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Authors: Shekelle, Myron, Groves, Colin, Merker, Stefan, and Supriatna, Jatna

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Tarsius tumpara: A New Tarsier Species from Siau Island, North Sulawesi

Myron Shekelle[1], Colin Groves[2], Stefan Merker[3], and Jatna Supriatna[4]

[1]*Department of Biological Sciences, National University of Singapore, Singapore*
[2]*School of Archaeology and Anthropology, Australian National University, Canberra, Australia*
[3]*Institute of Anthropology, Johannes-Gutenberg University Mainz, Mainz, Germany*
[4]*Conservation International – Indonesia, Jakarta, Indonesia*

Abstract: A new, critically endangered species of tarsier, one of the world's 25 most endangered primates, is described from the remote island of Siau, North Sulawesi, based on distinguishing characteristics of the tail tuft, pelage coloration, skull, and vocalizations. Siau is part of the Sangihe Island chain, a volcanic arc composed of islands that rise from the ocean floor. There is a single previous record of a tarsier from Siau; a skull in the Dresden Museum that Meyer (1897) classified with tarsiers from Sangihe Island as *Tarsius sangirensis*. Sangihe and Siau Islands are geologically separated by about 60 km of ocean that greatly exceeds 1,000 m in depth. Genetic data for the new species are not available, but genetic evidence indicates that its probable sister species, *T. sangirensis*, is a relatively ancient clade. The observations of Siau tarsier behavior seem to indicate adaptations for predator avoidance, which is intriguing, since the human inhabitants of Siau hunt and eat tarsiers for food, and tarsiers there seem to be under severe threat of extinction.

Key Words: *Tarsius sangirensis*, *Tarsius* new species, taxonomy, morphology, vocalization, Sangihe, biogeography

Introduction

Tarsiers are small nocturnal primates found on a scattering of Southeast Asian islands. Hill (1955) recognized a single genus, *Tarsius*, with three species groups, each endemic to a distinct biogeographic region. This broad-scale framework for tarsier classification has held until the present, and today taxonomists recognize the *Tarsius tarsier* complex (= *spectrum*), found throughout Sulawesi and several offshore islands groups, *T. syrichta*, from islands of the southern Philippines that formed the Ice Age landmass Greater Mindanao, and *T. bancanus*, from a restricted subset of islands that formed the Ice Age landmass Sundaland, including Borneo, Bangka, Belitung, southern parts of Sumatra, and several smaller islands (Brandon-Jones *et al*. 2004).

MacKinnon and MacKinnon (1980) provided the first reports of wild tarsiers from the *T. tarsier*-complex. They described an animal with a conspicuous sexually-dimorphic dawn chorus, which they termed a "duet call". They reported geographically-structured variation in tarsier duet calls that appeared to parallel the distribution of Sulawesi macaques, and suspected that each duet form diagnosed a distinct cryptic species. They also noted reports of the presence of tarsiers on several offshore island groups, and predicted unrecognized taxonomic diversity on those as well. Thus, they offered a biogeographic hypothesis that predicted that numerous unrecognized, cryptic, tarsier species were to be found within the distributions of Sulawesi macaques and on offshore islands. Numerous researchers have followed up on these predictions such that the population of lowland tarsiers (i.e., occurring up to 1,500 m altitude) that Niemitz (1984a) classified as *T. tarsier tarsier*, is now recognized to contain six species — *T. tarsier, T. sangirensis, T. dentatus* (= *dianae*), *T. pelengensis, T. lariang,* and what we describe here as *T. tumpara* (see Brandon-Jones *et al*. 2004; Merker and Groves 2006).

We describe a new species of tarsier from the tiny remote island of Siau, and focus global conservation priority setting on a little known island chain where human-mitigated extinctions might soon include a primate (Figs. 1 and 2). Siau is part of the Sangihe Islands, a volcanic arc stretching north from Sulawesi toward the Philippine island of Mindanao that are faunally related to Sulawesi. Sulawesi is the major landmass in Wallacea, a top hotspot for biodiversity conservation (Myers *et al.* 2000). One estimate rates Sulawesi the highest priority for the allocation of conservation resources,

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warranting the recommendation of "initially investing all resources in Sulawesi and no other place until all the species occurring in Sulawesi are conserved" (Wilson *et al.* 2006). As the focus of global conservation narrows to identifying the "hotspots within the hotspot", the Sangihe Island chain, and specifically Siau Island, appears as possibly the hottest hotspot within Sulawesi. Commensurately, the Siau Island tarsier was selected as one the World's 25 Most Endangered Primates 2006–2008 list (Mittermeier *et al*. 2007).

Tarsius tumpara new species

Holotype. Adult male, skin, skull and skeleton, MZB 27053, deposited in the Museum Zoologicum Bogoriense (MZB), Bogor, Indonesia. Captured alive on 1 April 2002, but died on 3 April 2005, in transit to the Museum Zoologicum Bogoriense (MZB).

Paratypes. None

Type locality. Siau Island (02°39.270'N, 125°23.944'E): the southern end of the island about 100 m from the north shore of a small lake.

