monitor lizards (*Varanus salvator* ssp.) occasionally observed along the Sekonyer Kanan riverside may represent another potential egg predator.
At present, the most critical threat to the survival of the Tomistoma population at the Sekonyer Kanan is the impact of gold mining activities (Fig. 17). Tidal rise/changes of the Sekonyer Kanan were clearly indicated by the intrusion of turbid milk coffee-brown water (up to the level of the Pondok Ambung Tropical Forest Research Station), originating from the Sekonyer River (Fig. 18). Other human-related threats to the survival of Tomistoma habitat require identification.

Figure 17. Degraded habitat due to gold mining activities, adjacent to Tanjung Puting National Park.
Photo: S. Brend.

Figure 18. Turbid water from the Sekonyer River penetrating into the blackwater of the Sekonyer Kanan River, at the level of Pondok Ambung, 30 Sept. 2005. Photo: M. Auliya.

5 DISCUSSION and CONCLUSIONS

5.1 Tomistoma in Tanjung Puting National Park

This short-term assessment confirmed that extraordinary high densities of Tomistoma occur in the Sekonyer River systems of the Tanjung Puting National Park and support the observations made by Simpson (2004). A range of small and large-sized Tomistoma was observed in the wild, confirming that a stable breeding population occurs in the Sekonyer River and Sekonyer Kanan River. This result almost resembles the two-fold value reported by Simpson (2004), "11 false gharials were seen in 7.6 km, resulting in a density of 1.45/km, one of the highest densities ever recorded for this species". Also after Simpson's survey in 2002, the density reported by Frazier & Maturbongs (1990) of 1.58 individuals/km still represented the highest ever recorded density of wild Tomistoma. Further data on population densities of Tomistoma have been summarized by Bezuijen et al. (1998), and therein the "highest overall density" was reported in 1990 at 0.34/km for the Berbak National Park (Jambi, Sumatra), in 1996 followed by 0.26/km on the Air Hitam Laut Rivers also in Berbak NP, in 1995 0.21/km at the Merang River (South Sumatra), and in 1994 0.12/km in the Danau Sentarum National Park, West Kalimantan.
Recent Tomistoma surveys in West Kalimantan Province revealed rather low densities (8 Tomistoma/227 km waterways). Here anthropogenic disturbances to Tomistoma populations in West Kalimantan include logging, draining of peat swamp forests, high fishing pressures, increased spreading/dispersal of human activities on water bodies, resulting in the fragmentation of small local populations (cf. Frazier 2000, Bezuijen et al. 2005). Tomistoma has also been reported from Danau Sentarum National Park (West Kalimantan), one of Indonesia's two Ramsar sites, however the human impact reported from there is particularly high during the dry season when water levels

recede, a period where the abundant local fisherfolk use “indiscriminate fish capturing methods” (Frazier 2000).
As evidenced, the density of 2.5 individuals/km recorded in this study is distinctly higher than that reported by Frazier & Maturbongs (1990), or all to-date survey results on population densities of *T. schlegelii* are distinctly lower than those ever recorded in the Tanjung Puting National Park (also cf. Bezuijen et al. 1995, 1997, 2001, 2002). The question that now arises is why does Tomistoma occur in these high densities, and does this population index reflect the situation of the entire Tanjung Puting National Park? Density calculations reported by Frazier & Maturbongs (1990), Simpson (2004) and this study all mention the observation of varying size classes of Tomistoma hence reflecting a stable breeding population for more than 15 years.
A possible reason to explain the high densities of Tomistoma in the survey area of Tanjung Puting National Park, are the constant conservation efforts since 1971, of Dr. Birute Galdikas and the Orangutan Foundation International (OFI).
Despite illegal logging and gold mining activities, elsewhere in the park, the enclave around Camp Leakey may represent one of the best protected areas in Indonesia. This area is protected around the clock, and ecotourism activities occur throughout the year. Although boat traffic by e.g., staff, volunteers and tourists of Camp Leakey and scientists have increased over the last few years, this impact so far may not have resulted in a decline of the Tomistoma population residing in the Sekonyer Kanan River and stretches of the main Sekonyer River. During the wet season boat traffic is much less, decreasing to approx. 1-2 boats/day (Brend, pers. comm. 2005).
An additional reason for explaining the high densities on the Sekonyer Kanan River may be since the main Sekonyer River has been altered due to the practices of gold mining workers, the river now is turbid and milk-coffee brown and may be contaminated (water samples are in the process of examination), more crocodiles seek refuge in the Sekonyer Kanan River (Pak Ibun, pers. comm., 30 Sept 05). These assumptions cannot be proven by this study. It is noteworthy that the turbid Sekonyer River apparently still harbours adult Tomistoma (cf. Figs. 19,20), however one carcass of an adult specimen was found in the Sekonyer River, but its cause of death could not be identified (see Figure 22).

