

# Herpetological Diversity of Timor-Leste: Updates and a Review of Species Distributions

Mark O'SHEA<sup>1</sup>, Caitlin SANCHEZ<sup>2</sup>, Andrew KATHRINER<sup>3</sup>, Sven MECKE<sup>4</sup>, Venancio LOPES CARVALHO<sup>5</sup>, Agivedo VARELA RIBEIRO<sup>5</sup>, Zito AFRANIO SOARES<sup>5</sup>, Luis LEMOS DE ARAUJO<sup>5</sup> and Hinrich KAISER<sup>2,6\*</sup>

<sup>1</sup> Faculty of Science and Engineering, University of Wolverhampton, Wulfruna Street, Wolverhampton WV1 1LY, United Kingdom; and West Midland Safari Park, Bewdley, Worcestershire DY12 1LF, United Kingdom

<sup>2</sup> Department of Biology, Victor Valley College, 18422 Bear Valley Road, Victorville, California 92395, USA

<sup>3</sup> Department of Biology, Villanova University, 800 East Lancaster Avenue, Villanova, Pennsylvania 19085, USA; present address: Department of Herpetology, Bronx Zoo, 2300 Southern Boulevard, Bronx, New York 10460, USA

<sup>4</sup> Department of Animal Evolution and Systematics, Faculty of Biology, Philipps Universität Marburg, Karl-von-Frisch-Straße 8, 35032 Marburg, Germany

<sup>5</sup> Universidade Nacional Timor-Lorosa'e, Faculdade de Ciências da Educação, Departamentu da Biologia, Avenida Cidade de Lisboa, Liceu Dr. Francisco Machado, Dili, Timor-Leste

<sup>6</sup> Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20013, USA

**Abstract** We report the results of five herpetological surveys during 2011–2013 that included visits to all districts of Timor-Leste (Aileu, Ainaro, Baucau, Bobonaro, Dili, Covalima, Ermera, Lautém, Liquiça, Manatuto, Manufahi, Viqueque) except the Oecusse exclave. Our fieldwork culminated in the discovery of one putative new frog species (genus *Kaloula*), at least five putative new lizard species (genera *Cyrtodactylus*, *Cryptoblepharus*, and *Sphenomorphus*), and two putative new snake species (genera *Stegonotus* and *Indotyphlops*). In addition, we present new distribution records of amphibians and reptiles for 11 of the country's 12 contiguous districts, along with additional natural history data. Results from our surveys increase the number of amphibian and reptiles known to occur in Timor-Leste from 22 species before our surveys began to over 60, including over 20 as yet undescribed species.

**Keywords** Timor-Leste, *Kaloula*, *Cyrtodactylus*, *Eremiascincus*, *Stegonotus*

## 1. Introduction

Timor-Leste (Figure 1) comprises four separate land areas, (1) the eastern half of Timor Island in the Outer Banda Arc of the Lesser Sunda Archipelago, with an area of approximately 14,480 km<sup>2</sup>; (2) the small (12 km<sup>2</sup>) uninhabited Jaco Island, a landmass of corallogenic origin lying ca. 750 m off the coast of Timor's easternmost point; (3) the much larger (105 km<sup>2</sup>) inhabited Atauro

Island, a volcanogenic island geographically positioned in the Inner Banda Arc and situated ~25 km north of mainland Timor-Leste's northern coast at the capital city Dili; and (4) the Oecusse District, an exclave (810 km<sup>2</sup>) on the northern coast of Timor, 53 km air-line distance west of contiguous Timor-Leste and surrounded on all landward sides by Indonesian West Timor. Timor-Leste's position at the southeastern edge of Wallacea makes the country an interesting area from a biogeographical perspective, as it is inhabited by a mosaic of faunal elements with either Southeast Asian or Australo-Papuan origin (see Monk *et al.*, 1997). Due to its turbulent history as the Portuguese colony farthest from the mother country (nominally since 1515; West, 2009) and because of a

\* Corresponding author: Dr. Hinrich KAISER, from Victor Valley College, USA, with his research focusing on the diversity, morphology, and conservation of Southeast Asian amphibians and reptiles.

E-mail: hinrich.kaiser@vvc.edu

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violent annexation by Indonesia between 1975 and 1999, the area could not be properly surveyed until after Timor-Leste regained independence in 2002. A summary of the geography, geology, and habitats of Timor-Leste and a history of herpetological collecting in the country since the early 19<sup>th</sup> Century, was presented by Trainor (2010) and Kaiser *et al.* (2011).

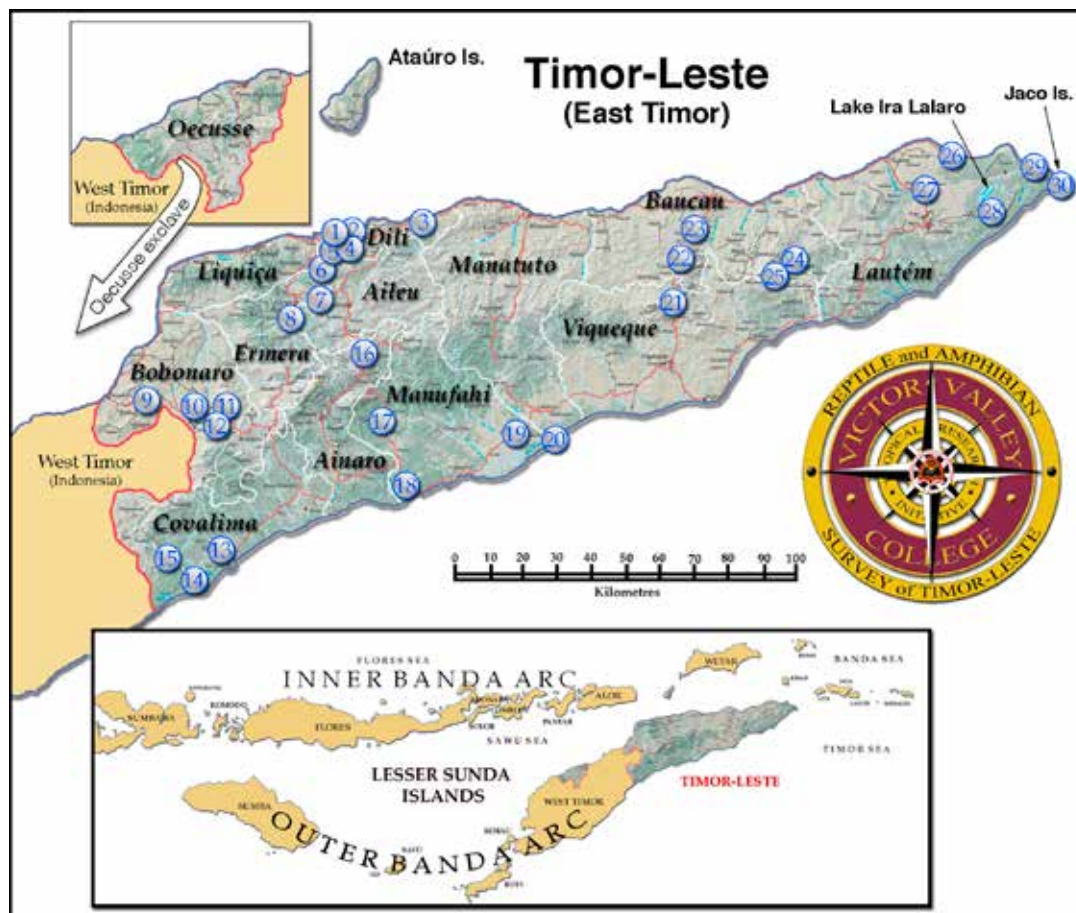
Timor-Leste is a country with very diverse habitats (Figure 2), ranging from beaches and rocky shores (Figure 2A) to montane meadows and mountains (e.g., Figure 2E). Much of the habitat has been altered by the presence of humans to a greater or lesser degree, ranging from active agricultural sites (e.g., Figure 2C) to patches of old-growth forest used by livestock (e.g., Figure 2D). The most pristine habitats include those demarcated by precipitous slopes (e.g., Figure 2E) or periodically inundated areas (e.g., Figure 2F), as well as those of particular cultural or religious significance where human alterations are prohibited (e.g., Figure 2G, H; pers. obs.). As we reported previously (Kaiser *et al.*, 2011), it appears that the herpetofauna of Timor-Leste has shown some

resilience to disturbance, and species diversity may be high locally despite low-level human disturbance, and even after the dramatic shift from primary tropical forest to coffee forest.

Beginning with an initial survey in 2009, we have been conducting fieldwork in all 13 districts of Timor-Leste under the banner of the Victor Valley College Tropical Research Initiative. The present report on the field seasons of 2011–2013, with the addition of some more limited surveys conducted by AVR, LLA, and ZAS, supplements our reports for 2009 (Kaiser *et al.*, 2011) and 2010 (O’Shea *et al.*, 2012). Reports for the politically and geographically isolated Oecusse District (Sanchez *et al.*, 2012) and Ataúro Island (Kaiser *et al.*, 2013b) have been published elsewhere.

## 2. Methods

Surveys were conducted during both the wet season (Phase IV: 18 January–6 February 2011; Phase VI: 24 January–7 February 2012) and the dry season (Phase V:



**Figure 1** Map of Timor-Leste and its position in the Lesser Sunda Islands. Numbered localities are listed in Table 1.

19 June–5 July 2011; Phase VII: 21 June–10 July 2012; Phase VIII: 18 June–2 July 2013). Shorter wet season surveys were also conducted by ZAS, LLA, and AVR (11–14 October 2010, 10–12 November 2010, and 7 January 2011, respectively). During 2011–2013, fieldwork was carried out at 35 main localities (Table 1) with smaller sub-localities clustered around some of these. The

general methods applied during fieldwork, the preparation of voucher specimens, and any associated scientific tasks, follow the protocols detailed by Kaiser *et al.* (2011). Most roadkills, depending on their state of decomposition, were skin- or scale-snipped to obtain tissue samples for molecular studies. All vouchered specimens have been deposited in the United States National

**Table 1** List of localities surveyed by the Victor Valley College Herpetofaunal Survey of Timor-Leste during Phases IV–VIII (2011–2013). Each locality includes a superscripted Roman numeral to indicate during which phase they were surveyed (locations only visited during Phases I–III, on Atauro Island, or in the Oecusse exclave are omitted (for these locations see Kaiser *et al.*, 2011, 2012; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012).

| Locality Number          | District             | Locality   | Elevation (m) | GPS coordinates <sup>1</sup> |
|--------------------------|----------------------|--|---------------|------------------------------|
| 1 <sup>I–VIII</sup>      | Dili                 | W Dili (Timor Lodge Hotel; Comoro; Tasi Tolu)                | 2–25          | S 08°33' E 125°31'           |
| 2 <sup>IV</sup>          | Dili                 | E Dili (Becora; Cristo Rei)                                  | 20            | S 08°33' E 125°35'           |
| 3 <sup>V–VI, VIII</sup>  | Dili                 | Metinaro mangrove swamp                                      | 1             | S 08°31' E 125°47'           |
| 4 <sup>VI</sup>          | Dili                 | S Dili (Dare)  | 545           | S 08°36' E 125°32'           |
| 5 <sup>III–IV</sup>      | Dili                 | Comoro River (Beduku)  | 60            | S 08°35' E 125°32'           |
| 6 <sup>V, VIII</sup>     | Dili, Liquiça, Aileu | Comoro River (confluence with Bemos River) <sup>2</sup>      | 115           | S 08°37' E 125°32'           |
| 7 <sup>VI</sup>          | Aileu                | Lake Be Matin  | 1105          | S 08°42' E 125°32'           |
| 8 <sup>I–II, V–VII</sup> | Ermera               | Eraulo (Meleotegi River; Sta. Bakhita Mission)               | 1100–1250     | S 08°47' E 125°27'           |
| 9 <sup>VII</sup>         | Bobonaro             | Balibo (Fiuren)  | 463           | S 08°57' E 125°04'           |
| 10 <sup>V</sup>          | Bobonaro             | W Maliana (Ramaskora; Soto River)                            | 196–230       | S 08°59' E 125°12'           |
| 11 <sup>VII</sup>        | Bobonaro             | E Maliana (Maganuto, Mt. Leolaco)                            | 1040–1063     | S 08°59' E 125°16'           |
| 12 <sup>V</sup>          | Bobonaro             | E Maliana (Galosapulu swamp)                                 | 712           | S 09°01' E 125°16'           |
| 13 <sup>I, IV</sup>      | Covalima             | Suai & surrounds (Castelo Fronteira Guest House)             | 30–53         | S 09°19' E 125°15'           |
| 14 <sup>IV</sup>         | Covalima             | Kasabauk rice-paddies  | 9             | S 09°24' E 125°09'           |
| 15 <sup>IV</sup>         | Covalima             | Tilomar (Tilomar Forest Reserve; Maubesi; Mt. Debululik)     | 260–900       | S 09°20' E 125°06'           |
| 16 <sup>I, IV</sup>      | Ainaro               | Maubisse (Pousada Maubisse)                                  | 1495          | S 08°50' E 125°36'           |
| 17 <sup>I, IV</sup>      | Manufahi             | Same (Ailelehun Guest House; Trilolo River; Ladiki; Mirbuti) | 340–1200      | S 09°00' E 125°39'           |
| 18 <sup>IV–V</sup>       | Manufahi             | Betano (Dry site; Wet site)                                  | 20–44         | S 09°10' E 125°42'           |
| 19 <sup>IV, VII</sup>    | Manufahi             | Fatucahi (Convent of St Antony d'Lisa; Lake Lenas)           | 36–38         | S 09°02' E 125°59'           |
| 20 <sup>IV, VII</sup>    | Manatuto             | Nancuro, Natarbora, S Umaboco                                | 3             | S 09°02' E 126°04'           |
| 21 <sup>VII</sup>        | Viqueque             | N Ossa (Liamida; Mt. Mundo Perdido)                          | 930–1160      | S 08°44' E 126°22'           |
| 22 <sup>VII</sup>        | Baucau               | Venilale caves, N Venilale                                   | 675           | S 08°37' E 126°23'           |
| 23 <sup>VII</sup>        | Baucau               | Uatubala, S. Afacaimau ( <i>Carlia</i> spot)                 | 370           | S 08°33' E 126°26'           |
| 24 <sup>VII</sup>        | Baucau               | Baguia (Vila Rabilhi Guest House; Pousada de Baguia)         | 440           | S 08°38' E 126°39'           |
| 25 <sup>VII</sup>        | Baucau               | Ossohuna (Ossohuna; Afaloicai)                               | 938           | S 08°41' E 126°37'           |
| 26 <sup>V, VIII</sup>    | Lautém               | Com (Com Beach Resort; Com wharf; Pousada de Com)            | 2–15          | S 08°21' E 127°03'           |
| 27 <sup>V, VIII</sup>    | Lautém               | Raça caves & surrounds                                       | 400–553       | S 08°26' E 126°59'           |
| 28 <sup>V</sup>          | Lautém               | Tutuala (Pousada de Tutuala)                                 | 373           | S 08°24' E 127°15'           |
| 29 <sup>V</sup>          | Lautém               | Malahara (Mainina sinkhole; Lake Ira Lalaro)                 | 336–424       | S 08°29' E 127°11'           |
| 30 <sup>V</sup>          | Lautém               | Jaco Island  | 10–40         | S 08°25' E 127°19'           |

<sup>1</sup>GPS coordinates are approximate to define the area in which the survey work was carried out. Exact localities are not provided to protect some of the unique and fragile habitats in Timor-Leste.

<sup>2</sup>The confluence of the Comoro and Bemos Rivers marks the border between Dili, Liquiça and Aileu Districts, with specimens collected on both banks in Liquiça and Aileu Districts.

Museum of Natural History, Smithsonian Institution, Washington D.C., USA (USNM). Those specimens not yet accessioned have field tags of the USNM (USNM-FS). Photographs of road-killed specimens, CITES-protected species, and other unvouchered specimens have been deposited in the herpetological image collection

of the USNM and are listed here with herpetological image numbers (accessioned as USNM-HI). Museum abbreviations are taken from Sabaj Pérez (2014).