Hypodigm. Only one other specimen of this species is known to exist in museums: Dresden B321, "*Tarsius spectrum sangirensis*" (Siao), skull. The specimen label includes the information "Di. Meyer Kf. 1875". Our research indicates that Meyer visited North Sulawesi and the Philippines in 1870, and that the museum in Dresden was founded in 1875. Thus, we conclude it most likely that Meyer himself collected the specimen, and placed it in the museum's collection upon its founding.

Diagnosis. A species of the genus *Tarsius* clearly allied with Sulawesian tarsiers of the *T. tarsier*-complex owing to the size of the tail tuft, the presence of postauricular white spots, and the presence of a vocal duet. *Tarsius tumpara* resembles its probable sister-taxon, *T. sangirensis*, and thereby differs from all other Sulawesian tarsiers, in (1) the tail tuft, which has shorter, sparser fur that is lighter in coloration, (2) the reduced furriness of the tarsal, and (3) in having paralabial hair that is white and pronounced (Figs. 3 and 4). *Tarsius tumpara* differs from *T. sangirensis* in characteristics of the pelage, skull, and vocalizations. (1) Pelage. *Tarsius tumpara* has dorsal fur that lacks the golden brown coloration that distinguishes *T. sangirensis*; the ventral fur of *T. tumpara* is grayer than the nearly white undercoat of *T. sangirensis* (Fig. 4). (2) Skull. The skull of *T. tumpara* is larger than three of the four available skulls of *T. sangirensis*, but relatively narrow across the orbits (Fig. 5, Tab. 1). (3) Vocalizations. In *T. tumpara*, the female contribution to the morning duet call lacks the two-note phrase that is diagnostic of *T. sangirensis*; most of the recordings of *T. tumpara* morning duet calls are of isolated one-note phrases, with one example of a multi-note phrase (Fig. 6). Furthermore, Sangihe and Siau Islands are geologically separated by approximately 60 km of ocean, where depths exceed 1,000 m (Shekelle and Salim in press) and there is no possibility of recurrent gene flow between tarsiers on these islands, nor any indication of a historical land



Figure 1. The Siau Island tarsier, *Tarsius tumpara*. Illustration ©Conservation International / Stephen D. Nash.

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bridge. *Tarsius sangirensis* is separated from other Sulawesian tarsiers by genetic distances consistent with a separation of a few million years (Shekelle 2003).

Description of type. The body fur is mottled brown with dark gray undercoat; in this it is like many other tarsiers, but totally unlike *T. sangirensis*. The grey upper facial fur (mainly above and lateral to the eyes) is margined by a conspicuous, thick brown line, giving it a look unlike any other tarsier; in *T. sangirensis* there is a similar line, but it is very weakly marked and thin, and deflects downward between the brows forming a 'V' at the root of the nose, whereas it is straight in this region in *T. tumpara* n. sp. The paralabial hair is contrastingly white, as in *T. sangirensis*. The tail tuft is short and relatively sparsely developed, and the tarsal hair is sparse and inconspicuous, more or less as in *T. sangirensis* (Figs. 3 and 4).

The skull is large, but relatively narrow across the orbits. The bulla is wide, and strongly elongated anterior to the carotid foramen. The palate is wide in the region of the third molars, and the maxillary molars are not enlarged mesiodistally, but are strikingly wide buccolingually.

Description of Dresden B321. The only other known specimen of *T. tumpara*, Dresden B321 (skull only), differs from *T. sangirensis* in exactly the same way as does the type (reduced biorbital breadth; wide, anteriorly elongated bulla; posteriorly widened palate; buccolingually broad maxillary molars).

Etymology. The specific name *tumpara* comes from the word for tarsier used by the inhabitants of Siau Island. The language spoken is *Bahasa Sangihe*, but the dialect of Siau is distinct from Sangihe Island, where tarsiers are called *senggasi* or *higo*.

Distribution. Siau Island.

Previous field research. The only evidence of any previous research on tarsiers from Siau is a lone skull in the