Figure 19. Adult Tomistoma on the Sekonyer River, between Pesalat and Pondok Tanggui, 5 July 2005, between 10 and 11:30 a.m. Photo: S. Brend.

Figure 20. Adult Tomistoma basking at almost 1 p.m. aside the Sekonyer River, 5 Oct 2005 (cf. Table 4). Photo: M. Auliya.

The survey results obtained from Sungai Buluh Kecil however, may cause some anxiety. Although illegal logging ended three years ago (illegal logging activities at Sungai Buluh Kecil commenced in 1995 and lasted approx. until 2002, Pak Idul, pers. comm.) the area still revealed suitable Tomistoma habitat. Two guard posts are now established along this river, and illegal logging seems to have disappeared in this area. Nonetheless during this study the river seemed void of crocodiles despite few secondary observations (see above). Numerous questions remain in explaining this. Did illegal loggers also hunt crocodiles, providing an additional lucrative income? Did some individuals remain but adopting an extremely shy behaviour, and did others escape through connecting rivers during the wet season in the logging era? Does Tomistoma display terrestrial migrations in search for alternative suitable habitats?
Furthermore, this study could uncover several ecological and behavioural traits in *T. schlegelii*. A long-term field study could reveal much-needed information on this species. This study possibly indicates niche partitioning between immature and mature Tomistoma. Follow-up studies would be necessary to assess this preliminary finding, also to ascertain whether human disturbances, e.g., boat traffic, may induce this observed habitat separation between age/size classes.

Overall, it would be of fundamental value to discover other viable local populations of Tomistoma in Tanjung Puting National Park not exposed to boat traffic, and thus providing a comparable data-set to the population surveyed at the Sekonyer Kanan River.

With knowledge of relative abundance and population structure of *Tomistoma schlegelii* gained through mark-recapture studies of all recognized populations in the National Park, it may be possible to assess ecological and behavioural traits of Tomistoma which respond to natural conditions and those raised by human impact. These results may identify further threats opposed to Tomistoma. Considering actual and potential threats to the survival of Tomistoma on the

background with a thorough analysis of habitat quality, profound baseline data would be available to address specific conservation measures and the establishment of management plans by the IUCN/SSC Crocodile Specialist Group-Tomistoma Task Force, in close co-operation with the Park Management authorities and the Orangutan Foundation.