In the species accounts, we provide information to aid in field identification of amphibians and reptiles, particularly for taxa not included in one of our earlier



**Figure 2** Sample habitat types surveyed in Timor-Leste during 2011–13. Localities are listed numerically (see Table 1). (A) Rocky shore at Cristo Rei Protected Area on the outskirts of Dili (Locality 2). The part of this habitat along the tidal and splash zones is a habitat of *Cryptoblepharus* cf. *schlegelianus* and *Laticauda colubrina*, whereas in the wooded area at higher elevation, sun skinks (*Eutropis* cf. *multifasciata*) and Timor monitors (*Varanus timorensis*) have been observed. (B) Montane habitat at Maganuto (Locality 11). This area has stands of tall bamboo in boulder-strewn areas, intermixed with a grassy meadow and a montane forest on the upper slopes. Whereas we found the forest to be unproductive in our search, the bamboo yielded *Hemidactylus* cf. *garnottii*, and in the grassy meadow we found a *Polypedates* cf. *leucomystax* under a flat rock some distance away from any vegetation. (C) The banana plantation at the confluence of the Bemos and Comoro Rivers (Locality 6; photo taken towards Aileu District) turned out to be an unexpectedly important site at which one of only two recent specimens of *Cylindrophis* cf. *boulengeri* was found. Other species recorded in this area include *Duttaphrynus melanostictus*, *Fejervarya* sp., *Polypedates* cf. *leucomystax*, sun skinks (*Eutropis* cf. *multifasciata*), and house geckos (e.g., *Hemidactylus frenatus*). (D) Disturbed forest at Fiuren (Locality 9). Overtly a nice patch of forest with an expansive growth of large trees, this area is beset by domestic pigs that scour the leaf litter and the root matter for food. We located *P.* cf. *leucomystax* and several gecko taxa (*Cyrtodactylus*, *Gekko*, *Gehyra*, *Hemidactylus*) in this area. (E) View of the mountains above our survey area near Baguia (Locality 25). A promising habitat with extreme topography, this is the only area in Timor-Leste where we have found individuals of *Hemiphyllodactylus* cf. *typus*. (F) The Mainina sinkhole (Locality 29) in Nino Konis Santana National Park. This locality is the only outflow of Lake Ira Lalaro, the largest lake in Timor-Leste. The area is seasonally inaccessible due to variations in the lake's water level, and it lies right at the foot of the steep-sided Paixau Mountains karst formation. (G) The road passing through tropical wet forest in the Nancuro Protected Area (Locality 20). On either side of this road is dense, mixed coastal forest that includes some large trees. The ground is partially inundated after rains. This has been a very productive collection locality with a high diversity of herpetofauna, including *Kaloula*, *Cyrtodactylus*, *Sphenomorphus*, *Dendrelaphis*, *Stegonotus*, and *Trimeresurus*. (H) Dry coastal forest on Jaco Island (Locality 30). Even though this corallogenic island appears to be very dry, we have found species that we have more commonly encountered in moist habitats elsewhere in Timor-Leste, including *Cyrtodactylus*, *Eremiascincus*, and *Sphenomorphus*. Photos (A), (C), and (E)–(H) by Hinrich Kaiser, (B) and (D) by Mark O'Shea. (Continued on facing page).

reports (Kaiser *et al.*, 2011, 2013b; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012), comment on new locality records for taxa previously recorded during Phases I–III (2009–2010), provide full accounts for taxa not previously recorded during our surveys, and discuss the natural history of the species and the manner in which they were encountered. The recording or collection of taxa during particular phases is indicated by the phase designation in bracketed superscripted Roman numerals, following taxon names. Thus, a species encountered in Phases IV and VII would carry the superscript <sup>[IV, VII]</sup>.

Common names are provided in English (E), German (G) and the country's lingua franca, Tetun (T). We made a number of decisions with regards to the use or coining of common names in Tetun and the interested reader is referred to O'Shea *et al.* (2012) for a discussion of our

arguments. Proposed common names for house geckos incorporate the commonly used Tetun name for small geckos and the scientific name or a descriptive term.

### 3. Results

#### Amphibia

##### Family Bufonidae — True Toads

***Duttaphrynus melanostictus* (Schneider, 1799)** <sup>[IV–V, VII–VIII]</sup>

**Common names.** (E) Black-spined Toad, Common Asian Toad. (G) Schwarznarbenkröte. (T) Manduku Interfet (manduku = frog, INTERFET = International Force for East Timor).

**Known distribution.** *Duttaphrynus melanostictus* (Figure 3) has heretofore been reported from nine of Timor-Leste's 13 districts (Table 2): Aileu, Bobonaro, Covalima,



Figure 2 Continued.

**Table 2** Amphibian records for the districts of Timor-Leste. Black dots indicate previously known records, red dots denote new records.

| Taxon                                     | District |        |        |          |          |              |               |        |        |         |          |          |         | References <sup>*</sup> |          |     |
|---|----------|--------|--------|----------|----------|--------------|---------------|--------|--------|---------|----------|----------|---------|-------------------------|----------|-----|
|   | Aileu    | Ainaro | Baucau | Bobonaro | Covalima | Dili (Timor) | Dili (Atauro) | Ermera | Lautém | Liquiça | Manatuto | Manufahi | Oecusse |                         | Viqueque |     |
| <b>BUFONIDAE</b>                          |          |        |        |          |          |              |               |        |        |         |          |          |         |                         |          |     |
| <i>Duttaphrynus melanostictus</i>         | ●        |        | ●      | ●        | ●        | ●            |               | ●      |        | ●       | ●        | ●        | ●       | ●                       | ●        | 1–5 |
| <b>DICROGLOSSIDAE</b>                     |          |        |        |          |          |              |               |        |        |         |          |          |         |                         |          |     |
| <i>Fejervarya</i> spp.                    | ●        |        | ●      | ●        | ●        | ●            |               | ●      | ●      | ●       | ●        | ●        | ●       | ●                       | ●        | 2–4 |
| <i>Limnonectes timorensis</i>             |          |        | ●      |          |          |              |               | ●      |        |         |          |          |         |                         |          | 2,5 |
| <b>HYLIDAE</b>                            |          |        |        |          |          |              |               |        |        |         |          |          |         |                         |          |     |
| <i>Litoria everetti</i>                   |          |        |        |          |          |              |               | ●      |        |         |          |          |         |                         |          | 2,6 |
| <b>MICROHYLIDAE</b>                       |          |        |        |          |          |              |               |        |        |         |          |          |         |                         |          |     |
| <i>Kaloula</i> sp.                        |          |        |        |          |          |              |               |        |        |         | ●        | ●        |         |                         |          | 5   |
| <b>RHACOPHORIDAE</b>                      |          |        |        |          |          |              |               |        |        |         |          |          |         |                         |          |     |
| <i>Polypedates</i> cf. <i>leucomystax</i> |          | ●      | ●      | ●        | ●        | ●            |               | ●      | ●      | ●       | ●        | ●        | ●       | ●                       | ●        | 2–5 |

\*References are identified numerically as follows: 1 = Trainor, 2009; 2 = Kaiser *et al.*, 2011; 3 = O'Shea *et al.*, 2012; 4 = Sanchez *et al.*, 2012; 5 = this paper; 6 = Menzies, 2006.

Dili, Ermera, Liquiça, Manufahi, Oecusse, and Viqueque (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012; Trainor, 2009).

**New localities.** We collected additional specimens from the Comoro River valley (Localities 5 and 6; Table 1), which included a series of tadpoles from the confluence of the Comoro and Bemos Rivers, which occurs at the boundaries of Aileu, Dili, and Liquiça Districts. Tadpoles were captured in riverine kolks, where back eddies create a respite from rushing water, on the Aileu side (Locality 6). An adult was captured at Beduku Aldeia (Dili District; Locality 5). We vouchered single specimens from the Soto River (Bobonaro District; Locality 10) and the Franciscan Convent of St. Antony d'Lisa (Manufahi District; Locality 19), and took voucher photographs for four other localities where we recorded this species: Sta. Bakhita Mission (Eraulo, Ermera District; Locality 8); Nancuro coastal forest (Natarbora, Manatuto District; Locality 20), Ossu (Baucau District; USNM-HI 2823), and Liamida (Viqueque District; Locality 21). The Manatuto and Baucau records constitute new district records and bring to a total of 11 (Table 2) the number of mainland districts that have been colonized by *D. melanostictus* since its arrival less than a decade ago. Based on our observations, the species has so far (mid-2013) not expanded into Lautém District, the country's easternmost and the site of Nino Konis Santana National Park, and it has not yet been

documented from Ainaro District.

**Natural history.** This is an introduced species that is believed to have arrived in Timor-Leste with INTERFET peacekeeping troops. The first reports appear to have come from Oecusse District in 1999, a date that coincides with the arrival of South Korean INTERFET peacekeepers. From there the toad appears to have gradually spread eastwards, arriving in Dili District in 2007 (Trainor, 2009). We recorded it further southeast at Same (Manufahi District) in 2009 (Kaiser *et al.*, 2011), concurring with Trainor (2009), who also recorded it in the area during the same year, and on the south coast at Uma Boot (Viqueque District) in 2010 (O'Shea *et al.*, 2012).

Sanchez *et al.* (2012) reported this species from the Oecusse exclave. Our surveys so far have not revealed the presence of *D. melanostictus* or any other amphibian species on Atauro Island (Kaiser *et al.*, 2013b). During 2011 and 2012 we were able to report a much wider range for the black-spined toad, across the contiguous districts of mainland Timor-Leste, from Bobonaro (Locality 10), in the extreme west near the border with West Timor, to Ossu Subdistrict of Viqueque District (Locality 21) in the east. We have now recorded *D. melanostictus* from nine of the 12 contiguous districts, plus Oecusse, from sea level to elevations of 930 m (Liamida, Viqueque District; Locality 21) and 1225 m (Sta. Bakhita Mission,

Ermera District; Locality 8), in habitats ranging from anthropogenic (roadways, convent grounds) to coastal forests, rocky river beds, and upland boulder-strewn grasslands. Based on our observations this introduced toad species favors anthropogenically-modified habitats, where it can be found in great numbers; it appears to be absent in pristine habitats. In drainage ditches and rice paddies, *D. melanostictus* is frequently found in sympatry with frogs of the genus *Fejervarya*.

Our vouchers include adult toads and a series of tadpoles (USNM 581259–63) collected from muddy rivulets and pools alongside the Comoro riverbed. *Duttaphrynus melanostictus* was also found to be very common in the grounds of the Franciscan Convent of St. Antony d'Lisa, Fatucahi (Manufahi District; Locality 19) but we vouchered only a single specimen (USNM 565895) that had predated and begun to pass a blindsnake (*Indotyphlops braminus*; O'Shea *et al.*, 2013). Another specimen was found sitting atop the 2.0 m stone convent wall, demonstrating the climbing ability of these terrestrial bufonids.

Although we initially did not collect voucher specimens of this non-Timorese amphibian, in our efforts to monitor its effects on native taxa, we collected 87 specimens in several districts in 2013 to be able to carry out a gut content analysis to study the diet of this exotic (Döring *et al.*, in prep.). Our most recent observations continue to confirm the absence from Timor-Leste of the much larger and elsewhere harmful cane toad (*Rhinella marina*), with which *D. melanostictus* has been confused by Timorese and expatriates alike.

### Family Dicroglossidae — Fork-tongued Frogs

#### Genus *Fejervarya* <sup>[IV–VIII]</sup>

**Common names.** (E) Rice Paddy Frogs. (G) Reisfrösche. (T) Manduku natar (manduku = frog, natar = rice paddy).

**Known distribution.** Frogs of the genus *Fejervarya* (Figure 4) have been reported from seven of Timor-Leste's 13 districts (Table 2): Baucau, Dili, Ermera, Lautém, Manufahi, Oecusse, and Viqueque (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012).

**New localities.** For 2011, we report additional voucher specimens from the localities at the confluence of the Comoro and Bemos Rivers (see *D. melanostictus* account), from the Aileu bank (Locality 6). We also added vouchers from a roadside marsh at the junction of the Com–Bauro road with the North Coast Road (Com, Lautém District; Locality 26), and from the southern shore of Lake Ira Lalaro (Malahara village, Lautém District; Locality 28). We also provide the first records of *Fejervarya* spp. from southern Timor-Leste, namely

for Manatuto District, from coastal forest (Locality 20); for Manufahi District from the grounds of the Franciscan Convent of St. Antony d'Lisa and the southern shore of Lake Lenas (both near Fatucahi; Locality 19); and for Covalima District from the grounds of the Castelo Fronteira Guest House (Suai town; Locality 13) and the extensive rice-paddies at Kasabauk (Locality 14). The Aileu, Manatuto, and Covalima specimens represent new district records (Table 2). ZAS also provided our first records for Bobonaro District with vouchers from the Soto River and Ramaskora (Locality 10), and a single voucher from the Galosapulu swamp (Locality 12).

In 2012 we obtained additional vouchers from west of Dili town (Timor Lodge Hotel grounds, Dili District; Locality 1) and the Meleotegi River (Ermera District; Locality 8), and made collections in two new localities: Lake Be Matin (Aileu District; Locality 7), and the Afaloicai and Ossohuna rice paddies (Baucau District; Locality 25). *Fejervarya* spp. have now been reported from 11 of the 12 contiguous mainland districts in addition to Oecusse (Sanchez *et al.*, 2012), but they have not been recorded from Ainaro District; based on the limited environments suitable for *Fejervarya*, we do not anticipate their presence on Atauro Island (Kaiser *et al.*, 2011; 2013b).

**Natural history.** Recorded widely on all previous phases, our additional collection confirms that rice-paddy frogs occupy a much broader variety of habitats than their common name indicates. Along the mostly dry Comoro riverbed (Locality 6), an adult (USNM 579397) was found under a rock right at the edge of the narrow flow, whereas a tadpole (USNM 581584) was collected from a nearby shallow pool shared with tadpoles of *Duttaphrynus melanostictus*. Near this locality, we observed a wolf spider (family Lycosidae) that appeared to follow the movements of *Fejervarya* tadpoles grazing near the surface (Figure 5), and we consider it likely that these spiders take tadpoles as prey. Lycosid spiders have already been documented as hunting in this way (Jara and Perotti, 2004).

Specimens were also vouchered from the Soto River (Locality 10; USNM 579287–92) and Meleotegi River (Locality 8; USNM 579710, 580466) during both the wet and the dry seasons. A population of rice paddy frogs from far-eastern Timor-Leste (Locality 26) was initially located based on their vocalizations along the edge of the road, where a leaking water pipe had created puddles. This population (USNM 579398–401) extended into a marshy area next to the road. In Bobonaro District, a single specimen was collected in a swamp at 712 m



**Figure 3** *Duttaphrynus melanostictus* found in a streamside refugium along the Comoro River (Locality 1). This specimen was not vouchered. Photo by Mark O'Shea.



**Figure 4** A female rice-paddy frog (genus *Fejervarya*) from active, inundated rice paddies near Bagaia (Locality 25; USNM 580467). Photo by Mark O'Shea.

elevation (Locality 12; USNM 279297). Near Malahara village (Lautém District; Locality 28) several individuals were seen in the marshy area along the edge of Lake Ira Lalaro, and a single specimen was vouchered (USNM 579402).

Our south coast records for a *Fejervarya* species come from pristine wet coastal forest (Locality 20; USNM 579279); grassy areas of a residential compound (Locality 19; USNM 579276–77); the grassy edge of a small lake (Locality 19; USNM 579278); and an ornamental fountain in a residential compound (Locality 13; USNM 579280–81), where they occurred in the company of a large number of tadpoles (USNM 581264–77). As expected, *Fejervarya* were found to be especially common in rice paddy habitats, from near sea level at Kasabauk (9 m, Locality 14; USNM 759284–86) and medium elevations (e.g., 229 m at Ramaskora; Locality 10; USNM 279293–96) to higher elevations (e.g., 775 m at Afaloicai and Ossohuna (Locality 25; USNM 580468–72, 581287–93),

and over 1105 m at Lake Be Matin (Locality 7; USNM 579706–09). Individuals were also encountered crossing or occupying rain puddles on the road (e.g., at Baucau District, between Localities 24 and 25; USNM 580467).

As during previous phases we found rice-paddy frogs to be extremely abundant where they occurred, and although numerous specimens were initially collected, only a few were selected as vouchers. The physiological plasticity of these species and their adaptability to anthropogenic habitats is discussed elsewhere (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012) and will not be expanded upon further here.

***Limnonectes timorensis* (Smith, 1927)** <sup>[iv, vii]</sup>

**Common names.** (E) Timor River Frog. (G) Timorfrosch (T) Manduku mota (manduku = frog, mota = river).

**Known distribution.** *Limnonectes timorensis* (Figure 6A) has heretofore been reported from only a single locality in Ermera District (Table 2; see Kaiser *et al.*, 2011)



**Figure 5** Tadpole of *Fejervarya* sp. (arrow) with its potential predator, a wolf spider. The spider was observed in close proximity to tadpoles along a slow-flowing side arm of the Comoro River (Locality 1). Photo by Hinrich Kaiser.



**New localities.** Additional specimens were collected at the Meleotegi River location (Locality 8) during the dry seasons of 2011 and 2012, and a single voucher was obtained from the Afaloicai rice paddies near Baguia (Baucau District; Locality 24). This single voucher is a juvenile and its location at Afaloicai is over 130 km E of the Meleotegi River.