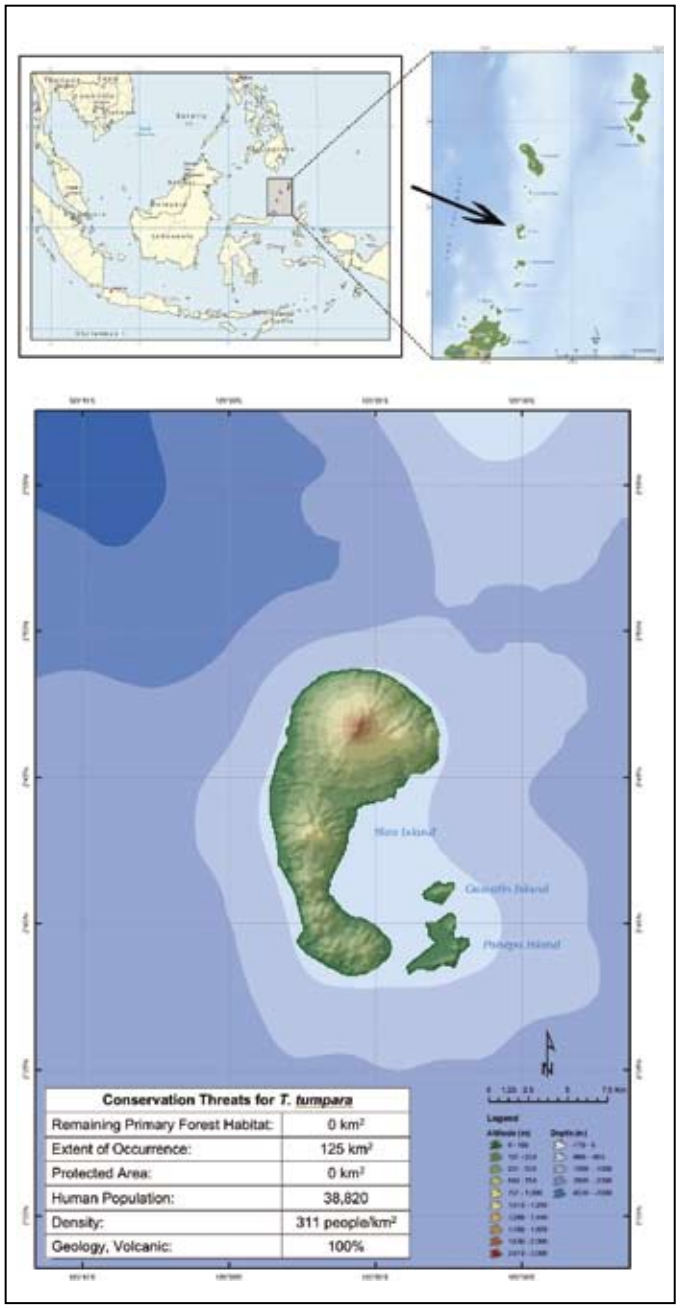


Figure 2. Maps of Siau, the Sangihe Island Chain, and SE Asia and conservation data (adapted from Shekelle and Salim, in prep.). The tiny island of Siau, showing the northern end dominated by the large, highly active volcano, Mt. Karengetang. Tarsiers were located on the extreme southern end of the island, where the holotype was captured. Tarsier scent was also located on a vertical cliff on the eastern coast.



Figure 3. *Tarsius tumpara* (left) and *T. sangirensis* (right), both showing a) a tail tuft that is sparsely furred with short light-colored hair, b) reduced furriness of the tarsal, and c) white paralabial fur. Photos [left] © Geoff Deehan; [right] © Myron Shekelle.

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Figure 4. Comparisons of *Tarsius tumpara* (left) and *T. sangirensis* (right). Top – *Tarsius tumpara* lacks the golden brown dorsal fur and (bottom) nearly pure white ventral fur of *T. sangirensis*. Photos [left] © Geoff Deehan; [right] © Myron Shekelle.

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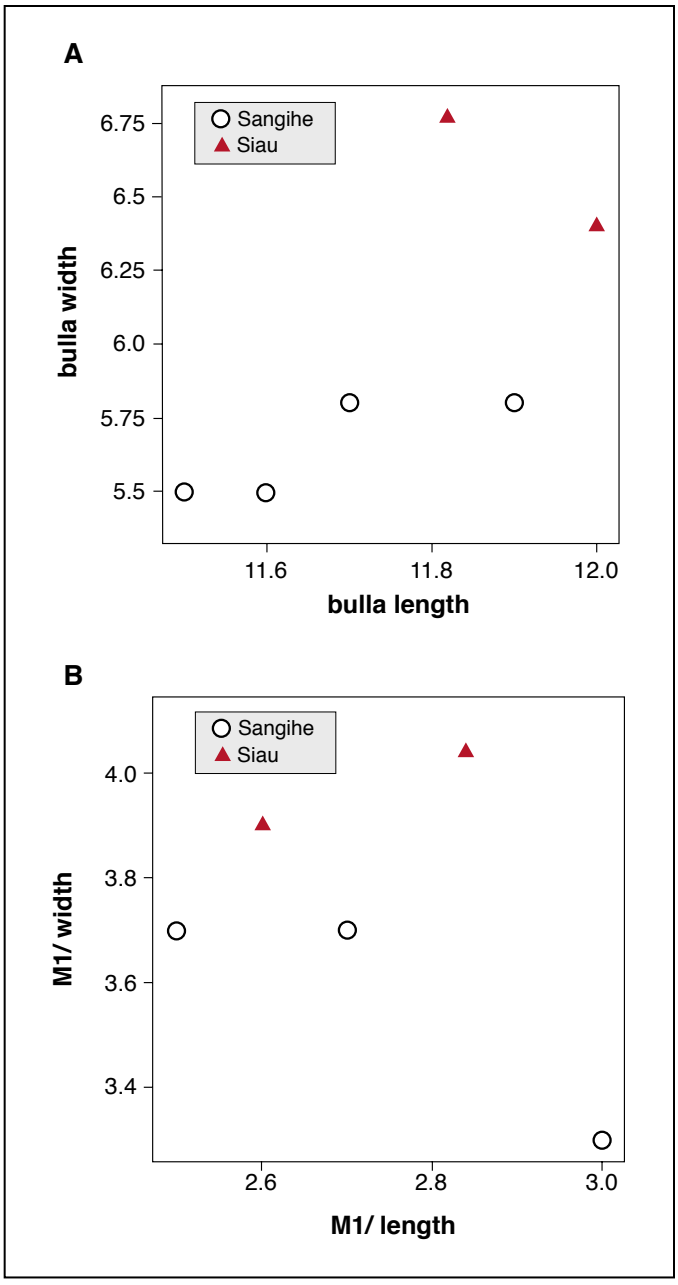