5.2 Coexistence with *Crocodylus porosus*

One Saltwater crocodile was observed during the site visit on 5 Oct on the Sekonyer River amid the riverlining stands of *Nypa fruticans* (see Fig. 21). The question that arises is, if there are any environmental variables which determine the coexistence of both species, *Crocodylus porosus* and *Tomistoma schlegelii*?
It is suspected that the local distribution of *C. porosus* coincides with the distribution and allocation of the extensive and pure stands of the Nypa palms fringing the Sekonyer River from its mouth to 13.5 km upstream. In fact this palm favours brackish waters in quiet estuaries, lagoons and rivers (Tomlinson 1994). Salinity therein may hinder Tomistoma to migrate further downstream, whereas diminishing salinity and acidic freshwater seem to be less favourable habitat conditions for *C. porosus,* although diverse freshwater habitats are commonly inhabited by the Saltwater crocodile within their annual movement patterns (Webb & Manolis 1989).
In 2002, a British tourist was killed by a large Saltwater crocodile in front of the jetty of Camp Leakey. The incident happened at approx. 11 a.m. in April, the Sekonyer Kanan had high water, during the late stages of the wet season (Pak Nuri, Pak Herman, pers. comm.). Apart from the reproductive behaviour and social status, seasonal changes induce a migratory behaviour in Saltwater crocodiles (Ross 1998). However, for the rest of that year, and into the start of 2003, a Saltwater crocodile remained present on the Sekonyer Kanan, and it is believed that it was the same individual which killed the tourist.
If individual *Crocodylus porosus* regularly penetrate into the peaty rivers upstream, e.g., Sekonyer Kanan River during the wet season, or during the high dry season when saline water can reach the junction of the Sekonyer River and Sekonyer Kanan River (Pak Yusran, Pos Sungai Bulu, pers. comm., 2 Oct 05), how do both crocodilians manage to coexist? Is there a specific niche partitioning (except e.g., dietary preferences) among both species, or do both represent competitors during the wet season? These interesting insights and questions will hopefully trigger field studies, also taking the fatal encounter (see above) into consideration. The sympatric and syntop occurrence of both crocodilians in southeastern Sumatra has been reported by Bezuijen et al. (2001), however interspecific relationships remain unclear.

Figures 21,22. Left: An approx. 2.40 m *Crocodylus porosus* recorded on the Sekonyer River, 5 Oct 2005. For details cf. Table 4. Right: approx. one-week old carcass of an adult ca. 2.8m Tomistoma recorded on the Sekonyer River (S02°45’116’’, E111°53’675’’), 2. Oct. 2005. Photos: M. Auliya.

5.3 Conservation issues

Tanjung Puting National Park may only possess a stable and viable Tomistoma population on the Sekonyer River systems. The long-term conservation efforts focusing on orangutans have also contributed to the protection of the local Tomistoma population of the Sekonyer River systems. The remaining park areas not included in this "zone of protection" may be subject to the same threats observed elsewhere in Kalimantan and Sumatra (see above, e.g., Bezuijen et al. 2001, 2002, 2005). Illegal logging activities may not be eradicated from the entire National Park, nonetheless, many areas now seem to have recovered and benefit from in situ national and international conservation efforts e.g., the establishment of control posts. The National Park cannot be monitored at every spot, day and night. Regular control surveys along the waterways in the entire National Park should be carried out.

The value in conserving this protected area has been portrayed in detail above. Southeast Asian peat swamp habitats are steadily decreasing, yet Tanjung Puting National Park still harbours extensive patches of this biodiversity-rich habitat and associated fauna. The park has globally significant populations of orangutans, proboscis monkeys and *Tomistoma*. However, the park has suffered from illegal logging, mining and wild fire and the risk of continued habitat degradation and loss remains high. There is a need for further conservation activities to be implemented, and these would ideally take place alongside a comprehensive programme of scientific monitoring.

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Appendix I Itinerary and operational sequence