**Natural history.** Previously we had encountered this frog only along the Meleotegi River (near the Sta. Bakhita Mission (Eraulo, Ermera District; Locality 8), with only two vouchers collected during the dry season of 2009. During the dry season of 2011 we again encountered *L. timorensis* along the Meleotegi River, where several males (e.g., USNM 579403–07) were discovered sheltering under rocks at the water's edge. Two of these specimens (USNM 579404, 579407) contained parasitic cestodes (Platyhelminthes: Cestoda) in their leg muscles (Figure 6C, D), which likely constitute another host record for spargana (Goldberg *et al.*, 2010). A return to the same location, at the same time of year, in 2012 produced a series of nine tadpoles (Figure 6B) collected from a rock pool on a large mid-stream rock (USNM 581278–86). The tadpoles were euthanized and photographed at sequential stages of development over the following ten days.

All specimens of *L. timorensis* collected at the Meleotegi River (elev. 1175–1185 m) were found in close association with the river, albeit in the dry season, on rocks along its periphery. The single juvenile collected at Afaloicai, near the Baucau-Viqueque boundary at an elevation of 775 m (USNM 580371) was taken at night in the grass surrounding a rice-paddy.

**Taxonomic comment.** The generic status of some of the frogs in the genus *Limnonectes* is being re-evaluated, and it appears that both molecular evidence and some morphological characteristics align the Timor population with ranids in the genus *Hylarana* (Che *et al.*, 2007; Kaiser *et al.*, 2014). If this generic concept is confirmed, this species should be assigned to the genus *Hylarana* and transferred to the Ranidae.

#### Family Hylidae — Treefrogs

##### *Litoria everetti* (Boulenger, 1897) <sup>[VI]</sup>

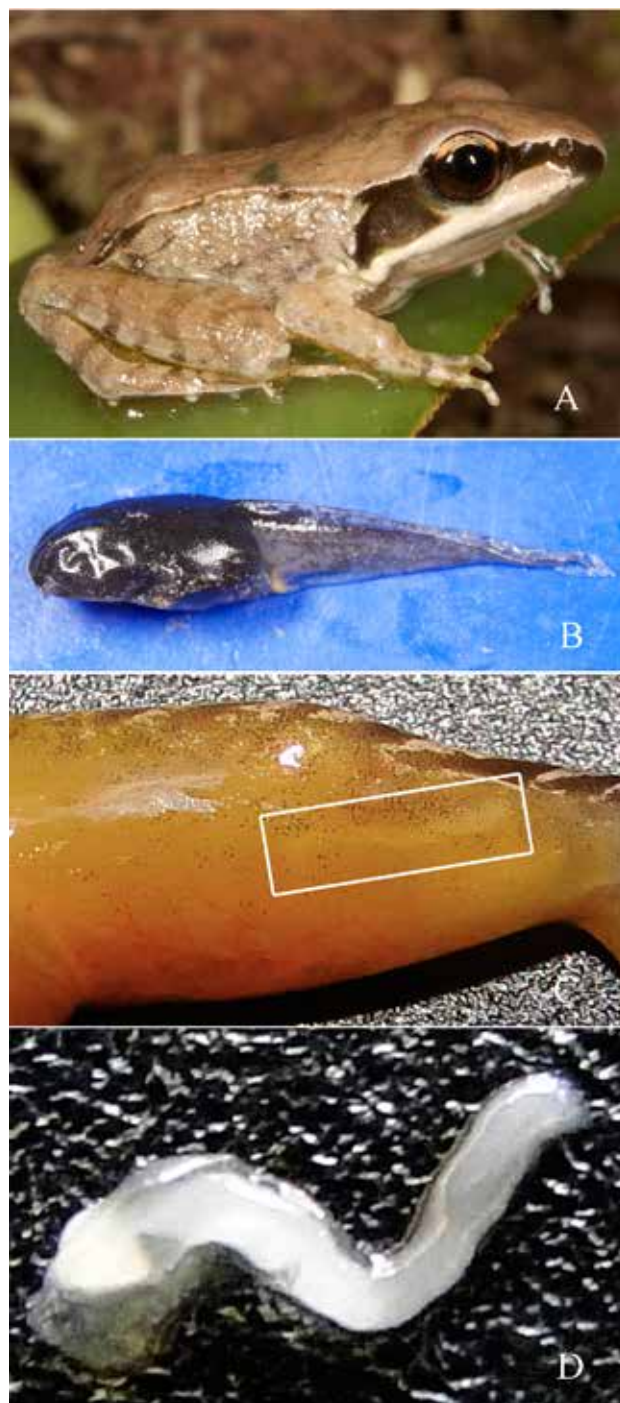
**Common names.** (E) Everett's Timor Treefrog. (G) Everett-Laubfrosch. (T) Manduku ai Timor (manduku = frog, ai = tree).

**Known distribution.** *Litoria everetti* (Figure 7) is reported from a single locality in Ermera District (Table 2; see Kaiser *et al.*, 2011).

**New localities.** None, but an additional specimen was collected at the known locality.

**Natural history.** As with *Limnonectes timorensis* (see

above), our previous encounters with this frog were in 2009, only on the Meleotegi River (Ermera District;



**Figure 6** (A) Juvenile *Limnonectes timorensis* from a grassy patch at Afaloicai (USNM 580473, Locality 25). (B) Tadpole of *L. timorensis* from the Meleotegi River (USNM 581286; Locality 8). (C) Upper leg of an adult *L. timorensis* from the Meleotegi River (USNM 579404, Locality 8), showing an embedded parasite (box). (D) Tapeworm extracted from the animal in (C), presumably a sparganum that is part of the host-parasite interaction described by Goldberg *et al.* (2010). Photos (A) and (B) by Mark O'Shea, (C) and (D) by Hinrich Kaiser.

Locality 8), when we collected two specimens. During 2011 we collected a third specimen (USNM 579408) at the same location. This specimen was discovered underneath a rock on a small rocky island in midstream, and it attempted to escape by jumping into the flowing water. After this initial escape attempt, it remained motionless on the bottom of a slow-flowing portion of the river, where it was easily captured.

**Family Microhylidae — Narrow-mouthed Toads**

***Kaloula* sp.** <sup>[IV, VII]</sup>

**Common names.** (E) Timor Pumpkin Bullfrog. (G) Timor-Ochsenfrosch. (T) Manduku lakeru (manduku = frog, lakeru = pumpkin).

**Identification.** *Kaloula* sp. is a small rotund frog with a blunt head and highly tuberculate dorsum (Figure 8A). The limbs are short, the toes unwebbed. Coloration consists of a mixture of olive green and light brown blotches. The only Timorese frogs with which this species could be confused are Asian black-spined toads (*Duttaphrynus melanostictus*), from which it can be separated by its smaller size, longer fingers and toes, discrete tympanum, the lack of cranial crests, parotoid glands, and black tipped tubercles.

**Known distribution.** There are no previous reports of this species from Timor Island or Timor-Leste.

**New localities.** Specimens collected in 2011, in southern Manufahi District (within the grounds of the Franciscan Convent of St. Antony d’Lisboa, Fatucahi; Locality 19) constitute the first records of this species, genus, and family for Timor Island. Two relatively juvenile specimens collected in 2012, in the wet coastal forest at Nancuro (Locality 20) represent the first records of the taxon from Manatuto District. These two localities are only 10 km apart.

**Natural history.** Within the grounds of the Franciscan Convent of St. Antony d’Lisboa we encountered four species of anurans, three of which (*Duttaphrynus melanostictus*, *Fejervarya* sp., *Polypedates* cf. *leucomystax*) are widespread in Timor-Leste. However, we also collected numerous specimens of *Kaloula* sp. at night in the vegetable gardens, on the rubbish dump, and around the convent wall. One specimen was found on a low tree axil approximately 45 cm from the ground, whereas all others were encountered at ground level, including under rocks together with *D. melanostictus*. A series of ten specimens was vouchered (USNM 579246–55).

The juvenile specimens collected at Nancuro (USNM 580464–65) were found on the forest floor in deep leaf litter. They demonstrated much more vivid markings than

the adults from Fatucahi, in the form of a series of black-edged, bright orange flashes across the flanks anterior to the hind limbs, on the inner surfaces of the thighs, and on the proximal portions of the hind limbs (Figure 8B).



**Figure 7** Female *Litoria everetti* found underneath a flat rock alongside the Meleotegi River, Ermera District (Locality 8; USNM 579394). Photo by Mark O’Shea.



**Figure 8** (A) Adult female *Kaloula* sp. (USNM 579254) from the grounds of the Convent of St. Antony d’Lisboa near Fatucahi, Manufahi District (Locality 19). (B) Juvenile *Kaloula* sp. from wet forest in the Nancuro Protected Area (Locality 20; USNM 580464) showing the characteristic flash colors on the posterior part of the body in juveniles of this form. Photos by Mark O’Shea.

These markings were exposed when the frogs made short hops and presumably constitute aposematic eyespots to deter potential predators, as has been well-documented for frogs of the genus *Physalaemus* (Wells, 2010).

**Taxonomic comments.** There are no previous records of *Kaloula*, or any microhylid frog, from the island of Timor, but three species of *Kaloula* are reported to occur on other islands in Indonesia. *Kaloula pulchra* Gray, 1831 has been reported from Sumatra, Borneo, Sulawesi, and Flores (Barbour, 1912; Dunn, 1928; Mertens, 1930), and it is unclear whether these populations are native or introduced. The same problem exists for *K. baleata* (Müller, 1833), which occurs on Bali, Borneo, Java, Komodo, Sulawesi, Sumatra, and Sumba (Dunn, 1928; Iskandar, 1998; McKay, 2006); the Western Australian Museum holds specimens from Flores and Lembata (Paul Doughty, *pers. comm.*). A population listed as “*K. albotuberculata*” by Inger and Voris (2001) may represent an endemic taxon found exclusively in central Sulawesi; the listing of this name, based on a manuscript by Djoko Iskandar, has created a *nomen nudum*, which was referred to as “*Kaloula* sp. n.” by Koch (2012). *Kaloula baleata*, as currently defined, is certainly a polymorphic taxon that contains at least three species in addition to the recently described *K. indochinensis* Chan *et al.*, 2013 and *K. latidisca* Chan *et al.*, 2014 (Rafe Brown, *pers. comm.*), and it seems likely that *K. pulchra* is a species complex as well. Specimens from the Lesser Sundas may well have been allocated to these two species without comparison to specimens from the type localities (Java for *K. baleata* and China for *K. pulchra*) and may therefore constitute undescribed species. Detailed examinations by one of us (HK) of the Timor specimens now housed in the USNM leads us to believe that they represent an undescribed species of *Kaloula*. True *K. baleata* and *K. pulchra* may be separated by the degree of toe webbing (webbing reaching the middle subarticular tubercle on the inner edge of the fourth toe in *K. baleata*, but not extending beyond the basal subarticular tubercle in *K. pulchra* (Inger, 1966), but the Timor material does not comply with either arrangement. The detailed morphological and morphometric information provided by Chan *et al.* (2013, 2014) to assist with delineating species boundaries in the *K. baleata* complex provides an excellent opportunity for determining the taxonomic status of the Timor population. On the basis of our discovery, and pending comparative examination of the Timor specimens with other Lesser Sunda and extralimital material of *K. baleata sensu lato*, we assign the specimens from Fatucahi and Nancuro to *Kaloula* sp.

## Family Rhacophoridae — Afro-Asian Foam-nest Treefrogs

### *Polypedates* cf. *leucomystax* <sup>[IV–VIII]</sup>

**Common names.** (E) Striped Treefrog, Four-lined Treefrog. (G) Weißbart-Ruderfrosch. (T) Manduku airkadu (manduku = frog, ai = tree, riskadu = striped) or manduku loron (manduku = frog, loron = sunlight).

**Known distribution.** *Polypedates* cf. *leucomystax* (Figure 9) is so far known from eight of Timor-Leste's 13 districts (Table 2): Ainaro, Baucau, Dili, Ermera, Lautém, Manufahi, Oecusse, and Viqueque (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012).

**New localities.** In 2011 we collected specimens at the confluence of the Comoro and Bemos Rivers, along the Liquiça bank (see *Duttaphrynus melanostictus* account; Locality 6), on the south coast (grounds of the Franciscan Convent of St. Antony d'Ílisboa, Fatucahi, Manufahi District; Locality 19), and in the Mt. Debululik area (north of Tilomar, Covalima District; Locality 15). The Liquiça and Covalima specimens represent new district records (Table 2).

Bobonaro specimens were collected by ZAS from all three of his study sites: the Soto River and Ramaskora rice paddies (Locality 10) and the Galosapulu swamp (Locality 12). These are our first records of *Polypedates* from Bobonaro District.

In 2012 we collected two specimens in the grounds of the Timor Lodge Hotel (Comoro, Dili District; Locality 1) and vouchered a series of specimens from near Baguia (Baucau District; Localities 24 and 25), near Balibo (Bobonaro District; Locality 9), and from the south coast in the wet coastal forest at Nancuro (Locality 20), this last record constituting a first record for Manatuto District. The only district without records of *Polypedates* cf. *leucomystax* is Aileu, and despite of our efforts on three collecting trips to Ataúro Island no frog vouchers were collected there (Kaiser *et al.*, 2013b).

**Natural history.** These treefrogs were found exclusively in microhabitats with some form of water storage capacity, sometimes in unexpected circumstances. For example, specimens found in village gardens along the Comoro River (Dili District; Locality 6; USNM 579395–96) were discovered by peeling back the stem leaves at the bases of banana plants (*Musa* sp.), where runoff water collects. These banana plots had recently undergone an agricultural slash-and-burn, yet several of the banana plant stems were found to harbor treefrogs. Striped treefrogs were also seen in the freshly mown grassy vegetation of the grounds of the Franciscan Convent (USNM 579256–62), where moisture is retained well and

where disturbed insects provide abundant food. Treefrogs were also fairly abundant near upland rice paddies at Ossohuna and Afaloicai (Baucau District; Locality 25; USNM 580453) at an elevation of 712 m. Another of our highest-elevation specimens (elev. 706 m; USNM 579263) came from a rock pile in the Mt. Debululik area (Covalima District; Locality 15), while specimen found on the ground in bamboo litter at Ossohuna (Baucau District; Locality 25; USNM 580452) occurred at 938 m. The highest elevation recorded for *P. cf. leucomystax* was 1074 m for a specimen curiously found under a rock on an exposed step-cultivated grassy hillside above Maganuto village, almost midway between, but still a considerable distance from, a large stand of bamboo and a stunted elfin forest growing in the shadow of Mt. Leolaco, Bobonaro District (Locality 11; USNM 580457).

Striped treefrogs found in anthropogenic habitats included a small series (USNM 580458–63) collected in a significantly degraded forest at Fiuren village, Bobonaro District. Curiously, these frogs were found in leaf litter or buttress roots close to the forest floor, despite the entire area being drastically altered by a large population of domestic pigs. The presence of the pigs resulted in a low number of terrestrial reptiles encountered, yet the treefrogs endured. Another treefrog was found at night, perched on the branch of a tree growing within the ruins of an old school (Escola do Reino de Haudere) near Baguia (Baucau District; Locality 24; USNM 580451). In a more natural environment, our single Manatuto specimen (Locality 20; USNM 580456) was found inside a hollow log.

**Taxonomic comments.** The taxonomic status of *P. cf. leucomystax* is discussed in previous reports (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012) and will not be elaborated upon here. The taxonomy of the *P. leucomystax* species complex is currently under investigation (Rafe Brown, *pers. comm.*; Hidetoshi Ota, *pers. comm.*). *Polypedates leucomystax* has generally been considered a widespread Asian species that also occurs on many islands across the Sunda Shelf. However, *P. leucomystax sensu stricto* may not extend further east than Bali, into the Lesser Sunda Archipelago, although molecular data for the Lesser Sundas is still lacking (Brown *et al.*, 2010; Kuraishi *et al.*, 2013; Kuraishi *et al.*, 2011). Specimens from Nusa Tenggara Province, including those from the island of Timor, could represent introduced populations originating in the Greater Sunda area, or they could be a regionally endemic, hitherto unrecognized Lesser Sunda species.

## LIZARDS (ORDER LACERTILIA)

### Family Agamidae—Agamas and Dragon Lizards

#### *Draco timoriensis* Kuhl, 1820 <sup>[IV–VI, VIII]</sup>

**Common names.** (E) Timor Flying Dragon, Timor Flying Lizard. (G) Timor-Flugdrache. (T) Teki liras (teki = gecko, liras = winged). In direct translation, the Tetun name more accurately describes the gekkonid genus *Ptychozoon*, which is not found east of Wallace's Line. We believe that the common name of *D. timoriensis* is not an indication that local residents are unable to tell a gecko from an agamid lizard. Instead, it may reflect the assumption that lizards of comparable size are likely geckos, an error culturally perpetuated by the lack of opportunities to catch more than a fleeting glance at an individual because of the *Draco* lifestyle.