Figure 5. Representative comparisons of craniodental measurements of *Tarsius tumpara* compared with *Tarsius sangirensis*, (A) width versus length of auditory bulla (left), (B) width versus length of first maxillary molar (right).

Table 1. Measurements used in Fig. 5 (above), Australian Museum (AM), Museum für Tierkunde Dresden (DM), Museum Zoologicum Bogoriense (MZB).

Origin	Specimen	Bulla Length	Bulla Width	M1 Length	M1 Width
Sangihe	MZB 6606	11.9	5.8	3.0	3.3
	AM M9993	11.7	5.8	2.5	3.7
	MZB 3288	11.5	5.5	2.7	3.7
	MZB 6607	11.6	5.5	2.7	3.7
Siau					
	MD B321	11.8	6.8	2.8	4.0
	MZB 27053	12.0	6.4	2.6	3.9

collections of the Dresden Museum. Riley (2002) notes only their presence on Siau.

Notes. *Tarsius tumpara* is subtly distinct from *T. sangirensis*, but both of these are strikingly distinct from other tarsiers in the *T. tarsier*-complex. In their sparse tail tuft and sparsely haired tarsus, *T. tumpara* and *T. sangirensis* approach the condition seen in Philippine tarsiers (*T. syrichta*). However, molecular evidence and shared morphological characteristics show robust support that *T. sangirensis* is allied to the *T. tarsier*-complex and not to *T. syrichta* (Shekelle 2003). Thus, we hypothesize that *T. tumpara* and *T. sangirensis* are sister-taxa, and are allied to the *T. tarsier*-complex.

Erratum. Shekelle *et al.* (1997) noted behavioral peculiarities in *T. sangirensis* that distinguished them from other tarsiers in the study (i.e., north and central mainland Sulawesi and Togian Islands). In retrospect, these differences (social groups foraging and socializing together but sleeping in separate sites, choosing sleeping sites that are very high) represent behaviors that are associated with predator avoidance, specifically avoiding humans and predators such as feral cats. In *Tarsius tumpara*, such differences are even more extreme. The largest social group observed was the individual we captured in association with an adult female. Vocalizations were extremely limited and never were more than two tarsiers heard together. Sleeping sites were very high and inaccessible. Even the scent mark of *Tarsius tumpara* seems to fade more rapidly than is the case for other tarsiers of Sulawesi. Typically, a human can smell a scent mark that is several days old, sometimes from several meters away. The scent marks of *Tarsius tumpara* were noticed to fade dramatically within an hour, and were almost undetectable to the human nose the next day. These observations are particularly curious because Siau is the one locality where the prevalence of hunting tarsiers for food is very high. It is an intriguing possibility that tarsiers on Siau, and to a lesser extent Sangihe, have evolved adaptations to avoid hunting by humans.

Taxonomic History

Opinions on taxonomic diversity among tarsiers of Sulawesi have varied over the years, but it is becoming evident that biodiversity on Sulawesi in general, but especially among tarsiers, has been greatly underestimated. Hill (1955) classified the Sulawesi tarsiers as belonging to a single species, *Tarsius spectrum*, with five subspecies, *T. s. sangirensis*, *T. s. spectrum*, *T. s. pumilus*, *T. s. dentatus*, and *T. s. pelengensis*. Hill cautioned, however, that the justification for some of these seemed to him to be on "rather slender grounds", and Niemitz (1984a) synonymized all of these subspecies with *T. s. spectrum* except for *T. s. pumilus*, which he later (1985) accepted as a distinct species, *T. pumilus*. Musser and Dagosto (1987) presented abundant evidence to support the recognition of *T. pumilus*—a montane endemic approximately 75% the size of *T. spectrum* in linear measurements. Feiler (1990) argued for the resurrection of *T. sangirensis* as a distinct species, an opinion that was independently supported by