25 Sep	Train departure from German residence in Bonn to Frankfurt airport.
26 Sep	Arrival at Jakarta airport. Entered Indonesia with VISA on arrival. Meeting with Pak Adi Susmianto (Director PHKA, Jakarta)
27 Sep	Obtained the research permit "Surat Ijin" Nomor: S. 498/IV/KKH-1/2005 from Pak Direktur Adi Susmianto at PHKA, Jakarta
28 Sep	various settlements e.g., arranging tickets, money matters, stocking equipment
29 Sep	Flight from Jakarta via Semarang (Central Kalimantan)to Pangkalan Bun. Obtained the "Police Report Certificate", No. POL: STM /012/IX/2005/Intelkam from Pak Nurdiona, Pangkalan Bun. Obtained the "Admission letter of Conservation Area", Nomor: S. 509/IV-T.29/Tek/2005, from Pak Drs. Bambang Darmadja, PHKA, Pangkalan Bun
30 Sep	Survey trip by foot from Pondok Ambung (S02°44'478''; E111°55'156'') left to the small land slide/beach strip (S02°44'567''; E111°55'282'') into the Sekonyer Kanan River. Between 9:45 a.m. and 10:15 a.m. no direct neither indirect signs of crocodiles/Tomistoma. Way back along the river line the habitat was surveyed (photographs!)
	At 3:30 p.m. Camp Leakey (S02°45'621''; E111°56'559'') upstream the Sekonyer Kanan was visited for the first time. Various interviews were made with staff of Camp Leakey concerning the occurrence of *Tomistoma schlegelii* (here known as "buaya sapit"). The information centre exhibits one image of Tomistoma. Photographer? (photographs!)
	Around 6:30 p.m. in the dark we headed back to Pondok Ambung from Camp Leakey conducting the first spotlight survey. The distance covered was approx. 3.4 km. Three Tomistoma were observed (see data sheets!)
1 Oct	At 7:30 a.m. a river stretch of 2.1 km by longboat (not using the engine but with two rows) was covered from Pondok Ambung towards Camp Leakey. Four Tomistoma were observed (see data sheets). Several habitat photos were made also from the seasonal lake which is separated by a broad belt of "Bakung" weeds (*Hanguana malayana*) and *Pandanus* sp. from the river. This area may prove to be a nesting area for Tomistoma. 9:30 a.m. back to Pondok Ambung
	At 6:45 p.m. a spotlight survey was undertaken from Pondok Ambung beyond Camp Leakey by longboat partially covering the distance by rowing. At 8:10 p.m. we returned back to Pondok Ambung. A total of nine Tomistoma were sighted (see data sheets!) along a distance of approx. 3.5 km
2 Oct	At approximately 11:45 a.m. we left Pondok Ambung heading to the junction of the Sekonyer Kanan and Sekonyer. The plan was to enter some smaller tributaries of the large Sekonyer River, inspecting potential nesting habitat and the occurrence of Tomistoma. At the "Pos Sungai Bulin", the Sungai Bulin (5-7 in width) could only be entered about 50 m, too many logs avoided the passage. River sides were lacking stands of weed, due to a relative dark habitat, almost no sunlight penetrated to the water surface and forest floor. Trees and logs characterised the river edges. From the "Pos Sungai Bulin" to the "Pos Sungai Buluh Sekonyer" five Tomistoma were observed (see data sheets!)
	At approximately 8:30 p.m. we left Pondok Ambung with five persons in the long boat (without engine!), heading right to the "Pos Muara" at the junction of the Sekonyer Kanan and Sekonyer River. Three Tomistoma were observed all approximately between 1-1.5 m in total length. The river stretch Pondok Ambung to Pos Muara almost lacks the riverine weed "Bakung" instead *Pandanus* stands are frequent
	Emerging into the Sekonyer River we covered another distance of around 1 km by engine. No Tomistoma were seen
3 Oct	Mrs. Ashley Leiman and Stephen Brend left Pondok Ambung around 9 a.m. Staff from Camp Leakey picked us up (Agus and Auliya) to Camp Leakey to recharge my Notebook and to compile my data sheets and interviews for the final research report. Bain was in charge of the Post Pondok Ambung
	At approx. 4:30 p.m. back to Pondok Ambung no Tomistoma were recorded (Speed boat with low speed), on the height of the lake "Danau Bulut" acidity was measured (pH = 4.2)

At approx. 8 p.m. one juv./subadult Tomistoma was observed (only eyeshine) directly opposite of the jetty of Pondok Ambung

4 Oct

No speed boat available, long boat "klotok" was leaking, too noisy to conduct a boat survey. By wireless radio a speedboat was arranged with staff from Camp Leakey to conduct a spotlight survey

Office day in Pondok Ambung, hoping my battery-charged Notebook would last a few hours.