**Known distribution.** *Draco timoriensis* (Figure 10) is currently reported from five of Timor-Leste's 13 districts (Table 3): Baucau, Lautém, Liquiça, Oecusse, and Viqueque (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012). There are no records of any *Draco* species from Ataúro Island (Kaiser *et al.*, 2013b), a location surrounded by islands where *Draco* have been recorded, but islanders are adamant that they do not occur there (O'Shea and Kaiser, 2013).

**New localities.** During 2011 and 2012 we obtained additional specimens from Lautém District, from Com (Locality 26) and Raça (Locality 27). New district records were established for Manufahi District through the collection of specimens in the Betano area on the south coast (Locality 18), and from several localities around Same (Locality 17): in the mountains, in the grounds of the Ailelehu Guest House, and at Ladiki village, 5 km NE of Same. Southern coastal records came from the Nancuro coastal forest (Manatuto District; Locality 20), the grounds of Castelo Fronteira Guest House in Suai (Covalima District; Locality 13), and two sites outside of Tilomar (Covalima District; Locality 15), namely the Tilomar Forest Reserve and just N of Maubesi. On the north side of Timor we obtained a single specimen from the Meleotegi River (Ermera District; Locality 8), as well as a specimen from Dare, in the hills above Dili (Dili District; locality 4). The vouchers from Manufahi, Manatuto, Covalima, Ermera, and Dili are first district records and this doubles the number of districts from which *Draco timoriensis* has been recorded to ten (Table 3).

**Natural history.** Although a relatively small and slender species, *Draco timoriensis* is a fairly conspicuous lizard. It is usually seen running up the trunks of coconut palms or smooth-barked eucalypts and if pursued will easily leap and glide gracefully to another tree. It clearly exhibits a wide distribution, both on the southern and



**Figure 9** Adult *Polypedates* cf. *leucomystax* from a creek-side tree near Ossohuna (USNM 580454, Locality 25). Photo by Mark O'Shea.



**Figure 10** Adult female *Draco timoriensis* from a tree at Dare (USNM 579711, Locality 4). Photo by Mark O'Shea.

northern coasts, including the Oecusse exclave (Sanchez *et al.*, 2012), and it is relatively common at elevations only marginally above sea level (e.g., at 3 m in the Nancuro wet coastal forest, Manatuto District; Locality 20; USNM 579298; at 3 m on a tree opposite the wharf at Com, Lautém District; Locality 26; USNM 579491). We also obtained specimens at significantly higher elevations, on the upland limestone plateaus and central mountains of Timor-Leste (e.g., at 412 m elevation on trees around Raça village, Lautém District; Locality 27; USNM 579310–12, 579490; on forest trees at 442 m elevation near Tilomar, Covalima District; Locality 15; USNM 579302–04; and at 600 m elevation on a large tree, opposite the war memorial at Dare, Dili District; Locality 14; USNM 579711). The Meleotegi River specimen (Ermera District; Locality 8; USNM 579492) was collected at 1177 m, and constitutes the highest elevation record for *D. timoriensis* we have observed on Timor Island.

#### Family Gekkonidae — True Geckos

##### *Cyrtodactylus* spp. <sup>[IV–VIII]</sup>

**Common names.** (E) Bent-toed Geckos, Bow-fingered Geckos. (G) Bogenfinger-Geckos. (T) Teki ain-fuan kleuk (Teki = small gecko, kluek = bent, ain-fuan = toe).

**Known distribution.** During our initial survey in 2009 we collected two geckos of the genus *Cyrtodactylus* in Timor-Leste (see Taxonomic comment below). This population, currently referred to as *Cyrtodactylus* sp. 'Trilolo River,' was collected 4 km north of Same (Manufahi District; Locality 17; Kaiser *et al.*, 2011). In 2010 we collected a single specimen of *Cyrtodactylus* sp. 'Manucoco' on the northwestern slopes of Mt. Manucoco on Ataúro Island (Kaiser *et al.*, 2013b), and a series of ten vouchers of a third population, *Cyrtodactylus* sp. 'Abanat

River,' in the Oecusse exclave (Sanchez *et al.*, 2012). Populations of *Cyrtodactylus* are therefore known from two mainland districts (Manufahi, Oecusse) and from Ataúro Island (Dili District) so far (Table 3).

**New localities.** During 2011 we discovered further populations of *Cyrtodactylus* (Figure 11) over a wide area of Timor-Leste. Specimens collected at sea level on Ataúro Island (USNM 579712–25) are being treated as *Cyrtodactylus* sp. 'Ataúro coast' (Kaiser *et al.*, 2013b). Additionally, we located two more populations in Lautém District, along the north coast at Com (Figure 11B; Locality 26; USNM 579411–23) and on the adjacent limestone plateau, at Raça (Figure 11A; Locality 27; USNM 579313, 579408–09), and near the Mainina sinkhole (Locality 29; USNM 579410, 579424) (see Taxonomic comment below).

During 2012 four further populations of *Cyrtodactylus* were discovered and sampled: from a network of man-made tunnels at Venilale, Baucau District (Figure 11C; Locality 22; USNM 580474–84); in the coastal forest at Nancuro, Manatuto District (Figure 11D; Locality 20; USNM 580485–86); near Maganuto village, in the mountains surrounding Maliana, Bobonaro District (Figure 11E; Locality 11; USNM 580457), and in Fiuren village, near Balibo, Bobonaro District (Figure 11F; Locality 9; USNM 580488). At an altitude of 1036 m, the Maganuto locality is the highest record for these geckos in Timor-Leste.

In the summer of 2013, we discovered yet another population of bent-toed geckos in the vicinity of Com (Locality 26; USNM 581153–54), one clearly distinct from the small-bodied form we found in 2011. *Cyrtodactylus* spp. have now been recorded from six mainland districts and Ataúro Island (Table 3).

**Natural history.** The only general habitat requirement

**Table 3** Records of lizard species for the districts of Timor-Leste. Black circles indicate previously known records, red circles denote new records. The black open circle refers to a literature record only. Records listed in grey denote literature records from West Timor, with open circles representing known museum specimens.

| Taxon  | District |        |        |          |          |              |               |        |        |         |          |          |         |          | References <sup>*</sup> |          |
|--|----------|--------|--------|----------|----------|--------------|---------------|--------|--------|---------|----------|----------|---------|----------|-------------------------|----------|
|  | Aileu    | Ainaro | Baucau | Bobonaro | Covalima | Dili (Timor) | Dili (Atauro) | Ermera | Lautém | Liquiça | Manatuto | Manufahi | Oecusse | Viqueque |                         | W.Timor  |
| <b>AGAMIDAE</b>                                  |          |        |        |          |          |              |               |        |        |         |          |          |         |          |                         |          |
| <i>Draco timoriensis</i>                         |          |        | ●      |          | ●        | ●            |               | ●      | ●      | ●       | ●        | ●        | ●       | ●        |                         | 1-4      |
| <b>GEKKONIDAE</b>                                |          |        |        |          |          |              |               |        |        |         |          |          |         |          |                         |          |
| <i>Cyrtodactylus</i> sp. 'Trilolo River'         |          |        |        |          |          |              |               |        |        |         |          | ●        |         |          |                         | 1        |
| <i>Cyrtodactylus</i> sp. 'Manucoco'              |          |        |        |          |          |              | ●             |        |        |         |          |          |         |          |                         | 5        |
| <i>Cyrtodactylus</i> sp. 'Atauro coast'          |          |        |        |          |          |              | ●             |        |        |         |          |          |         |          |                         | 5        |
| <i>Cyrtodactylus</i> sp. 'Abanat River'          |          |        |        |          |          |              |               |        |        |         |          |          | ●       |          |                         | 3        |
| <i>Cyrtodactylus</i> sp. 'Plateau'               |          |        |        |          |          |              |               |        | ●      |         |          |          |         |          |                         | 4        |
| <i>Cyrtodactylus</i> sp. 'Com small'             |          |        |        |          |          |              |               |        | ●      |         |          |          |         |          |                         | 4        |
| <i>Cyrtodactylus</i> sp. 'Com large'             |          |        |        |          |          |              |               |        | ●      |         |          |          |         |          |                         | 4        |
| <i>Cyrtodactylus celatus</i>                     |          |        |        |          |          |              |               |        |        |         |          |          |         |          | ○                       | 6        |
| <i>Cyrtodactylus</i> sp. <i>incertae sedis</i>   |          |        | ●      | ●        |          |              |               |        |        |         | ●        |          |         |          |                         | 4        |
| <i>Gehyra mutilata</i>                           |          |        | ●      | ●        |          |              | ●             |        | ●      | ●       | ●        |          |         |          |                         | 1,4      |
| <i>Gekko gekko</i>                               |          |        | ●      | ●        |          | ●            | ●             |        | ●      | ●       | ●        | ●        | ●       | ●        |                         | 1-5      |
| <i>Hemidactylus frenatus</i>                     |          |        | ●      |          | ●        | ●            | ●             |        |        | ●       | ●        | ●        | ●       | ●        |                         | 1-5      |
| <i>Hemidactylus</i> cf. <i>garnotii</i>          |          |        |        | ●        |          |              |               |        |        |         |          |          |         |          |                         | 4        |
| <i>Hemidactylus platyurus</i>                    |          |        |        |          | ●        | ●            |               |        | ●      | ●       | ●        |          | ●       | ●        |                         | 1-4      |
| <i>Hemidactylus tenkatei</i>                     |          |        |        |          |          | ●            |               |        | ●      | ●       |          |          | ●       |          |                         | 1-4      |
| <i>Hemiphyllodactylus</i> cf. <i>typus</i>       |          |        | ●      |          |          |              |               |        |        |         |          |          |         |          |                         | 4        |
| <b>SCINCIDAE</b>                                 |          |        |        |          |          |              |               |        |        |         |          |          |         |          |                         |          |
| <i>Carlia peronii</i>                            |          |        |        |          |          |              |               |        |        |         |          |          |         |          | ○                       | 7        |
| <i>Carlia spinauris</i>                          |          |        |        |          |          |              |               |        |        |         |          |          |         |          | ○                       | 7,8      |
| <i>Carlia</i> sp. 'Maubisse'                     |          | ●      |        |          |          |              |               |        |        |         |          |          |         |          |                         | 1        |
| <i>Carlia</i> sp. 'Meleotegi River'              |          |        |        |          |          |              |               | ●      |        |         |          |          |         |          |                         | 1,2      |
| <i>Carlia</i> sp. 'South Coast'                  |          |        |        |          |          |              |               |        | ●      |         | ●        | ●        |         | ●        |                         | 1,2,4    |
| <i>Carlia</i> sp. 'Baucau'                       |          |        | ●      |          |          |              |               |        |        |         |          |          |         |          |                         | 1,2      |
| <i>Carlia</i> sp. 'Abanat River'                 |          |        |        |          |          |              |               |        |        |         |          |          | ●       |          |                         | 3        |
| <i>Carlia</i> sp. <i>incertae sedis</i>          |          |        |        |          |          |              |               |        |        |         |          | ●        |         |          |                         | 4        |
| <i>Cryptoblepharus leschenault</i>               |          |        | ●      |          |          |              | ●             |        | ●      |         | ●        |          |         |          |                         | 1,2,4,5  |
| <i>Cryptoblepharus</i> sp. 'Bakhita'             |          |        |        |          |          |              |               | ●      |        |         |          |          |         |          |                         | 2        |
| <i>Cryptoblepharus</i> cf. <i>schlegelium</i>    |          |        |        |          |          | ●            |               |        | ●      |         |          |          |         |          | ○                       | 4,9      |
| <i>Eremiascincus antoniorum</i>                  |          |        |        |          |          |              |               |        |        |         |          |          |         |          | ○                       | 10       |
| <i>Eremiascincus</i> cf. <i>timorensis</i>       |          |        |        |          |          |              |               |        |        |         |          |          |         |          | ○                       | 4,10     |
| <i>Eremiascincus</i> sp. 'Ermera'                |          |        |        |          |          |              |               | ●      |        |         |          |          |         |          |                         | 4        |
| <i>Eremiascincus</i> sp. 'Montane'               |          | ●      |        |          |          |              |               |        |        |         |          | ●        |         |          |                         | 1,2      |
| <i>Eremiascincus</i> sp. 'Lautém'                |          |        |        |          |          |              |               |        | ●      |         |          |          |         |          |                         | 1,2      |
| <i>Eremiascincus</i> sp. 'Jaco'                  |          |        |        |          |          |              |               |        | ●      |         |          |          |         |          |                         | 4        |
| <i>Eremiascincus</i> sp. 'Atauro'                |          |        |        |          |          |              | ●             |        |        |         |          |          |         |          |                         | 5        |
| <i>Eutropis</i> cf. <i>multifasciata</i>         |          |        |        |          |          |              | ●             | ●      | ●      |         | ●        | ●        | ●       |          |                         | 1-5      |
| <i>Lamprolepis smaragdina</i> cf. <i>elberti</i> |          |        | ●      | ●        | ●        |              | ●             |        | ●      |         | ●        | ●        | ●       | ●        |                         | 1-5      |
| <i>Sphenomorphus</i> cf. <i>melanopogon</i>      |          |        |        |          |          |              |               |        | ●      |         | ●        |          |         |          |                         | 1,2,4    |
| <i>Sphenomorphus</i> sp. 'Highland large'        |          |        |        |          |          |              |               | ●      |        |         |          |          |         |          |                         | 1,2      |
| <i>Sphenomorphus</i> sp. <i>incertae sedis</i>   |          | ●      | ●      |          |          |              |               |        | ●      |         | ●        | ●        |         |          |                         | 1,2,4    |
| <b>VARANIDAE</b>                                 |          |        |        |          |          |              |               |        |        |         |          |          |         |          |                         |          |
| <i>Varanus timorensis</i>                        |          |        | ●      |          | ●        | ●            |               | ●      |        | ○       | ●        |          |         |          |                         | 1,2,4,11 |
| <i>Varanus</i> cf. <i>salvator</i>               |          |        |        |          |          |              | ●             |        |        |         |          |          |         |          |                         | 5        |

<sup>1</sup>References are identified numerically as follows: 1 = Kaiser *et al.*, 2011; 2 = O'Shea *et al.*, 2012; 3 = Sanchez *et al.*, 2012; 4 = this paper; 5 = Kaiser *et al.*, 2013b; 6 = Kathriner *et al.*, 2014; 7 = Zug, 2010; 8 = Smith, 1927; 9 = Brongersma, 1942; 10 = Aplin *et al.*, 1993; 11 = Bethencourt Ferreira, 1898.

for representatives of this versatile gecko genus on Timor appears to be the availability of hiding places. Beyond this, we have encountered representatives of putative, undescribed species in habitats ranging from the wall of a cave in limestone karst (Raça, Locality 27) to the vertical walls of man-made tunnels (Venilale, Locality 22), and from wet lowland forest (Nancuro, Locality 20) to dry montane forest (Maganuto, Locality 11). Having had all of these encounters, it appears obvious to us that members of *Cyrtodactylus* on Timor display a considerable ecological plasticity when it comes to colonizing new

habitats and adapting.

On Ataúro Island, the lowland population appears to occur in most sampled habitats from near-coastal cliffs to disturbed localities, such as plantations or residential areas. Whereas the majority of our specimens came from areas near a source of water (e.g., in proximity to a riverbed, a shallow ravine with water run-off), some were found under rocks in Barry's Place Ecoresort, or by rolling palm logs and pulling apart palm leaf piles in a plantation.

Some of the microhabitats where we discovered



**Figure 11** Species of *Cyrtodactylus* in Timor-Leste. These six individuals represent populations of bent-toed geckos we consider distinct at the species level (Kathriner *et al.*, in prep.). We refer to them here by their localities. (A) Adult specimen (sex not determined, SVL = 60 mm) of the 'Plateau' population from the wall of a limestone karst cave near Raça (USNM 579408, Locality 27). (B) Adult male (SVL = 42 mm) of the small north coast bent-toed gecko from the ruin of the Portuguese pousada at Com (USNM 579412, Locality 26). (C) Adult male (SVL = 55 mm) from a wall in the man-made tunnels at Venilale (USNM 580474, Locality 22). (D) Adult female (SVL = 41 mm) from inside a rotten log in the coastal wet forest at Nancuro (USNM 580486, Locality 20). (E) Adult individual (sex not determined, SVL = 44 mm) from a dry rotting tree in the alpine habitat at Maganuto (USNM 580487, Locality 11). (F) Adult male (SVL = 40 mm) from a fallen log in disturbed dry forest at Fiuren (USNM 580488, Locality 9).