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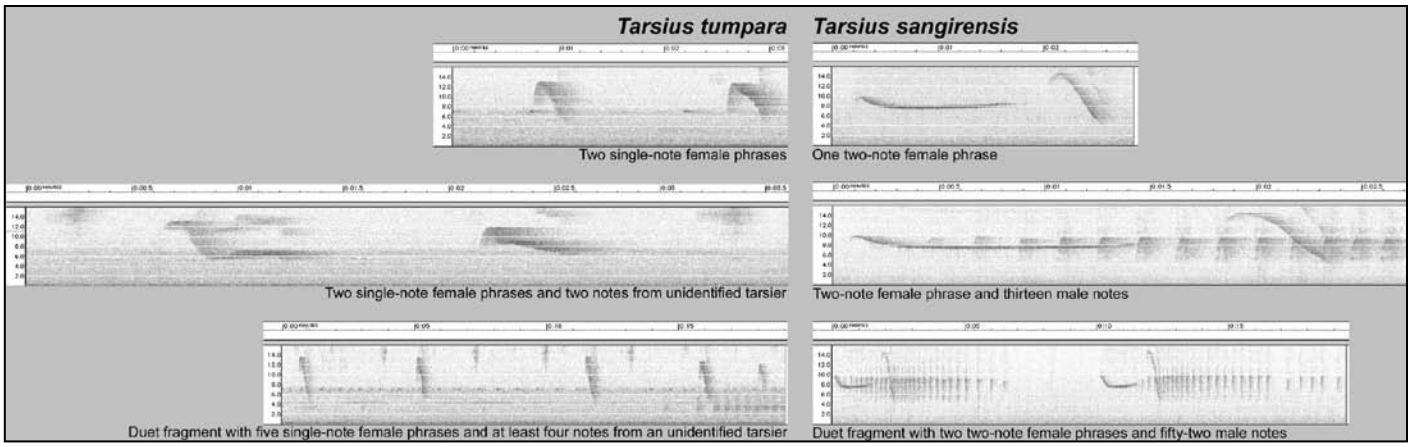


Figure 6. *Tarsius tumpara* lacks the characteristic two-note phrase of *T. sangirensis* females, nearly all of the recordings being one-note phrases (top and middle). The duet of *T. tumpara* is utterly different than that of *T. sangirensis*, having many more female notes and many fewer male notes (middle and bottom). (Sound recordings of wild tarsier calls were converted to spectrograms with SoundEdit. Brightness and contrast were adjusted for clarity.)