Presumably the wet season was introduced, two heavy rains accompanied the day

Measurements of the water at the jetty of Pondok Ambung: pH = 4.20; 27.1°C five cm below water surface

At 7 p.m. spotlight survey with three persons in speedboat, all were equipped with torches. A very low speed 8 Tomistoma were observed from Pondok Ambung to Camp Leakey. All specimens could be approached so close that total length could be estimated. No data sheets available: Therefore the following data exists: 2 specimens at 160-200cm; 4 specimens at 100-130 cm and 2 specimens at 80 – 90 cm. Specimen No. 8 was captured. Total length 80 cm, head length 12cm, SVL 34 cm and tail length 36 cm. Photos were made with reflex camera. Observations: At first approach many specimens had their mouths gaping a few centimetres. The juveniles were observed as extremely agile under water, finding shelter between roots of Bakung with impressive body turns. Many specimens remained in the first observed position lying in the water during approach up to 1-3 m. After submerging most escaped only a few metres down resting on the river bottom

On the way back with higher speed only four specimens were observed

Measurements outside my room at Pondok Ambung: at 10:45 p.m. 72% rel. humidity

5 Oct

Measurements outside my room at Pondok Ambung: 6:15 am. 76% rel. humidity, at 3:45 p.m. 28,3°C and 55% humidity

At 7 a.m. we left by speedboat (with high speed) to Kumai port (food supply). On the entire distance no crocodiles were observed. Agus, Jak, the captain and myself arrived at approx. 8:30 a.m. after a short stop at Tanjung Harapan

From Kumai we left at approx. 12:15 a.m. Entering the Sekonyer River we measured the distance/river stretch (from the river mouth upriver the Sekonyer!) to where Nypa palms (*Nypa fruticans*) lined the river edges. *Nypa* stands were lining the Sekonyer River in ca. 13,5 km distance. *Pandanus* stands followed and soon the first assemblages of Bakung weeds were observed. Within the *Nypa* stands we observed the first *Crocodylus porosus* (see data sheet!). It was approached up to 3-4 m. Presumably the occurrence of *Crocodylus porosus* is correlated with the abundance of *Nypa fruticans*. Therein the salinity amount in this brackish water favours the distribution of *C. porosus*. Further upstream freshwater is recognised when stands of Pandanus and Bakung weeds occur, the habitat of Tomistoma

6 Oct

Measurements outside my room at Pondok Ambung: 4:30 a.m. = 25.1°C, and 69% rel. humidity

Today we left to the Sungai Buluh Kecil. A first stop at Kumai port for the supply with petrol. Again we measured the stretch with *Nypa* palms beginning from the river mouth of the Sungai Buluh Kecil. The total distance was 5.3 km. At the first post " Pos Jaga Sungai Buluh Kecil" I had an interview with Pak Bambang. He observed *C. porosus* capturing Proboscis monkeys and wild pigs within the river stretch with *Nypa* palms. The way to the second post "Pos Kerikil" was largely characterised by logged area. At approx. 12 a.m. we surveyed the Sungai Buluh Kecil about 8 km downstream. Many habitat shots with the reflex camera. No crocodiles were observed, although habitat quality may support the occurrence of Tomistoma, within sections not too intensively logged. The logging period lasted from ?1995 to ?2000, (Pak Idul, pers. comm.). "Pos Kerikil" was first established in 2003. Either Tomistoma also occurs here in relatively high densities, or Tomistoma reacts much more shyly to boat traffic (due to the fact that here is no regular boat traffic as compared to the Sekonyer River and the Sekonyer Kanan River), or a former local population has declined as a result of the logging activities of several years. Tonight spotlight survey!

River width is in part narrowed by *Pandanus* stands to 2 m, some stretches are more than 15-20 m wide, around "Pos Kerikil" the average width may be approx. 8-10 m. Not rarely, along the riverline which lack *Pandanus*, the observer enters bays with plenty driftwood and peaty soil patches characterising the river edge. The acidity at Pos Kerikil was measured at pH = 3.92, the water depth at 3-4 m