*Cyrtodactylus* include oddities. For example, our highest elevation specimen (1036 m, Maganuto; Locality 11) was recovered from the inside of a decaying tree that stood isolated in an alpine meadow surrounded by very little vegetation. Our search there was focused on *H. garnotii* (see below), individuals of which we had found nearby in decaying bamboo microhabitat, and when breaking apart the decaying wood, a single *Cyrtodactylus* was discovered. A second unusual locality was the rather disturbed forest habitat in Fiuren (Locality 9) that appeared to endure regular disturbance from the foraging activity of a group of free-roaming domestic pigs. The most unusual locality, however, were the roadside tunnels at Venilale (Locality 22). These tunnels were dug by forced labor during the Japanese occupation of Timor in the 1940s, and upon our first visit to the locality in 2009 we did not even consider conducting a careful search for reptiles there. While showing this locality to some of our team members in 2012, however, we chanced upon a gecko at head height on the surface of a vertical tunnel wall. Our subsequent, careful search revealed several additional specimens distributed throughout the tunnel system, including all tunnel surfaces (sides, floor, and ceiling), and in both exposed positions as well as underneath rocky debris. There was no evidence of standing or running water in the tunnels, although the air was cool and the humidity high.

**Taxonomic comments.** *Cyrtodactylus* is the largest genus in the Gekkonidae, indeed the most speciose in the entire Gekkota, a highly diverse group that comprises seven families, over 100 genera, and around 1400 species. *Cyrtodactylus* currently comprises one eighth of that diversity (199 species; Uetz and Hošek, 2014; Wood *et al.*, 2012), distributed from Tibet, China and India to northern Australia (Western Australia, Queensland) and east across the Indonesian island chain and New Guinea into the Solomon Islands, with new species being described at considerable frequency. Despite the geographic position of Timor near the center of this range, the only previous record of the genus from the territory of what is now Timor-Leste was a single specimen of '*Gymnodactylus timorensis*' listed by Duméril and Bibron (1836). However, this specimen is neither a member of the genus *Cyrtodactylus*, nor did it originate from anywhere close to the island of Timor (L. L. Grismer, in prep.; HK, unpubl. data). Therefore, prior to the initiation of this project, Timor-Leste was considered devoid of any representatives of the genus *Cyrtodactylus*.

Our fieldwork soon proved this not to be the case as the first six populations sampled during the project

were found to represent six different species, from at least two different larger clades (AK, unpubl. data). The Ataúro coastal population has similarities to the regionally endemic *C. darmandvillei* (Weber, 1890) but some morphological characteristics lead us to consider this population as a potentially new species, here called 'Ataúro coast' (*Cyrtodactylus* sp. 2 of Kaiser *et al.*, 2013b). We only possess a single specimen of the montane *Cyrtodactylus* sp. 'Manucoco' but it clearly represents a different taxon from its lowland neighbor based on both morphological and molecular data (AK, unpubl. data). The five mainland populations also represent distinct and separate species, which currently lack names and are therefore documented here as *Cyrtodactylus* sp. 'Trilolo River,' *Cyrtodactylus* sp. 'Abanat River,' *Cyrtodactylus* sp. 'Plateau' (Figure 11A), *Cyrtodactylus* sp. 'Com small' (Figure 11B), and *Cyrtodactylus* sp. 'Com large.' The taxonomic status of the four more recently sampled populations, from Venilale (Baucau District; Figure 11C), Nancuro (Manatuto District; Figure 11D), and Maganuto and Fiuren (both Bobobaro District; Figs. 11E and 11F, respectively) has yet to be determined, and we list them here as populations *incertae sedis*. In addition Kathriner *et al.* (2014b) described *C. celatus* from near Kupang, West Timor, from a single specimen collected in 1924 by M. A. Smith, and deposited, then essentially forgotten, in the Natural History Museum, London, United Kingdom.

Three of the populations we discovered stand out by their body size (up to 75 mm SVL), including the highland karst dwellers at Raça and Mainina (Localities 27 and 29, respectively), the lowland coastal limestone form at Com (Locality 26), and the lowland form on Ataúro. A preliminary analysis of molecular data (Kathriner *et al.*, unpubl. data) indicates that the larger mainland populations likely constitute a separate radiation from the small-bodied forms (up to 46 mm SVL). While it is too early to determine their exact phylogenetic affinities or the vector by which they arrived on Timor, there appears to have been sufficient time elapsed for the two major radiations to adapt to diverse niches and to diversify into an unexpectedly rich bent-toed gecko fauna.

***Gehyra mutilata* (Wiegmann, 1834)** <sup>[IV-VII]</sup>

**Common names.** (E) Mutilated Gecko. (G) Vierklauen-Gecko. (T) Teki kulit kanek (Teki = small gecko, kulit = skin, kanek = injured).

**Known distribution.** *Gehyra mutilata* (Figure 12) has so far been reported from only two districts (Table 3), from Dili and Lautém, as well as on Mt. Manucoco, Ataúro Island, Dili District (Kaiser *et al.*, 2011, 2013b).

**New localities.** During the last four surveys additional



specimens were obtained from sea level to an elevation of 572 m on Ataúro Island (Kaiser *et al.*, 2013b), and in Lautém District from sea level habitats at Com (Locality 26) to the elevated central limestone plateau at Raça (elevation > 400 m; Locality 27). Additional lowland records from Phases IV–VII on the mainland came from the confluence of the Comoro and Bemos Rivers (8 km S of the Comoro River bridge, Liquiça District; Locality 6; USNM 579425), and the wet coastal forest at Nancuro (Natarbora, 8 km S Umaboco, Manatuto District; Locality 20; USNM 581759), while upland localities include the ruins of Escola do Reino de Haudere, Baguia (Baucau District; Locality 24; USNM 580489), and the grazed forest at Fiuren, near Balibo (Bobonaro District; Locality 9; USNM 580490–91). On the mainland *Gehyra mutilata* has now been recorded from five districts, on both the northern and southern coastal lowlands, at altitudes > 400 m in the central massif of Timor and > 570 m on Ataúro Island (Table 3).

**Natural history.** Specimens of *G. mutilata* have been recovered from the standard set of microhabitats typically frequented by house geckos (see natural history comments on the species of the genus *Hemidactylus* below). Most frequently, these geckos were found associated with dry wooden structures, such as the loose bark on decaying trees, in dry leaf litter, or in the building materials used to make traditional huts. They were also collected from the walls of houses. Occasionally, a specimen was retrieved from underneath dry rocks (such as in a rock pile) or by rolling rocks in dry habitats.

***Gekko gekko* (Linnaeus, 1758)** [IV–VII]

**Common names.** (E) Tokay Gecko. (G) Tokeh, Tokee, Panthergecko. (T) Toke.

**Known distribution.** *Gekko gekko* (Figure 13) has so far been reported from five of Timor-Leste's 13 districts (Lautém, Liquiça, Manufahi, Oecusse, and Viqueque; Kaiser *et al.*, 2011; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012) and from Ataúro Island, Dili District (Kaiser *et al.*, 2013b) at elevations from near sea level to over 500 m (Table 3).

**New localities.** During 2011 and 2012 four more mainland districts were documented as part of the range for *Gekko gekko* in Timor-Leste (Baucau, Bobonaro, Dili, Manatuto). Since this is an introduced species and there are no arguments regarding its identity or taxonomy, we collected only few voucher specimens whenever it was encountered; some of our records therefore comprise a voucher photograph rather than a specimen. In addition, this is the most vocal member of the Gekkonidae on the island of Timor, and it possesses a characteristic,

eponymous vocalization. Individuals issuing the onomatopoeic “toh-kay” call are frequently heard in forests, on rocky outcrops or buildings, both by night and day.

Voucher specimens were collected along the Comoro River (Dili District; Locality 1; USNM 579314), at Betano ‘dry site’ (Manufahi District; Locality 18; USNM 579315), and near Raça (Lautém District; Locality 27; USNM 579316–17). Voucher photographs were contributed for the wet coastal forest at Nancuro (Natarbora, 8 km S Umaboco, Manatuto District; Locality 20; USNM-HI 2824), Com village (Lautém District; Locality 26; USNM-HI 2764), the ruins of Escola do Reino de Haudere (Baguia, Baucau District; Locality 24; USNM-HI 2759–60), and from the grazed forest at Fiuren (Bobonaro District; Locality 9; USNM-HI 2762). Aural observations were made in the forest on Jaco Island (Lautém District; Locality 30) and along a rocky outcrop at Maganuto (Bobonaro District; Locality 11) for specimens that could be heard but not seen. *Gekko gekko* is now known from ten districts, including Ataúro Island (Table 3).

**Natural history.** *Gekko gekko* is the largest member of the Gekkonidae in the Lesser Sunda Archipelago, and one of the most visible elements of the gecko fauna anywhere. As a predator of significant size (we encountered adult specimens with SVL in excess of 22 cm), this is not a species that needs to hide itself but tends to threaten when disturbed. Our relatively frequent encounters with this species have happened during both day and night and we have seen adults, juveniles, and eggs containing developing embryos (but destroyed by local children as sport) during both wet and dry season surveys. This species is familiar to the local population throughout the country, and we believe its range encompasses all of Timor.

***Hemidactylus frenatus* Schlegel, 1836** [IV–VIII]

**Common names.** (E) Common House Gecko. (G) Asiatischer Hausgecko. (T) Teki uma baibain frenatus (teki = small gecko, uma = house, baibain = common).

**Known distribution.** *Hemidactylus frenatus* (Figure 14) has so far been reported from seven of Timor-Leste's 13 districts (Baucau, Dili, Lautém, Liquiça, Manatuto, Oecusse, and Viqueque; Kaiser *et al.*, 2011; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012) and from Ataúro Island, Dili District (Kaiser *et al.*, 2013b) (Table 3).

**New localities.** We here report additional voucher specimens from mainland Dili District on the shoreline at Tasi Tolu, the grounds of the Timor Lodge Hotel, the mangrove swamp at Metinaro, and from the Comoro



**Figure 12** Adult male *Gehyra mutilata* from a fallen log at Fiuren (USNM 580490, Locality 9). Photo by Mark O'Shea.



**Figure 13** Subadult *Gekko gekko* still showing the distinct juvenile tail pattern. This specimen was not vouchered. Photo by Mark O'Shea.



**Figure 14** Adult *Hemidactylus frenatus* (sex not determined) from the tidal rocks at Tasi Tolu, near Dili (USNM 580494, Locality 1). This individual is a good example of the habitat plasticity displayed by house geckos, as it was discovered in an area near the tidal splash zone that it shared with individuals of *Cryptoblepharus cf. schlegelianus*. Photo by Mark O'Shea.

River (Localities 1, 3 and 5; USNM 579726, 579731–32, 579736, 580494, 581746). Vouchers were also taken at the confluence of the Comoro and Bemós Rivers, on the Liquiça bank (Locality 6; USNM 579425, 579431). Further specimens were obtained from Lautém District, from Com at sea level, and from Raça on the central limestone plateau (Localities 26 and 27; USNM 579428–40, 581755–56). Other low-lying locations sampled during 2011 and 2012 produced vouchers from both the 'wet site' and 'dry site' at Betano (Manufahi District; Locality 18; USNM 581753–54), and the grounds of the Castelo Fronteira Guest House, Suai (Covalima District; Locality 13; USNM 581747). Vouchers were also obtained from upland localities, such as the ruins of the Escola do Reino de Haldere, Bagaia (Baucau District; Locality 24; USNM 580492–93). The Covalima and Manufahi District records constitute first records for these districts, elevating the number of districts where *H. frenatus* has been recorded to nine (Table 3). We believe that this species is likely found associated with human disturbances almost anywhere on Timor Island, certainly at elevations between sea level and 600 m (see Natural history for *H. cf. garnotii*).

**Natural history.** Throughout all of our surveys, this species is clearly the most frequently encountered gecko. Due to its perianthropic lifestyle, it is encountered on the walls of almost any human habitations. These geckos are able to colonize even new construction rapidly and indiscriminately, and they appear to live in clean hotel rooms just as well as in natural vegetation, rock piles, or even trash. We have not encountered them in pristine habitats, with the exception of healthy-looking forest areas experiencing some minor form of human impact, such as those adjacent to coffee plantations. We believe that the species exists in all of Timor-Leste's districts, and we believe its arrival on the island and its dispersal throughout the country may be correlated with historic and current local trade patterns.

#### *Hemidactylus cf. garnotii*<sup>[VII]</sup>

**Common names.** (E) Indo-Pacific House Gecko. (G) Indopazifischer Halbfinger-Gecko, Jungfern-Halbfinger-Gecko. (T) Teki uma baibain garnotii (teki = small gecko, uma = house, baibain = common).

**Identification.** *Hemidactylus cf. garnotii* (Figure 15) is the fourth house gecko species (genus *Hemidactylus*) recorded from Timor-Leste, and especially in preservative it is one easily confused with the more common species (e.g., *H. frenatus*, *H. tenkatei*). Specimens encountered in Bobonaro were dark brown when collected, with several longitudinal rows or dark-edged light spots on the dorsum

and a prominent ventrolateral series of white spines along the edge of the tail. The dorsal color paled in captivity but the light spots and white caudal spines were still in evidence. *Hemidactylus cf. garnotii* can be distinguished from *H. platyurus* by a tail that is not dorsoventrally flattened and by the absence of skin webbing and fringing associated with tail, digits, limbs, and flanks; from *H. tenkatei* by the absence of that species' distinctive longitudinal rows of raised dorsal tubercles, and from *H. frenatus* by a series of small scales that separate the 2<sup>nd</sup> pair of postmental scales from the infralabials (both pairs of postmentals are in contact with the infralabials in *H. frenatus*). *Hemidactylus frenatus* also has four longitudinal rows of elevated spines on its original tail, whereas in *H. cf. garnotii* the character of tubercle rows is limited to two lateral rows. *Hemidactylus cf. garnotii* is easily distinguished from *Gehyra mutilata* by its longer and flatter snout and the pattern of chin scales. Several of our specimens had symmetrical calcium deposits in the neck area (Figure 15B), which is something we never observed in the other house gecko species found in Timor-Leste.

**Known distribution.** There were no previous records of this species for Timor-Leste.

**New localities.** *Hemidactylus cf. garnotii* was encountered only during the survey in 2012 (Phase VII) when seven vouchers were collected in the bamboo forest above Maganuto, near Maliana (Bobonaro District; Locality 11; USNM 580495–501) and a single voucher obtained from the degraded, grazed forest at Fiuren, near Balibo (Bobonaro District; Locality 9; USNM 580502). The Fiuren specimen came from an elevation of 463 m but the Maganuto specimens were collected at 1041–1063 m on the slopes of Mt. Leolaco at an altitude far above that recorded for any other *Hemidactylus* species in Timor-Leste.

**Natural history.** The seven specimens collected in the bamboo forest above Maganuto were mostly sheltering at the bases of bamboo leaf-axils or in termite-inhabited dead bamboo stalks, but one specimen was found under a rock and another behind the bark of a tree in close proximity to the bamboo. Several specimens had regenerated tails, and one (USNM 580498) had lost both its left fore- and hind limbs but had healed and survived the trauma. The Fiuren specimen, containing two eggs, was also found inside a clump of bamboo.

*Hemidactylus garnotii* Duméril and Bibron, 1836 is an all-female parthenogenetic species and should be considered a good colonizer: only a single adult female is needed to produce eggs to establish a new colony. It is

therefore somewhat surprising that its reproductive ability has not made this species more prevalent in Timor-Leste. We believe that it may be its reduced genetic variability, inherent in clonally reproducing organisms, that gives this species only few options to successfully compete with aggressive bisexual species, such as *H. frenatus* or *H. tenkatei*. If it is difficult for *H. garnotii* to live in sympatry with other house geckos, unlike *Gehyra mutilata* or *H. platyurus*, its presence and apparent success on the slopes of Mt. Leolaco at elevations above 1000 m might be explained by the fact that no other house geckos have yet been found above 563 m in mainland Timor-Leste.

**Taxonomic comments.** *Hemidactylus garnotii* is a colonizing species, which we would most expect to encounter in coastal lowland beachheads. Whilst the Fiuren record came from a locality which was at an intermediate elevation (463 m) and heavily influenced by human activities, both being common factors associated with colonizing species, the majority of our specimens were collected at Maganuto, on the slopes of Mt Leolaco at an elevation considerably above that documented for any other Timor *Hemidactylus* (1041–1063 m), in a habitat that seemed to us incompatible with a colonizing species such as *H. garnotii* due to its remoteness and high elevation. This leads us to wonder if this taxon is an undescribed species of *garnotii*-like *Hemidactylus*, but in the absence of any males we cannot as yet differentiate it morphologically from true *H. garnotii*. We therefore refer to it as *Hemidactylus cf. garnotii*.

***Hemidactylus platyurus* (Schneider, 1792)<sup>[IV-V]</sup>**

**Common names.** (E) Common Flat-tailed Gecko. (G) Saumschwanz-Hausgecko. (T) Teki ikun belar (teki = small gecko, belar = flat, ikun = tail).