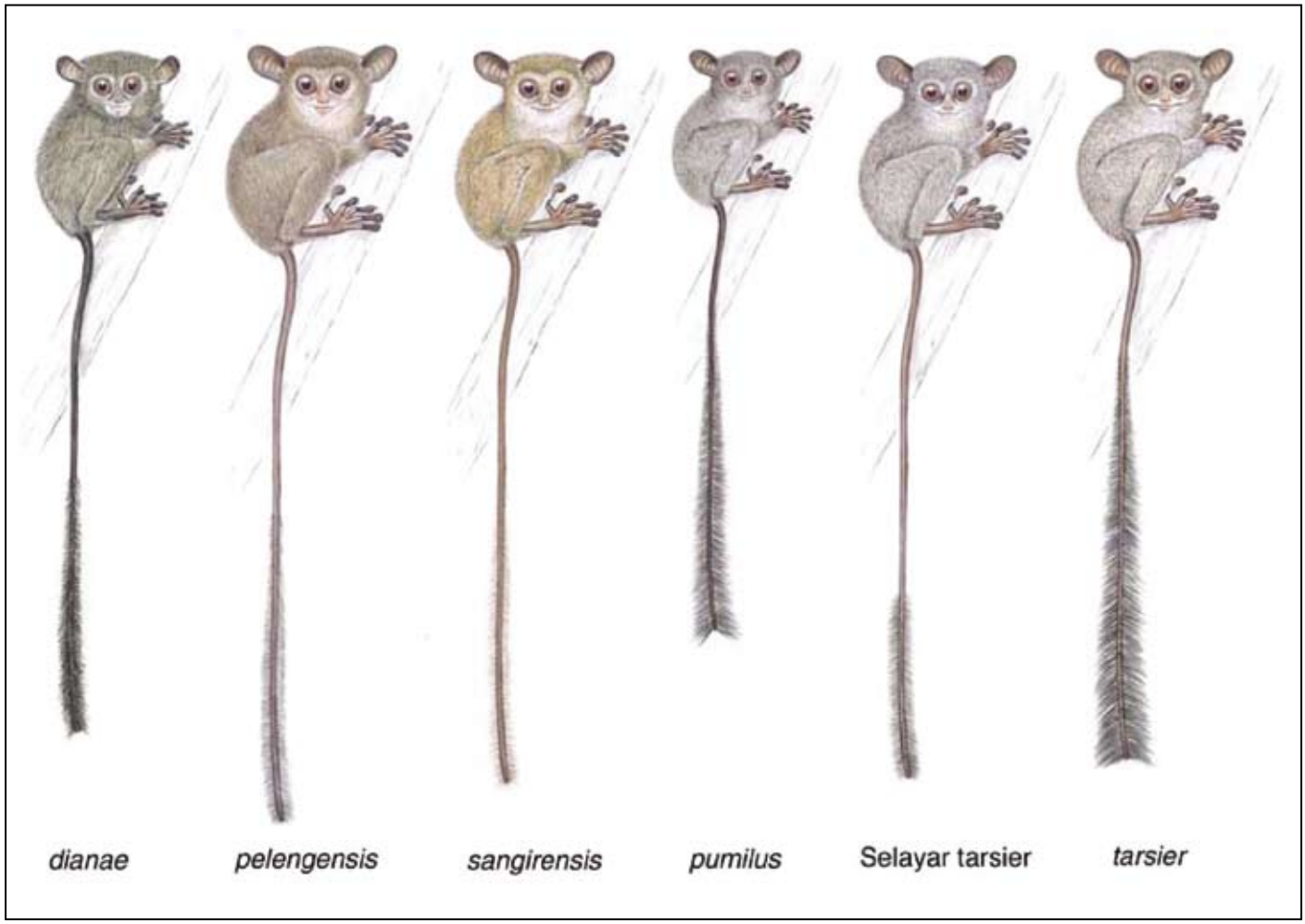


Figure 7. Six species of tarsiers from the *Tarsius tarsier*-complex. Otherwise cryptic species are diagnosable by often subtle variation in tail tuft, skin and pelage coloration. Illustration by © Conservation International / Stephen D. Nash.

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Shekelle *et al.* (1997) and Groves (1998). Niemitz *et al.* (1991) described a new species, *T. dianae*, from central Sulawesi, but they unfortunately neglected to compare the new taxon with a senior taxon from the region. Shekelle *et al.* (1997) found the "*T. dianae*" duet form at the type locality of *T. fuscus dentatus* Miller and Hollister, 1821 (*T. spectrum dentatus* in Hill's (1955) combination), and suggested that the name *dianae* may be a junior synonym of *dentatus*. Groves (2001) accepted all of Hill's subspecies, and *T. dianae*, as distinct species, noting the problem with the name *T. dianae*. Brandon-Jones *et al.* (2004) used a taxonomy similar to that of Groves (2001), but argued that *T. tarsier* was a subjective senior synonym of *T. spectrum*. No evidence to contradict this opinion has been forthcoming, and more recent surveys in 2005 confirmed that the type locality of *T. dentatus* lies within the range of the acoustic form that diagnoses what had hitherto been designated *T. dianae* (Shekelle unpubl. data), virtually assuring that the latter is a subjective junior synonym of the former.

The taxonomy of the *T. tarsier* group may be far more complex than this, however. MacKinnon and MacKinnon (1980) published spectrograms of three distinct forms of tarsiers based upon recordings of their duet calls. Each of these forms came from a distinct biogeographic subregion of Sulawesi, and they interpreted this to indicate unrecognized taxonomic diversity. Niemitz (1984b) published a spectrogram of a tarsier from Gimpu (Central Sulawesi), which he identified *as T. t. pumilus*, but which has since been shown to be the Palu acoustic form of MacKinnon and MacKinnon (1980), recently described as *T. lariang* Merker and Groves, 2006. Nietsch and Niemitz (1993) identified a fourth acoustic form from the Togian Islands of Central Sulawesi. In subsequent work, Nietsch used acoustic evidence to argue for taxonomic separation of this population at the species level (Nietsch and Kopp 1988; Nietsch 1999), but did not name it. Shekelle *et al.* (1997) found two more acoustic forms from Central Sulawesi and a third from North Sulawesi, bringing the total number of known acoustic forms at the time to seven. Only two of these were associated with known taxa, Kamarora or "*T. dianae* form" (= *T. dentatus*) and the Sangihe form (= *T. sangirensis*). The other five acoustic forms were hypothesized to indicate unrecognized taxonomic diversity (Shekelle 2003).

Several daunting obstacles, however, befuddled a stable taxonomy for tarsiers, and prevented progress on naming the new forms. Type specimens and well-localized type localities were non-existent for both *T. tarsier* and *T. spectrum*. Hill (1955) suggested Makassar as the type locality for *T. spectrum*, and although the rationale for this is somewhat weak, it has become generally accepted (for example, Musser and Dagosto 1987; Groves 2001; Brandon-Jones *et al.* 2004). *Lemur spectrum* Pallas, 1778 is a junior objective synonym *of Lemur tarsier* Erxleben, 1777 (Brandon-Jones *et al*. 2004); accordingly, the correct name for the Makassar tarsier is *Tarsius tarsier* (Erxleben, 1777).

While the *T. tarsier* group has been extensively studied in the wild and is well represented in museum collections, Makassar is today a large city, from which there are no known field studies or museum specimens. Thus, putative new taxa could not be compared to the most senior name-bearer. A solution for this dilemma was proposed by Merker and Groves (2006). For comparative purposes, they represented *T. tarsier* in their study with four specimens from Lombasang, about 50 km ESE of Makassar, in the American Museum of Natural History (AMNH), along with two living specimens collected by one of us (Shekelle) from Maros, about 30 km NNE of Makassar, and kept at the Museum Zoologicum Bogoriense (MZB). Subsequently, another one of us (Groves, together with Jacques Cuisin and Cécile Callou) rediscovered the type specimen of *Lemur tarsier* and. although studies are ongoing, nothing about the specimen contradicts our hypotheses concerning *T. tumpara* (Groves, unpubl. data).