On 25 Nov. 2004 Pak Idul from "Pos Kerikil"observed a *C. porosus* devouring a Water Monitor Lizard (*Varanus salvator*) not too far downstream 1-2 km from "Pos Kerikil" (in litt., by Pak Idul to PHKA). In the same year (no precise date available) Pak Idul observed an adult Tomistoma at Sungai Lopo Kiri, a small affluent of Sungai Buluh Kecil. In 2005 (no precise date available!), Pak Idul observed a *C. porosus* at the Sungai Lopo Kanan (opposite of Sungai Lopo Kiri) devouring a wild pig

At 7:15 p.m. we left "Pos Kerikil" for a spotlight survey by speedboat. We covered a distance of 10.3 km in one way (by low speed) in 1h and 15 min. At 9:45 p.m. we returned back to "Pos Kerikil". The result: Not one crocodile!

7 Oct

We left "Pos Kerikil" at 7:30 a.m. On the way back downstream of the Sungai Buluh Kecil no crocodile was observed

Stop in Kumai port: Loading my camera battery, and having lunch with boat crew.
Way back through the Sekonyer River, one adult Tomistoma was observed (data sheet!)

At night at 7:45 p.m. spotlight survey with long boat (no engine), rowing the boat at the level of the "Danau Bulut". Three Tomistoma were observed (approx. between 90 and 130 cm). On the way back using the engine again three Tomistoma were recorded, however, all were spotted at different locations. One juvenile/subadult specimen was photographed, unfortunately not focused that well. We arrived back in Pondok Ambung at 9 p.m.

8 Oct

Measurements outside my room at Pondok Ambung: at 7:40 = 27°C and 68% rel. humidity

At 8:30 a.m land survey. By long boat directing towards Camp Leakey we stopped at the level of the seasonal lake Danau Bulut searching for suitable Tomistoma nesting sights. In part, patches of this area were destroyed by illegal loggers (no date available!). In fact the habitat was characterised by prominent stands of *Pandanus*, and presumably may not serve as adequate nesting sites. Further down, heading towards Camp Leakey we entered a swamp forest habitat (photographs!), plentiful of leaf litter and shadow adjacent to the waterline. This seemed a more appropriate nesting site for Tomistoma, however there were no indications of any older nesting activities

In Camp Leakey I charged my Notebook and compiled data of the Tanjung Puting field trip in the Information Centre

9 Oct

Last day in Pondok Ambung. It is intended to visit the gold mining area and to enter once more the Sungai Bulin, affluent of the Sekonyer River to search for nesting sites by foot. Due to the early departure by plane from Pangkalan Bun to Semarang (Central Java), these plans had to be discarded

Records and autecological data of *Tomistoma schlegelii* in Tanjung Puting NP - 2005

DATA sheet no.:……

Date:……..**Time**:…….

Fotos:……
……

Crocodile species:……*Tomistoma schlegelii* ☐……*C. porosus* ☐

Juv.: ☐……**subadult**: ☐……**adult**: ☐…….

Approx. total length (cm):……..

Nest: ☐**……..Size:……Eggs:…….**yes ☐…….no ☐

Soil temperature (below nest)**:……..°C**
Nest temperature (on top of nest):……°C

Locality(River):……**GPS:**……

Position in water/distance from waterline:……..
……
……

Approximate distance from any human activities/settlements:
……
……
Macrohabitat:……
……
……
Microhabitat:……
……
……
Water chemistry: Salinity(TDS):……EC(electrical conductivitiy): ……
pH:……Temperature (10 cm below surface):……..
……
……..
Behaviour during encounter:……..
……
……
……
……

DEPARTEMEN KEHUTANAN
DIREKTORAT JENDERAL PERLINDUNGAN HUTAN DAN KONSERVASI ALAM
DIREKTORAT KONSERVASI KEANEKARAGAMAN HAYATI
Gedung Pusat Kehutanan Manggala Wanabhakti, Blok VII Lantai 7
Jalan Jenderal Gatot Subroto, Jakarta 10270 – Telp. 5720227 – Fax. 5720227

Jakarta, 27 September 2005.