**Known distribution.** *Hemidactylus platyurus* (Figure 16) has so far been reported from six of Timor-Leste's 13 districts (Dili, Lautém, Liquiça, Manatuto, Oecusse, and Viqueque; see Kaiser *et al.*, 2011; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012). It has not been recorded on Atauro Island (Table 3; see Kaiser *et al.*, 2013b).

**New localities.** Additional specimens were collected in 2011 in Lautém District, near sea level on the north coast at Com (Locality 26; USNM 579445–47) and at 520 m elevation, 5 km N of Maubesi (Tilomar, Covalima District, Locality 15; USNM 581757–58). This is a little lower than our elevation record for *H. platyurus* at 545 m near Dare, Dili District (Locality 4; USNM 579112) during Phase III. Covalima is the seventh district from which we have recorded *H. platyurus* (Table 3).

**Natural history.** This is another of the perianthropic house gecko species, though it is seen around human



**Figure 15** Adult *Hemidactylus* cf. *garnotii* from a bamboo stand above Maganuto (USNM 580502, Locality 11). This individual shows the presence of mature eggs and gular calcium deposits. Photo by Mark O'Shea.

habitations in considerably lower numbers than either *H. frenatus* or *H. tenkatei*. In each of the new localities, other house geckos were present, although not all cohabiting gecko species were vouchered. The two Maubesi specimens were found on a roadside tree that initially caught our attention because of the presence of a monitor lizard (*Varanus*; see below). After capturing the monitor lizard, we managed to obtain both specimens from a height of ca. 5 m above ground level. Both of the specimens caught in Com were found along with individuals of *H. frenatus* and *H. tenkatei* in the rafters of the cabins at Com Beach Resort and on stone walls surrounding the compound.

***Hemidactylus tenkatei* van Lidth de Jeude, 1895** <sup>[IV-VII]</sup>

**Common names.** (E) Roti House Gecko. (G) Roti-Hausgecko. (T) Teki uma baibain Roti (teki = small gecko, uma = house, baibain = common).

**Identification.** *Hemidactylus tenkatei* (Figure 17) can be distinguished from *H. frenatus* by the presence of 16–20 longitudinal rows of large, strongly keeled tubercles,



**Figure 16** Adult *Hemidactylus platyurus* (sex not determined) from the wall of a building at the Com Beach Resort (USNM 579447, Locality 26). Photo by Mark O'Shea.

as opposed to the numerous scattered, small conical tubercles of its more common congener. It also lacks the broad, flattened, filamentous-edged tail and strongly webbed toes of *H. platyurus*. *Hemidactylus tenkatei* may be distinguished from *Gehyra mutilata* by its chin shields, which are arranged to form a smoothly arched posterior border in the latter species, and from *H. garnotii* by the presence of enlarged keeled tubercles on its dorsum.

**Known distribution.** *Hemidactylus tenkatei* had previously only been recorded from Liquiça and Oecusse Districts (Table 3; see O'Shea *et al.*, 2012; Sanchez *et al.*, 2012).

**New localities.** We here report new district records for *H. tenkatei* from Dili District at Timor Lodge Hotel, Dili (Locality 1; USNM 579728–30) and Metinaro mangrove swamp (Locality 3; USNM 579733), and from Lautém District at Com Beach Resort (Locality 26; USNM 579417, 579430, 579441–44), elevating the number of districts from which this introduced species has been recorded to four. All records are from elevations below 25 m and from northern coastal locations, indicative of



**Figure 17** Adult *Hemidactylus tenkatei* (sex not determined) from a wall in the grounds of the Timor Lodge Hotel in Dili (USNM 581158, Locality 1). Photo by Mark O'Shea.

an invading species establishing bridgeheads. The lack of any specimens of *H. tenkatei* further inland could be a result of its recent arrival, its inability to compete with the already established *H. frenatus*, *H. platyurus*, or *Gehyra mutilata*, or its adaptation to a microhabitat that currently remains undiscovered. At our accommodation in Dili, the Timor Lodge Hotel, we have noticed an increase in the abundance of *H. tenkatei* relative to *H. frenatus* over the five-year period of our survey work, but this observation will require further verification.

**Natural history.** We collected six specimens of what we initially believed to be *H. frenatus* from trees and rocks in the center of a seasonally dry riverbed, west of Maubara (Liquiça District: locality 3) on 6 February 2010 (Phase II). Upon later examination, one of these (USNM 579064)

was re-identified as *H. cf. tenkatei* (A. M. Bauer, *pers. comm.*), the first specimen of the perianthropic *H. brookii* complex recorded from Timor-Leste. With a distribution of this species complex ranging from Pakistan and Indian Ocean islands to the Philippines and south into the Lesser Sunda archipelago (Bauer *et al.*, 2010), ancestors of Timorese *H. tenkatei* may have found their way onto Roti Island, the type locality of *H. tenkatei*, and later on to Timor Island by stowing away with neolithic human migrants and their chattels.

**Taxonomic comments.** Geckos called *Hemidactylus brookii* exist in museum collections from throughout South and Southeast Asia, and the broad distribution and the likely influence of historical human trading and colonization patterns has led to an inconsistent use of names for these forms. Recently, Bauer *et al.* (2010) completed a molecular analysis, in which they restricted the distribution of true *H. brookii* to Borneo, Peninsular Malaysia, Burma, and Karnataka State in India. However, their analysis conspicuously excluded data from islands of the Indonesian Archipelago, notated with a centrally placed question mark in their distribution map (Figure 1 in Bauer *et al.*, 2010).

The species *H. tenkatei* was described by van Lidth de Jeude (1895) based on three specimens from Roti, a small (1200 km<sup>2</sup>) island off the extreme southwestern corner of Timor. Two decades later, de Rooij (1915) placed the species into the synonymy of *H. brookii* after a limited study of specimens from Flores and Wetar, presumably with literature accounts then available, but without the presentation of data. In two recent revisions of the *H. brookii* group, of which *H. tenkatei* is a member, Rösler and Glaw (2010) and Mahony (2011) removed *H. tenkatei* from the synonymy of *H. brookii*, but did not examine the relevant type material. Addition of these important specimens to the analysis, along with the Bornean type material of *H. brookii* and molecular data for specimens from Timor-Leste to the data set of Bauer *et al.* (2010), shows that *H. tenkatei* is a species distinct from *H. brookii* and that Timorese populations are indeed identical to those on Roti (Kathriner *et al.*, 2014a). Furthermore, it appears that the species *H. tenkatei* is a widespread and successful colonizer found not only in the Lesser Sundas but also in Sarawak, Borneo, and Penang Island, Malaysia (Kathriner *et al.*, 2014a), and that these populations can therefore all be referred to *H. tenkatei*.

***Hemiphyllodactylus cf. typus*** <sup>[VII]</sup>

**Common names.** (E) Dwarf Tree Gecko. (G) Zigeunergecko, Gewöhnlicher Halbblattfinger-Gecko. (T) Teki ai isin lotuk (teki = gecko, ai = tree, isin lotuk = very

small body).

**Identification.** *Hemiphyllodactylus cf. typus* (Figure 18) is the smallest gecko in the region and easily overlooked, as it had been during six previous phases of our survey. This is an extremely slender, etiolated gecko, its body so elongated that the adpressed limbs do not overlap or even come into contact. It can be distinguished from *Hemidactylus* spp. by its clawless 1<sup>st</sup> digit, a characteristic it only shares with members of the genus *Lepidodactylus*, a taxon as yet unrecorded from Timor, and the complete lack of any enlarged postmental scales in the chin region. In *L. lugubris* the clawless 1<sup>st</sup> digit is otherwise well developed, being at least two-thirds the length of the 2<sup>nd</sup> digit, whereas in *H. cf. typus* the 1<sup>st</sup> digit is much reduced in size.

**Known distribution.** There were no previous records of this genus from Timor-Leste.

**New localities.** Two specimens of *Hemiphyllodactylus cf. typus* were collected at Ossohuna, near Baguia (Baucau District; Locality 25) during Phase VIII, the first record of the taxon from Timor Island.

**Natural history.** The only two specimens of *H. cf. typus* (USNM 580503–04) found in Timor-Leste so far were collected in a clump of bamboo in a dry river gorge, sheltering behind the leaf-like culm sheaths that protect the base of the bamboo shoots. Their movements, when uncovered, were slow, meaning they did not ‘scamper’ as do many species of *Hemidactylus*.

**Taxonomic comments.** The Indo-Pacific genus *Hemiphyllodactylus* contains as many as 20 species although most exhibit fairly or extremely localized distributions (Zug, 2010b; Grismer *et al.*, 2013, 2014). The one widespread species is the parthenogenetic *H. typus* Bleeker, 1860, which is found from southern Myanmar and Taiwan of China to New Guinea and across the South Pacific to Fiji and Tonga, with established but isolated populations in Sri Lanka, the Mascarene Islands,



**Figure 18** Adult *Hemiphyllodactylus cf. typus* from a bamboo stand near Ossohuna (USNM 580503, Locality 25). Photo by Mark O'Shea.

and the Hawaiian Islands (Zug, 2010b, 2013). This is a colonizing species that often goes undetected due to its small size and secretive nature, so its true distribution is incompletely documented (Zug, 2010b). Small beachhead populations of parthenogenetic geckos are most commonly found in lowland coastal localities where they have become established, either through the actions of man or by some other means, such as rafting.

The population recorded here is located near Ossohuna, 22 km from the north coast and 10 km from the south coast of Timor-Leste, at an elevation of 938 m. Although the distances to either coast are not great, the road from the north coast to Ossohuna is rough, long, and winding and the road from the south coast is only accessible seasonally by vehicles with off-road capability and by no means a reliable transport connector. This leads us to query whether the specimens represent the parthenogenetic *H. typus* or an undescribed sexual species, such as occur at inland locations in India, China, Southeast Asia, Sumatra, and Borneo. In most characters examined, the Timor specimens appear to fall within the characteristics of *H. typus* as detailed by Zug (2010b), and given that the only specimens collected to date are a juvenile and an adult female we are unable to disprove the parthenogenetic species argument. However, in light of the cryptic diversity seen in mainland Southeast Asian *Hemiphyllodactylus* populations (Grismer *et al.*, 2013, 2014), a molecular analysis of the Timor specimens is now being conducted (P. Wood, in prep.).

### Family Scincidae—Skinks

#### Genus *Carlia* <sup>[IV–VII]</sup>

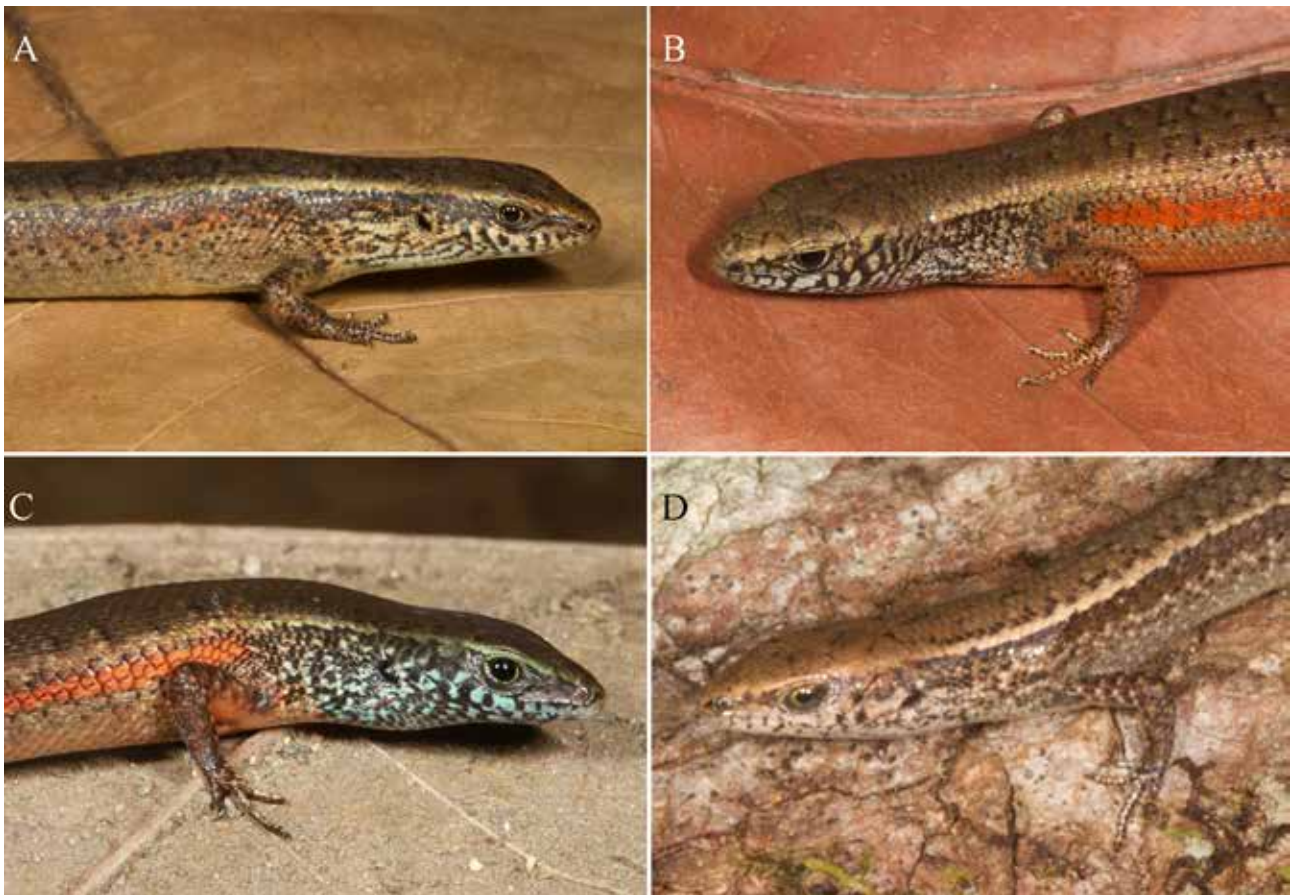
**Common names.** (E) Four-fingered Skinks, Rainbow Skinks. (G) Regenbogen-Skinke. (T) Mamór liman-fuan haat (mamór = skink, haat = four, liman fuan = finger).

**Known distribution.** During Phases I–III we collected *Carlia* in six of Timor’s mainland districts (Ainaro, Baucau, Ermera, Lautém, Oecusse, and Viqueque), but did not locate the genus on Ataúro Island (Table 3), despite reports of the genus from Alor to the northwest and Wetar to the northeast (Zug, 2010a). Our vouchers comprised two apparently montane forms: *Carlia* sp. ‘Maubisse’ (Figure 19A) from Ainaro District (Maubisse; Locality 16), and *Carlia* sp. ‘Meleotegi River’ (Figure 19B) from Ermera District (Sta. Bakhita Mission and Meleotegi River; Locality 8), and three seemingly lowland forms: *Carlia* sp. ‘South Coast’ (Figure 19C) from Loré village, southeast Lautém District and Beçu on the coast of Viqueque District, *Carlia* sp. ‘Baucau’ (Figure 19D) from Afacaimau, Baucau District (Locality 23), and *Carlia* sp. ‘Abanat River’ from the Oecusse

District. For reports from these localities, see Kaiser *et al.* (2011), O’Shea *et al.* (2012), and Sanchez *et al.* (2012).

**New localities.** During 2011 and 2012 (Phases IV–VII) we collected additional vouchers of all the above species, except *Carlia* sp. ‘Abanat River.’ *Carlia* spp. ‘Maubisse’ and ‘Meleotegi River,’ which were only found at their original locations. However, vouchers of *Carlia* sp. ‘South Coast’ were collected as a series from Nancuro (Natarbora, 8 km S Umaboco, Manatuto District; Locality 20; USNM 579319–27), and as single specimens from the southern shore of Lake Lenas (near Fatucahi, Manufahi District; Locality 19; USNM 579328) and a roadside ditch on the road between Fatucahi and Betano (Manufahi District; Locality 18; USNM 579329), greatly extending the westerly range of this taxon from Beçu, Viqueque District, and providing the first *Carlia* records for Manatuto and Manufahi Districts. Another single specimen obtained by one of us (LLA) at the Betano “wet site” may also belong to this taxon and extends the range further west, although it is currently documented as *Carlia incertae sedis*. *Carlia* sp. ‘South Coast’ was also collected for the first time along the north coast, when two specimens were obtained from the ruins of the Pousada de Com (Lautém District; Locality 26; USNM 579448–49). A single additional specimen of *Carlia* sp. ‘Baucau’ was collected at Afacaimau (Baucau District; Locality 23; USNM 580506), a site known to the project as the “*Carlia* spot,” and another single specimen, seemingly also of *Carlia* sp. ‘Baucau,’ was collected on the sandstone cliff above the Japanese caves at Venilale (Baucau District; Locality 22; USNM 580505), although this specimen was taken at an elevation of 675 m while the “*Carlia* spot” vouchers were collected at 290–370 m. *Carlia* populations have now been documented for eight mainland districts (Table 3).