Our current taxonomy of tarsiers of the *T. tarsier*-complex thus currently includes six species:

Tarsius tarsier (Erxleben, 1777): Makassar. Includes synonyms *T. spectrum* (Pallas, 1778), and many others. Tarsiers from other parts of Sulawesi that are not classified as one of the species below are, by default, classified as *T. tarsier* but, as Brandon-Jones *et al*. (2004) observed, this leaves an improbably disjunct distribution. We are currently examining this issue in greater detail and expect to subdivide this taxon into numerous new taxa in the future.

Tarsius sangirensis Meyer, 1897: Sangihe Island, North Sulawesi

Tarsius pelengensis Sody, 1949: Peleng Island, Central Sulawesi

Tarsius dentatus Miller and Hollister, 1921 (a senior subjective synonym of *T. dianae* Niemitz *et al*., 1991): Central Sulawesi, northern and eastern portions of the central core, including Marantale (a few kilometers north of Labua Sore) on the east coast of the isthmus of Palu, Kamarora, Lake Poso, Ampana, Luwuk.

Tarsius lariang Merker and Groves, 2006: Central Sulawesi, western portion of the central core, from Gimpu to the west and south-west (including Gimpu, Marena, both banks of the Lariang River and the downstream part of its northern tributary, the Meweh River).

Tarsius tumpara new species: Siau Island, North Sulawesi.

Biogeography

The discovery of *Tarsius tumpara* was guided by the hybrid biogeographic hypothesis for Sulawesi, which predicted that 16 or more species of tarsier exist within the *T. tarsier*-complex, and which also highlighted a biogeographic discontinuity between the northern tip of Sulawesi and Sangihe Island, home of *T. sangirensis*, nearly 200 km away (Shekelle and Leksono 2004). Between these two tarsier populations lay a scattered island chain known as the Sangihe Islands. The Sangihe Islands are infamous for their critically endangered avifauna, including the Cerulean Flycatcher of Sangihe Island (Whitten *et al*. 1987, BirdLife International 2001, Whitten 2006). The combined pressures of habitat loss

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and hunting pressure are argued to be pushing some mammals towards local extinctions (Riley 2002).

The Sangihe Island chain stretches approximately 200 km from the northern tip of Sulawesi, north towards, the Philippine island of Mindanao. The chain is a volcanic arc of oceanic islands that arise from a sea floor over 1000 m deep. Five major islands, or island groups, are each spaced about 40 km apart. Nearest to Sulawesi is Biaro, followed by Tagulandang and Ruang, then comes Siau, then a complex cluster of many small islands, and finally, Sangihe, sometimes called Great Sangihe (with alternate spellings, such as Sangi and Sangir). The geology of volcanic arcs, such as the Hawaiian Islands and the Galapagos Islands, is ideal for producing isolation, endemism, and diversification.

Meyer (1897) included Sangihe and Siau islands in the distribution of *T. sangirensis*, but made no mention of the other islands in the chain, and how tarsiers ever came to these islands is a mystery. The reduced furriness of the tarsus and tail tuft of *T. sangirensis* led Meyer (1897) to state: "*Es liegt hierin also eine insulare Abweichung und Hinneigung zur Philippinen Form*." Hill (1955) classified these animals with *T. spectrum* (= *T. tarsier*), however, and genetic data offer robust support for a *T. tarsier*/*T. sangirensis* clade exclusive of *T. syrichta* (Shekelle 2003).

Myron Shekelle led surveys to Biaro, Tagulandang, and Ruang in 2004, in which no evidence of tarsiers was found, results that accord with Riley (2002). A follow up survey in Siau in 2005 succeeded in locating tarsiers on the first day, culminating in a capture on the fourth day. Thus, the biogeographic evidence from brief surveys presents the surprising irony that tarsiers are present on the more distant Sangihe Islands, but there is no evidence for them on islands that are closer to Sulawesi. Indeed, island biogeography in the Sangihe Island chain is made interestingly complex by the fact that island size happens to be inversely proportional to distance from Sulawesi (i.e., area of Biaro<Tagulandang/Ruang<Siau<Sangihe, and distance from Sulawesi to Biaro<Sulawesi to Tagulandang/Ruang<Sulawesi to Siau< Sulawesi to Sangihe). Thus, tarsier distributions support the prediction from island biogeography theory that larger islands are more likely to support extant populations of emigrants, but conflict with the prediction that nearer islands are more likely to support extant populations of emigrants than are more distant islands.

Conservation

By several measures, the conservation threat on Siau is notably more acute than it is on Sangihe, including: much smaller island size (and thus extent of occurrence); lesser extent of remaining forest; higher human density; and greater volcanism (Shekelle and Salim in press). Sangihe is tiny, about the size of Singapore, yet Siau is barely one-fifth as large. The population density on Siau, 311 people/km^2, is about as great as that of India. This population is further squeezed onto the southern 45% of the island in order to avoid a highly active volcano (Fig. 8). Neither island has any protected areas (Riley 2002; Shekelle and Salim in press), although this fact is obscured because the term *hutan lindung* (literally, "protected forest") is not a protected forest in the normal legal sense, but more akin to a 'green belt/area'. The largest expanse of forest on either island is a 800–900 ha patch of mixed primary/old growth secondary forest on the flank of Mt. Sahendaruman on Sangihe Island (Riley 2002; Whitten 2006).