Nomor : S. 498 /IV/KKH-1/2005
Lampiran :
Perihal : Penelitian Buaya Senyulong (*Tomistoma schlegelii*)
Di Taman Nasional Tanjung Putting

Kepada Yth.
Kepala Balai Taman Nasional Tanjung Puting
Di
PANGKALAN BUN

Sehubungan dengan miskinnya informasi yang berkaitan dengan populasi dan kondisi buaya senyulong (*Tomistoma schlegelii*), salah satu bagian dari keanekaragaman hayati yang ada di Taman Nasional Tanjung Puting, dengan ini diminta agar Balai Taman Nasional Tanjung Puting melakukan survey terhadap buaya senyulong (*Tomistoma schlegelii*) tersebut.

Untuk keperluan tersebut, Balai Taman Nasional Tanjung Puting akan dibantu oleh :
Nama : Dr. Mark Auliya
Pekerjaan : Peneliti
Institusi : Universitas Bonn

Dengan ketentuan :
1. Selama melakukan survey harus didampingi staff Balai Taman Nasional Tanjung Puting.
2. Setelah survey, tidak ada sample atau specimen yang dibawa.
3. Seluruh biaya ditanggung oleh yang bersangkutan.

Demikian disampaikan, atas perhatian Saudara diucapkan terima kasih.

DIREKTUR

ADI SUSMIANTO
NIP. 080 054

Tembusan : Kepada Yth.
Direktur Jenderal Perlindungan Hutan dan Konservasi Alam

DEPARTEMEN KEHUTANAN
DIREKTORAT JENDERAL PERLINDUNGAN HUTAN DAN KONSERVASI ALAM
BALAI TAMAN NASIONAL TANJUNG PUTING
Jalan H.M Rafi'i KM. 2 Telp. / Fax. (0532) 23832 Pangkalan Bun
Kotawaringin Barat – Kalimantan Tengah

SURAT IJIN MASUK KAWASAN KONSERVASI
The Admission Letter Of Conservation Area
Nomor : Si. 509 /IV-T.29/Tek/2005

Dasar : Surat dari Direktorat Konservasi Keanekaragaman Hayati
Depends No : S.498/IV/KKH-1/2005
Dengan ini memberi ijin masuk kawasan Taman Nasional Tanjung Puting :
Giving the admission letter Of Tanjung Puting National Park to under the name :

Kepada *Name*	: Dr. Mark Auliya
Instansi *Institution*	: Universitas Bonn
Untuk *The Purpose Of Visit*	: Survey terhadap buaya senyulong (*Tomistoma schlegelii*)
Di lokasi *Research location*	: Taman Nasional Tanjung Putting
Waktu *Priod Of research time*	: Berlaku sejak tanggal diterbitkan dan berakhir pada 13 Oktober 2005

Dengan ketentuan :
The requirements are :

1. Didampingi petugas dari Balai Taman Nasional Tanjung Puting dengan beban tanggung jawab dari pemegang **SIMAKSI** ini.
   Having a supervisor from officer of Tanjung Puting National Park
2. Menyerahkan copy laporan tertulis hasil kegiatan penelitian/pendidikan/cinta alam/kegiatan jurnalistik kepada Direktorat Jenderal perlindungan Hutan dan Konservasi Alam 1 (satu) eksemplar dan Balai Taman Nasional Tanjung Puting 1 (satu) eksemplar.
   Giving the result of the study about research schedule/education/the nature conservasion jurnalistics activity in written form to the Direktorat Jenderal Perlindungan Hutan Dan Konservasi Alam ant Tanjung Putting National Park respective 1 exemplar
3. Segala resiko yang terjadi dan timbul selama berada di lokasi sebagai akibat kegiatan yang dilaksanakan menjadi tanggung jawab pemegang **SIMAKSI** ini.
   All of the risky occurred because the research activity responsibility by the holder admisision letter of conservation area.
4. Mematuhi peraturan perundang-undangan yang berlaku.
   Obey with the law lines
5. Diwajibkan memberikan persentasi selambat-lambatnya 1 (satu) minggu setelah selesai melaksanakan penelitian di BTNTP.
   Giving the presentation study at least 1 week after finising the observation in Tanjung Putting National Park.