**Natural history.** Members of the genus *Carlia* in Timor-Leste appear to be habitat generalists, found in both dry and moist habitats, as well as both pristine and disturbed areas. When out in the open, we have observed individuals foraging in and around leaf litter and decaying plant material, or basking on exposed “perches,” such as small boulders, tree trunks, fallen banana plants, or retaining walls near human habitations. These lizards also interact with one another by signaling (e.g., tail waving: Langkilde *et al.*, 2004; O’Shea, 1993) and were occasionally observed chasing each other as part of aggressive or mating encounters. Where they occur, *Carlia* can be very abundant lizards: at the Sta. Bakhita Mission, *Carlia* sp. ‘Meleotegi’ occurs at numbers of perhaps as many as one or two individuals per m<sup>2</sup> on the



**Figure 19** Representatives of four populations of four-fingered skinks (genus *Carlia*) we consider to be distinct at the species level. Important characteristics to differentiate these forms in the field include the coloration of the throat and venter of breeding males as well as the presence, color, and extent of lateral stripes in both sexes. (A) Adult female (SVL = 44 mm) from the grounds of the Portuguese Pousada at Maubisse (USNM 579334, Locality 16). (B) Adult male (SVL = 46 mm) from man-made gardens at the Sta. Bakhita Mission (USNM 579450, Locality 8). (C) Adult male (SVL = 42 mm) from among the leaf litter in wet coastal forest at Nancuro (USNM 579324, Locality 20). (D) Adult male (SVL = 40 mm) from banana plant debris in an agricultural environment (USNM 580506, Locality 23). Photos by Mark O'Shea.

terraced hillside. In other localities, abundance clearly depends on the presence of a potential source of food (e.g., invertebrates in a pile of decaying leaves). Only rarely did we encounter single individuals.

We have been unable to observe particular adaptive specializations among the four or five putative taxa occurring in Timor-Leste (see Taxonomic comments below), which can be expected when dealing with a habitat generalist. One of us (SM) was able to observe that male *Carlia* from highland locations (Bakhita and Meleotegi) held in captivity become flushed with color during the breeding season. Females, from those locations, however, may also show a color change towards a more intense coloration (limited to a mid-lateral stripe), which is related to reproductive readiness. On the other hand, such drastic changes in coloration in specimens from the lowland rainforest of Nancuro were not observed (SM, pers. obs.). More detailed observations will be possible

once the taxonomic status of these populations has been clarified.

**Taxonomic comments.** Prior to the initiation of this survey in 2009, two species of *Carlia* were documented for the island of Timor: *Carlia peronii* (Duméril and Bibron, 1839) and *C. spinauris* (Smith, 1927). Although Greer (1976) treated *C. spinauris* as a synonym of *C. peronii*, Zug (2010a) recognized them to be separate but related species within the *C. peronii* species group (sensu Greer, 1976), a group that also extends onto other islands in Indonesia's provinces of East Nusa Tenggara (e.g., Roti, Sema, Alor) and southern Maluku (e.g., Wetar, Kisar). This species group also includes the recently described *C. sukur* Zug and Kaiser, 2014 from Pulau Sukur, a small island north of Flores (Zug and Kaiser, 2014).

In addition to a suite of morphological and morphometric characters, Zug (2010a) separated *C.*

*peronii* and *C. spinauris* spatially, stating that the former was a lowland species, whereas the latter was a highland species. The type locality for *C. peronii* was erroneously given as “Île de France” (= Mauritius), having been reassigned to Kupang, West Timor by Greer (1976), the only location on Timor visited by the collector, François Auguste Péron. This species is also known from other low-lying locations to the east of Kupang (e.g., Kokabris, Noil Toko, Djamplong = Camplong). In contrast, the type locality for *C. spinauris* is Lelogama (elevation 750 m), where it was personally collected by M. A. Smith and his wife in 1924, and it was also recorded from Soë (elevation 800 m) by de Jong (1927). To date neither of these species has been recorded in Timor-Leste. The material available to us has already undergone preliminary molecular analysis and there is strong evidence to support the recognition of four or five different species, distinct from the aforementioned West Timorese taxa.

***Cryptoblepharus leschenault* (Cocteau, 1832)** <sup>[IV, VI-VII]</sup>

**Common names.** (E) Leschenault’s snake-eyed skink. (G) Leschault-Schlangenaugenskink. (T) Mamór matan samea leschenault (mamór = skink, matan = eye, samea = snake).

**Known distribution.** During Phase I (2009) *Cryptoblepharus leschenault* (Figure 20) was documented from lowland locations in Lautém and Baucau Districts, with three and one vouchers collected, respectively (Kaiser *et al.*, 2011), and a single voucher was collected from a coastal location on Ataúro Island, part of Dili District (Kaiser *et al.*, 2013b). *Cryptoblepharus leschenault* is therefore known from three districts to date.

**New localities.** Single vouchers of *C. leschenault* were collected on each of our visits to the coastal forest at Nancuro (Natarbora, 8 km S Umaboco, Manatuto District; Locality 20; USNM 579335, 580520), bringing to four the number of districts where the species has been collected (Table 3).

**Natural history.** *Cryptoblepharus leschenault* is an infrequently encountered species, but where it occurs it may be relatively abundant but difficult to capture. Specimens would run rapidly up the trunks of large hardwood trees, from where they could usually only be captured using blowpipes. Despite intensive searches in many locations these small skinks appeared to be much more patchily distributed than the other tree-bole inhabiting lizards, the larger *Draco timoriensis* and *Lamprolepis smaragdina* cf. *elberti*. The two Nancuro specimens collected during Phase IV (2011) and Phase VII (2012) were also found on the boles of trees, 5.0 m



**Figure 20** Adult male of *Cryptoblepharus leschenault* from 3 m above ground on the trunk of a tree in wet coastal forest at Nancuro (USNM 580520, Locality 20). Photo by Mark O’Shea.

and 3.0 m from the ground, respectively.

**Taxonomic comments.** Prior to the initiation of this survey two species of *Cryptoblepharus* had been recorded from Timor Island, *C. leschenault* and *C. schlegelianus*. Whereas the former was only recently documented for Timor-Leste (Kaiser *et al.*, 2011), the latter is known only from Semau, a small island off West Timor, where it apparently occurs in sympatry with *C. leschenault* (Brongersma, 1942). The dorsal pattern of *C. leschenault* consists of a dark background with a pair of narrow light dorsolateral stripes from snout to tail and a narrow light vertebral stripe from the snout to a point anterior to the forelimbs, where it then splits, in the shape of a tuning fork, to continue to the tail as a pair of even narrower paravertebral stripes. The pattern of *C. schlegelianus* comprises a pale background without a vertebral stripe, but with a pair of relatively broad, pale dorsolateral stripes above a narrower pair of dark narrow stripes that continue to the tail (Horner, 2007). Without the benefit of a detailed review of available material, we are unconvinced that *C. schlegelianus* is present in Timor-Leste; the species has only been verified for Semau Island, in the absence of actual specimens from the western end of Timor (Horner, 2007; Mertens, 1931), although a very similar, perhaps conspecific form is present in Timor-Leste (see account of *C. cf. schlegelianus* below).

***Cryptoblepharus* sp. ‘Bakhita’** <sup>[VI]</sup>

**Common names.** (E) Bakhita snake-eyed skink. (G) Bakhita-Schlangenaugenskink. (T) Mamór matan samea bakhita (mamór = skink, matan = eye, samea = snake). The common name ‘Bakhita’ is used in reference to the Sta. Bakhita Mission, the location from which our exploration of the nearby Meleotegi River habitat originated.

**Identification.** This hitherto undescribed species of



*Cryptoblepharus* (Figure 21) has a dorsal stripe pattern similar to that of *C. leschenault*, but with a critical difference. The dorsal pattern of *C. leschenault* consists of a black background with a pair of narrow light yellow dorsolateral stripes from snout to tail and a yellow vertebral stripe, from the snout to a point anterior to the forelimbs, where it then splits into two narrower paravertebral stripes that continue to the tail, the overall impression being of a 'tuning-fork' pattern. In the two Meleotegi specimens, the vertebral stripe does not fork on the back and continues to the tail as a single stripe.

**Known distribution.** During Phase II (2010) a single specimen of *Cryptoblepharus*, collected from a tree on the Meleotegi River, near the Sta. Bakhita Mission (Eraulo, Ermera District; Locality 8), was considered sufficiently distinct from known species (*C. leschenault* and *C. schlegelianus*—see Taxonomic comments below) to warrant recognition as a third Timorese species, pending the collection of additional material.

**New localities.** During Phase V (2011) a second voucher (USNM 579472) was obtained from the same locality as in Phase II.

**Natural history.** With only two specimens known, our knowledge of this species' natural history is obviously very scant. Both specimens were discovered at a considerable height above ground on the trunks of large trees (as high as 7 m), and their somewhat jerky movements and body aspect remind us of other small tree-dwelling skinks in Southeast Asia, such as *Lipinia vittigera* (Boulenger, 1894). Both individuals appeared to be foraging on the bark surface when first seen, moving downwards along the tree trunk. When disturbed they reversed course and began moving back up the tree, though unhurriedly and once again appearing to forage. Specimens of both *C. leschenault* and *Cryptoblepharus* sp. 'Bakhita' are infrequently encountered, and when seen appear as individual lizards without conspecifics present, in contrast to *C. cf. schlegelianus*.

**Taxonomic comments.** The presence/absence and condition of various types of dorsal and lateral stripes is an important characteristic in the recognition of *Cryptoblepharus* species, with a number of species (Horner, 2007) exhibiting the 'tuning-fork' vertebral stripe pattern. These include *C. leschenault* from Timor and Flores and *C. balinensis* Barbour, 1911 from Bali. Other taxa exhibit a non-forking vertebral stripe, including *C. balinensis sumbawanus* Mertens, 1928 from Sumbawa, *C. renschi* Mertens, 1928 from Sumba and Komodo, and *C. keiensis* (Roux, 1910) from the Kei Islands. All of the aforementioned taxa occur at elevations up to

500 m, and in this assemblage highland forms (above 800 m) are uncommon. The presence of a population of *Cryptoblepharus* in the highlands of Timor exhibiting the non-forked vertebral pattern on a dark background is therefore indicative of a species undescribed so far (Kaiser *et al.*, in prep.).

***Cryptoblepharus cf. schlegelianus*** <sup>[V, VII–VIII]</sup>

**Common names.** (E) Timor north coast snake-eyed skink. (G) Schlegel-Schlangenaugenskink. (T) Mamór matan samea tasi ibun utara (mamór = skink, matan = eye, samea = snake, tasi ibun utara = north coast).

**Identification.** Differentiation of this coastal form (Figure 22) from both other species of *Cryptoblepharus* so far found in Timor-Leste (*C. leschenault*, *Cryptoblepharus* sp. 'Bakhita') is quite simple, considering the absence of prominent yellow or cream dorsal stripes. Coastal specimens tend to be brown or black with broad (1.5–2.0 scales wide), lighter brown longitudinal dorsolateral stripes over a broader (3.0–4.0 scales wide), darker irregular stripe that occupies much of the upper flanks of the body. The mid-dorsal region is brown with lighter flecking on some of the keeled margins of the scales and occasional scattered dark-brown spots. Specimens from the Tasi Tolu series (Dili District; Locality 1) had more extensive dark markings that obscured the ground color and exaggerated the light brown dorsolateral stripes; one specimen was virtually melanistic.

**Known distribution.** *Cryptoblepharus schlegelianus* Mertens, 1928 is known from specimens collected on Semau Island, off the southwestern part of Timor, near the port of Kupang in West Timor, but we have been unable to find any specimens from Timor associated with this species name in museum collections. We are therefore unable to confirm the occurrence of *C. schlegelianus* on mainland Timor. Although Mertens (1928) listed the species for Timor in his original description, that listing is based on material the Senckenberg Museum (Frankfurt, Germany) obtained in an exchange from the collections at Gießen, Germany, in 1854. Given that the port of Kupang was the main shipping center in this region in the early part of the 19<sup>th</sup> century, and given that at least one other species' origin was in error based on shipping and not collection locality – *Malayopython timorensis* (Peters, 1876), which does not occur on Timor Island (Barker and Barker, 1996; O'Shea *et al.*, 2012) – we consider the provenance of the Gießen material problematic and wonder whether the distribution of *C. schlegelianus* actually includes Timor (see Taxonomic Comment below).

**New localities.** *Cryptoblepharus cf. schlegelianus*, was



**Figure 21** Adult male of *Cryptoblepharus* sp. 'Bakhita' from 5 m above ground on the trunk of a large tree in coffee forest at the Meleotegi River (USNM 579181, Locality 8). Note the absence of a forked line pattern, unlike that seen in *C. leschenaulti*. Photo by Mark O'Shea.



**Figure 22** Adult individual of *Cryptoblepharus* cf. *schlegelianus* from the rocky shore at Tasi Tolu, Dili (USNM 580513, Locality 1). Photo by Mark O'Shea.

sampled as small series from each of three northern coastal locations. During Phase V (2011) a voucher series was collected on the wharf at Com (Lautém District; Locality 26; USNM 579455–71), in the final days of Phase VII (2012) a second voucher series was collected along the rocky beach at Tasi Tolu, near Dili (Dili District; Locality 1; USNM 580512–19), and during Phase VIII (2013) we discovered a population on the other side of Dili, below the Cristo Rei monument (Dili District; Locality 2; USNM 581114–27).

**Natural history.** These skinks were found in densely populated colonies, exclusively in locations right at sea level. At Com (Locality 26) they were found hiding in cracks on the sloping concrete of the wharf walls, or hunting in the flotsam, rocks, coral debris, and seaweed below the wharf walls. Much of this foraging activity was in the saltwater splash zone and while the animals

seemed unperturbed by the spray, they actively avoided swells. Individuals were more commonly encountered on the landward, more protected inner side of the wharf but were also in evidence on the seaward, outer wall, where they were much more exposed to wave activity. At Tasi Tolu (Locality 1) skinks were found in almost an identical scenario as in Com, on a wharf and on the rocky shore right at sea level. Near Cristo Rei (Locality 2), individuals were encountered on large boulders, in rocky crevices, as well as in the pebbles of the splash zone.

*Cryptoblepharus* cf. *schlegelianus* occurs at much greater densities than either *C. leschenaulti* or *Cryptoblepharus* sp. 'Bakhita' and obviously has a much different ecological niche. It displays a propensity to forage in the saltwater splash zone, where it will have access to terrestrial arthropods feeding on exposed littoral vegetation as well as tidal invertebrates, and where the food supply would permit the observed population densities.

**Taxonomic comments.** In general appearance, specimens of *C. cf. schlegelianus* resemble dark specimens of *C. schlegelianus* from Semau. However, differences in pattern, scalation, and ecology (HK, pers. obs.), as well as the geographic separation between populations in Timor-Leste and the southwestern end of Timor Island where Semau is situated, lead us to question whether the form found in Timor-Leste is indeed conspecific with *C. schlegelianus*. We therefore conservatively assign the name *C. cf. schlegelianus* to this form.

#### **Genus *Eremiascincus*** <sup>[IV–VIII]</sup>

**Common names.** (E) Night Skinks. (G) Glatte Nachtskinke. (T) Mamór kalan (mamór = skink, kalan = night).

**Known distribution.** Night skinks (genus *Eremiascincus*; Figure 23) have been collected on most phases of the project, but their status and identity has been the source of some confusion (see Taxonomic comments below). During Phases I and II, species of *Eremiascincus* were documented from four mainland districts (Ainaro, Ermera, Lautém, and Manufahi; see Kaiser *et al.*, 2011; O'Shea *et al.*, 2012), followed during Phase VI by the first specimens collected on Atauro Island (Dili District; see Kaiser *et al.*, 2013b). *Eremiascincus* is therefore known from five districts of Timor-Leste to date.

**New localities.** During Phases IV–VIII *Eremiascincus* was again encountered and collected and those records pertaining to mainland Timor-Leste and Jaco Island are included here. Additional vouchers were obtained from the Meleotegi River (Ermera District; Locality 8; USNM 579474, 579760, 580521–24, 581128–39), Maubisse

(Ainaro District; Locality 15; USNM 579339–45), and Mirbuti village, near Same (Manufahi District; 17; USNM 579336–38). New records for Lautém District were supported by voucher material from Raça (Locality 27; USNM 581762) and Jaco Island (Locality 30; USNM 579473), the former only as an autotomized tail as the skink escaped into a limestone hole.