Riley (2002) argued that hunting pressure is causing local extinctions of some mammal populations in the Sangihe Islands. Shekelle and Salim (in press) report that on Siau, local inhabitants have the unique habit of eating tarsiers for a snack food they call "*tola-tola*". Surveys indicate this habit has extirpated tarsiers over much of the island. They recommended that the Siau Island tarsier be categorized as Critically Endangered, and it was listed as one the "World's 25 Most Endangered Primates 2006–2008" to draw attention to its urgent need for conservation measures (Shekelle and Salim 2007).

The hybrid biogeographic hypothesis for Sulawesi (Shekelle and Leksono 2004) guided the discovery of *T. tumpara* (Brandon-Jones *et al*. 2004) and predicted that 16 or more species of tarsier exist within the population that was classified

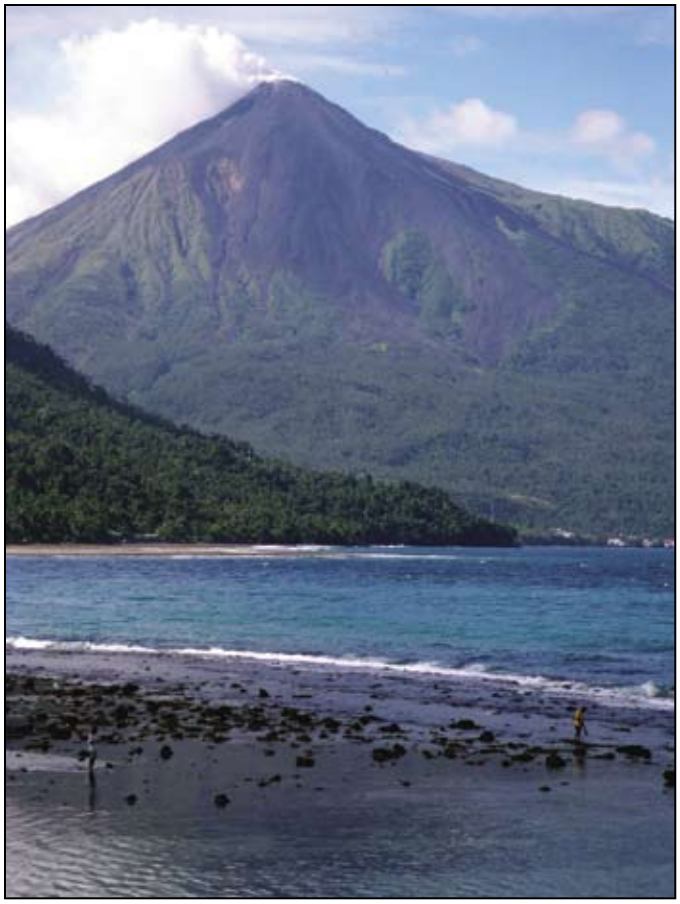


Figure 8. Mt. Karengetang, seen from the southeastern coast, is one of Indonesia's most active and dangerous volcanoes. It dominates the northern half of Siau Island, accounting for approximately 55% of the total land area. The outskirts of the main port of Ulu are barely visible at the water's edge on the far right hand side.

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until recently as a single subspecies. With the identification of *T. tumpara*, six of those species have now been recognized, offering increased support for the prediction that biodiversity on Sulawesi may be underestimated by an order of magnitude. Unfortunately, it has taken 27 years, since MacKinnon and MacKinnon (1980) first reported the possibility of numerous cryptic tarsier taxa on Sulawesi, to evaluate and describe just six species; approximately 4.5 years per species. There are at least 10 more populations to assess, while conservation biologists estimate that all of Sulawesi's lowland forests are essentially gone (FWI/GFW 2002) and the tarsiers that remain are largely persisting in degraded habitats outside of protected areas, and are as such highly vulnerable to extinction (Supriatna *et al*. 2001). The bleak situation indicates that some primate species in Sulawesi may go extinct before they have even been identified, leaving scientists with unpleasant and controversial choices for taxonomy and conservation. We foresee increased criticism and controversy down either path: either publishing new species at an increased pace with the heightened chance of error, or not doing so at the risk that primate species are driven to extinction before they have been recognized and named.

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Authors' addresses:

Myron Shekelle, Department of Biological Sciences, National University of Singapore, Singapore 117543. E-mail: <dbssm@nus.edu.sg>.

Colin P. Groves, School of Archaeology and Anthropology, Australian National University, Canberra A.C.T. 0200, Australia.

Stefan Merker, Institute of Anthropology, Johannes-Gutenberg University Mainz, Colonel-Kleinmann-Weg 2 (SB II), D-55099 Mainz, Germany.

Jatna Supriatna, Conservation International-Indonesia, Jl. Pejaten Barat No. 16 A, Jakarta 12550, Indonesia.

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