Demikian Surat Ijin Masuk Ini dibuat untuk dipergunakn sebagaimana mestinya.
In this way, the admission letter had made more of benefit.

DIKELUARKAN DI : PANGKALAN BUN
PADA TANGGAL : 29 September 2005
Date
Kepala Balai,
Head office,

ng SIMAKSi
mission

Dr. Mark Auliya

Drs. P. Bambang Darmadja, MS
NIP. 710004816

Tembusan :
1. Direktur Jenderal Perlindungan Hutan dan Konservasi Alam di Jakarta
2. Kepala Seksi Konservasi wilayah III Tanjung Harapan di Kumai
3. Yayasan Orangutan Foundation International di Pangkalan Bun
4. Yayasan Friend Of National Park Foundation di Kumai

Appendix V Police Report Certificate

KEPOLSIAN NEGARA REPUBLIK INDONESIA
DAERAH KALIMANTAN TENGAH
RESORT KOTAWARINGIN BARAT
Jl. Pangeran Diponegoro No. 34 Pangkalan Bun

SURAT TANDA MELAPOR
REPORT CERTIFICATE

NO. POL : STM /1012 / IX / 2005 / INTELKAM

Nama : Name :	Alamat : Address :	
Pekerjaan : Profesion :	Pada hari ini : Today :	
Tanggal : 29 SEPTEMBER 2005 Date :	Jam : 12.30 WIB Hour :	Tanda tangan : Signature :
Telah melaporkan tentang tamu-tamu WNA nya sbb : Has Repored his foreign quest as follow		
1. Nama : MARK AULIYA Name :	10. Pelabuhan Pendaratan : S. HATTA Di Indonesia Port of entry in Indonesia :	
2. Alamat :JERMAN Address :	11. Datang dari Negara : JERMAN Arrival From Country	
3. Kebangsaan : JERMAN Nationality :	12. Maksud Kunjungan : WISATA Purpose of viset :	
4. Tempat Tgl Lahir : JOHANNESBURG Date Of Birth : 16 MARET 1963	13. Tanggal keberangkatan : 13 OKT 2005 Departure Date :	
5. Pekerjaan : PENELITI Profession :	14. Tujuan selanjutnya : JAKARTA Next Destination :	
6. Pasport No : 5204810934 Pasport :	15. Negara : INDONESIA Country :	
7. Dikeluarkan Oleh IMG JERMAN Issued By :	16. Kota Di Indonesia : PANGKALAN BUN City in Indonesia :	
8. Jenis Visa : KUNJUNGAN	17. Tanda tangan : Quest Signature :	
9. Tanggal Kedatangan Arrival date : 29 SEPTEMBER 2005		
PASPORT BERLAKU 21 JULI 1999 S/D 20 JULI 2009	Pangkalan Bun, 29 SEPTEMBER 2005 Nama : NURDIONO Pangkat / Nrp : BRIPTU/ 77090824 Jabatan : ANGGOTA SAT INTELKAM POLRES KOBAR Tanda tangan :	
FOR YOUR CONVIENCE, PLEASE KEEP THIS CARD WITH YOU !		

Appendix VI Incidental observations of the vertebrate community

Class	Family	Species, subspecies
Amphibia	Megophryidae	*Leptobrachium nigrops*
	Bufonidae	*Pseudobufo subasper*
	Ranidae	*Rana baramica*
	Rhacophoridae	*Rhacophorus appendiculatus*
Reptilia	Gekkonidae	*Gehyra mutilata*
	Scincidae	*Eutropis rudis*
	Varanidae	*Varanus salvator* ssp.
	Colubridae	*Homalopsis buccata*
Aves	Accipitridae	*Haliastur indus*
	Trogonidae	*Harpactes* sp.
	Alcedinidae	*Alcedo meninting*
Mammalia	Cercopithecidae	*Nasalis larvatus*
	Hylobatidae	*Hylobates muelleri funereus*
	Pongidae	*Pongo p. pygmaeus*
	Suidae	*Sus barbatus*