**Natural history.** Individuals of *Eremiascincus* were invariably found by turning over rocks and logs, in both moist and dry substrate, and never out in the open, either during the day or by night. It appears that these animals require shelter by day and are fairly indiscriminate how they find it. We have found some individuals in man-made rock piles and underneath large flat rocks near human habitations, while elsewhere (such as in the dry coastal forest on Jaco Island; Locality 30) we encountered them under rotten logs. The daytime refuges also appear to require a certain level of moisture.

**Taxonomic comments.** The genus *Eremiascincus* was initially formed for a group of closely related Australian sand-swimming skinks nested within the genus *Sphenomorphus* (Greer, 1979). It was then expanded to include a number of taxa from the genus *Glaphyromorphus* (Mecke *et al.*, 2009), including the Lesser Sunda taxa *E. antoniorum* (Smith, 1927), *E. butlerorum* (Aplin *et al.*, 1993), *E. e. emigrans* (van Lidth de Jeude, 1895), *E. e. wetariensis* (Mertens, 1928), and *E. timorensis* (Greer, 1990). Three *Eremiascincus* species have been documented for Timor so far (*E. antoniorum*, *E. cf. emigrans*, and *E. timorensis*), but the taxonomy of *Eremiascincus* populations in the Lesser Sunda Islands, let alone Timor Island, is far from resolved. All previous reports of *E. antoniorum* and *E. timorensis* are from the central mountains of West Timor (Aplin *et al.*, 1993; Greer, 1990; Smith, 1927), whereas reports of *E. cf. emigrans* are from the south coast at Loré, Lautém



**Figure 23** Representatives of populations of *Eremiascincus*. Images (A)–(B) show the *timorensis* morphotype, (C) depicts *Eremiascincus* ‘Ermera’, and (D) and (E) show specimens of the *emigrans* morphotype. (A) Adult male *E. cf. timorensis* (SVL = 96 mm) from under a man-made rock pile at the edge of the Meleotegi River (USNM 579760, Locality 8). (B) Adult male *Eremiascincus* sp. ‘Montane’ (SVL = 72 mm) from the grounds of the Portuguese Pousada at Maubisse (USNM 579339, Locality 16). This population has undetermined species affinities and may represent an undescribed species. (C) Adult male *E. ‘Ermera’* (SVL = 53 mm) from a dry bamboo root mass alongside the Meleotegi River (USNM 580522, Locality 8). (D) Adult individual of *Eremiascincus* sp. ‘Lautém’ (SVL = 51 mm) from underneath palm leaf litter in a near-coastal habitat (USNM 579194, Loré, Lautém District; see Kaiser *et al.*, 2011). (E) Adult individual of *Eremiascincus* sp. ‘Jaco’ (SVL = 39 mm) from underneath a coralline rock in dry coastal forest (USNM 579473, Locality 30). Photos by Mark O’Shea.

District (Kaiser *et al.*, 2011).

After collecting over sixty voucher specimens from five districts at elevations ranging from 10–2046 m we believe that as many as five species of *Eremiascincus* are present in Timor-Leste. Overall morphology ranges from large species with stout limbs and a relatively short trunk (a *timorensis* morphotype), to small-sized species, with reduced limbs and an elongated body that are superficially similar to *E. emigrans*.

Among the forms with the *timorensis* morphotype are those exhibiting an orange venter, but with the ventral coloration not extending onto the chin region (Figure 23A). These are the largest, most strongly built forms in Timor-Leste, and they have been collected on the Meleotegi River at an elevation around 1180 m (Ermera District; Locality 8); they are herein listed as *Eremiascincus cf. timorensis*. A second member with this stout morphology is a slightly smaller, more slender, yellow-bellied form, whose ventral coloration extends across the gular region to the snout. This form is found at other highland locations (e.g., Maubisse, Ainaro District; Locality 16), the slopes of nearby Mt. Ramelau, and at various locations around Same (Manufahi District; Locality 17); it might be conspecific with *Eremiascincus cf. timorensis* or represent an undescribed taxon, and it is listed here as *Eremiascincus* ‘Montane’ (Figure 23B). A third highland taxon, similar to *E. antoniorum* in some respects (Figure 23D), has a yellow venter that does not extend into the gular region, and displays a more slender and elongated body than forms with the *timorensis* morphotype. This form is known from the Meleotegi River and surrounds (Ermera District; Locality 8), and we did not find it anywhere else in Timor-Leste. We refer to this species as *Eremiascincus* ‘Ermera.’ In each case, both male and female specimens show the respective ventral coloration, but intraspecific variation or color change related to reproductive readiness cannot be excluded at this point.

The *emigrans* morphotype appears to inhabit only lowland habitats in Timor-Leste (below 500 m elevation, and most frequently near the coast), which is consistent with the distribution of *E. emigrans* complex forms on other islands in the region. The Lautém taxon listed by Kaiser *et al.* (2011) is referred to as *Eremiascincus* sp. ‘Lautém’ here (Figure 23C), and this population may inhabit the limestone habitats that make up the eastern end of Timor Island, at elevations from sea level up to 462 m. The mainland Lautém form is similar to, and may be conspecific with, a population found on Jaco Island, which we call *Eremiascincus* ‘Jaco’ (Figure 23E).

Finally, the population found at coastal localities on northeastern Ataúro Island (Dili District) is referred to as *Eremiascincus* ‘Ataúro’ (Kaiser *et al.*, 2013b), a taxon certainly different from *E. emigrans wetariensis* from nearby Wetar Island. A comprehensive study of these forms is currently underway (Mecke *et al.*, in prep.).

#### *Eutropis cf. multifasciata* [IV, VI–VII]

**Common names.** (E) Common Sun Skink, Many-lined Sun Skink. (G) Vielstreifen-Skink. (T) Mamór loro (mamór = skink, loro = sun).

**Known distribution.** *Eutropis cf. multifasciata* (Figure 24) has so far been documented from Ermera, Lautém, and Oecusse Districts, on the mainland (Kaiser *et al.*, 2011; O’Shea *et al.*, 2012; Sanchez *et al.*, 2012), and also from Ataúro Island (Kaiser *et al.*, 2013b).

**New localities.** During Phases IV–VII additional vouchers of *Eutropis cf. multifasciata* were collected from the Meleotegi River and Sta. Bakhita Mission (Ermera District; Locality 8; USNM 579787–88), while first district records were obtained for Manufahi District, at Betano “wet site” (Locality 18; USNM 579347–49), and for Manatuto District, in the Nancuro coastal forest at Natarbora, 8 km south of Umaboco (Locality 20; USNM 580525–26), bringing to six the districts of Timor-Leste where this taxon has been documented.

**Natural history.** Skinks of this species were most frequently seen moving around in the open during daytime and were found in a variety of habitats, including rain and dry forests, grasslands, as well as coastal environments. We also encountered them on paths, roadways, and patios near human habitations. A single juvenile specimen was found underneath a flat rock along the Meleotegi River (Locality 8).

**Taxonomic comments.** We refer to the population of *Eutropis* in Timor-Leste as *E. cf. multifasciata* because other than a resemblance to other Southeast Asian populations of the *E. multifasciata* species complex, there is insufficient evidence to align it more closely with any other island or mainland population. The taxon currently referred to as *E. multifasciata* (Kuhl, 1820) has a very wide distribution, from the Southeast Asian mainland down to Timor and east to the Philippines. It is in dire need of taxonomic revision and once this has been carried out it may be possible to be more precise about the status of the Timorese populations. In the Lesser Sunda region, the population on Bali currently has subspecific status as *E. m. balinensis* (Mertens, 1927).

#### *Lamprolepis smaragdina cf. elberti* [IV–VII]

**Common names.** (E) Emerald or Green Tree Skink.



**Figure 24** Adult male *Eutropis* cf. *multifasciata* from a sun spot in leaf litter in wet coastal forest at Nancuro (USNM 579346, Locality 20). Photo by Mark O'Shea.

(G) Elbert-Smaragdsinkin. (T) Mamór modok (mamór = skink, modok = green).

**Known distribution.** *Lamprolepis smaragdina* cf. *elberti* (Figure 25) has been documented from Baucau, Lautém, Oecusse, and Viqueque Districts on the mainland (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012; Sanchez *et al.*, 2012), and also from Ataúro Island (Kaiser *et al.*, 2013b).

**New localities.** During Phases IV–VII we added further records for Lautém District, from Raça (Locality 27; USNM 579357–58) and the Pousada de Tutuala (Locality 28; USNM 579475–76), as well as the first district records for Manatuto District, from the Nancuro coastal forest at Natarbora (8 km south of Umaboco, Locality 20; USNM 579350); for Manufahi District, from Betano (“wet site,” Locality 18; USNM 579356); for Covalima District, in western Suai (Locality 13; USNM 579351–52); and for Bobonaro District, from a heavily grazed forest at Fiuren (near Balibo, Locality 9; USNM 580527–28), bringing the total number of districts where *L. s.* cf. *elberti* has been documented to nine.

**Natural history.** Specimens of *L. s.* cf. *elberti* were primarily collected by blow-piping or hand-slapping from the trunks of trees. The majority of individuals was encountered fairly high above ground level (3–7 m) on tree trunks with varying diameters (> 20 cm). This position is used as a perch for basking, as a base for foraging, and as an eyrie from which to observe the surroundings. Our earlier observation (Kaiser *et al.*, 2011) of site fidelity for this skink appears to be confirmed by additional observations: specific individuals seem to remain on the same tree during a days-long period of incidental observations.

**Taxonomic comments.** Preliminary examinations of the subspecies of *Lamprolepis smaragdina* undertaken

by HK and AK revealed that the form encountered on Timor would most likely be *L. s. elberti* (Sternfeld, 1918), a subspecies described from Wetar Island in the Inner Banda Arc, across the Wetar Strait from Timor. However, our examination of the holotype and topotypic specimens of that subspecies has revealed differences in color pattern and pholidosis, and we therefore find the use of *L. smaragdina* cf. *elberti* the most appropriate approach. It is interesting to note that coloration of this skink is quite variable and may deviate considerably from the emerald-green suggested by the name. While there are no individuals with entirely green body coloration in Timor-Leste, we have seen individuals possessing a bright green anterior half of the body that transforms in the medial section of the body into a “pepper-and-salt pattern” on a bronze-brown background (Figure 25A). This dorsal “pepper-and-salt pattern” still has the remnants of green coloration ventrally and on to the lower lateral parts of the body, but turns entirely bronze-brown on the tail. The alternative form is one devoid of any green coloration,



**Figure 25** Individuals of *Lamprolepis smaragdina* cf. *elberti* showing variation in dorsal coloration. This is not an example of sexual dimorphism, as both male and female individuals may possess either color pattern. Both specimens shown here were seen on tree limbs in their respective habitats. (A) Adult male presenting the two-part color pattern with a green anterior half of the body and a pepper-and-salt pattern on bronze background covering the posterior half and the tail (USNM 579213, Viqueque town, Viqueque District; see Kaiser *et al.*, 2011). (B) Adult male from coastal wet forest at Nancuro presenting the unicolor dorsal pattern that includes light green portions of the venter and the bronze dorsal coloration with pepper-and-salt patterning along the entire body (USNM 579350, Locality 20). Photos by Mark O'Shea.

with perhaps only a greenish sheen on the venter (Figure 25B).

### Genus *Sphenomorphus* <sup>[IV–VIII]</sup>

**Common names.** (E) Forest or Wedge skinks. (G) Waldskinke. (T) Mamór ai laran (mamór = skink, ai laran = forest).

**Known distribution.** The genus *Sphenomorphus* (Figure 26) has so far been recorded from four districts (Ainaro, Ermera, Lautém, and Manufahi; see Kaiser *et al.*, 2011; O’Shea *et al.*, 2012).

**New localities.** During Phases IV–VIII additional records for the genus *Sphenomorphus* were obtained for Lautém District at Raça (Locality 27; USNM 579371–72, 579477–81), the Mainina sink-hole (Locality 29; USNM 579482–83), and Jaco Island (Locality 30; USNM 579484–86); for Ermera District (Meleotegi River, Locality 8; USNM 579487–89, 579765–66,

580539); and for Manufahi District (Betano “wet site,” Locality 18; USNM 579369–70). First district records for Manatuto District are supported by voucher specimens from Nancuro (Natarbora, 8 km S of Umaboco, Locality 20; USNM 579359–67, 580529–33, 580534–38), and for Baucau District from the Japanese caves at Venilale (Locality 22; USNM 580540–41), increasing the number of districts from which *Sphenomorphus* skinks have been documented to six. The genus has yet to be documented for Ataúro Island.

**Natural history.** Among the forms of *Sphenomorphus* found in Timor-Leste, it may be possible to declare a distinction between lowland and highland forms. Some lowland forms (including those in the wet coastal forest of Nancuro and Betano as well as the dry forest on Jaco Island) are likely closely related to or identical with *S. melanopogon* (Duméril and Bibron, 1839). We have encountered these fairly robust and long-limbed animals



**Figure 26** Representative individuals of several different phenotypes of forest skinks, genus *Sphenomorphus*. (A) Male individual of *S. melanopogon* (SVL = 69 mm) from a root buttress in coastal wet forest at Nancuro (USNM 579364, Locality 20, near sea level). (B) High-altitude color variation is seen in this adult *S. cf. melanopogon* (SVL = 64 mm) found on the trunk of a tree in coffee forest (USNM 579368, Locality 17 at 1200 m elevation). (C) Male individual of *Sphenomorphus* sp. ‘Highland large’ (SVL = 55 mm) from the wall of a limestone cave near Raça (USNM 579479, Locality 27 at 550 m elevation). (D) Male specimen of the Jaco Island population of *Sphenomorphus* (SVL = 75 mm, USNM 579486, Locality 30). Individuals of this population are seen quite commonly running across the leaf litter covering the limestone karst on their way into refugia that run deep into the rock. (E) Male individual of *Sphenomorphus* sp. ‘Highland small’ (SVL = 42 mm) from the leaf litter outside the man-made caves at Venilale (USNM 580540, Locality 22). Photos by Mark O’Shea.

most frequently in a head-down posture on the trunks of trees or root buttresses, from where they can launch themselves quickly and escape into the underbrush. We also found juvenile *Sphenomorphus* skinks in all areas where we recorded this genus, attesting to a fairly high reproductive rate and a high population density. In contrast, there are fewer individuals of the highland form found, for example, in the coffee forest along the Meleotegi River (Locality 8) or in the drier forest of the karst plateau of Lautém District (e.g., in Raça and Mainina, Localities 27 and 29, respectively). In addition, we have seldom encountered juveniles of this latter form (or these forms), and their bodies have a more vivid coloration in general, and on the belly in particular. Until a thorough taxonomic treatment is concluded, it is not feasible to provide detailed, taxon-specific data regarding the natural history.

**Taxonomic comments.** The taxonomy of *Sphenomorphus* in Timor-Leste appears to be even more complex than that of *Eremiascincus*. We may have collected specimens belonging to different taxa but are unable to attribute them to any known species at this time. Shea (2012) investigated the Lesser Sunda and New Guinea populations of *Sphenomorphus melanopogon*, and selected as the lectotype for this species a syntype collected by Péron on Timor, presumably in West Timor. This confirms that *S. melanopogon sensu stricto* is a Lesser Sunda-Moluccan endemic, and New Guinean populations formerly considered conspecific with *S. melanopogon* are now treated as *S. meyeri* (Doria, 1874). Some of our lowland specimens from Lautém and Manatuto Districts may be referable to *S. melanopogon* (Figure 26A), but there remain some differences in coloration and *gestalt* (Figure 26B). Those with a similar overall morphotype but different coloration collected on the Meleotegi River and on the Lautém karst plateau appear distinct and are referred to as *Sphenomorphus* sp. 'Highland large' (Figure 26C), but once again, there is merely similarity but not identity with forms from Jaco Island (Figure 26D). One other, small and slender form from the Venilale caves, with a very distinct pattern of stripes and blotches, may be referred to as *Sphenomorphus* sp. 'Highland small' (Fig. 26E). All other specimens, including those from the Meleotegi River collected during Phases I and III, are currently retained as *incertae sedis* within *Sphenomorphus*.

#### Family Varanidae—Monitor Lizards

*Varanus timorensis* Gray, 1831 <sup>[IV, VI–VIII]</sup>

**Common names.** (E) Timor Tree Monitor, Spotted Tree Monitor. (G) Timor-Waran. (T) Lafaek rai-maran (lafaek

= crocodile or large lizard, rai = dirt, maran = dry).

**Known distribution.** *Varanus timorensis* (Figure 27A) is the only varanid currently known to occur on Timor and it was recorded from Lautém during Phase I and the north coast of Manatuto District during Phase III (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012). Bethencourt Ferreira (1898) also reported specimens collected by Rafael das Dôres in Liquiça District, at Lahane, Fatunaba, and Maubara, which were subsequently lost to a fire at the Museu Bocage in Lisbon.

**New localities.** Phases IV, VI, and VII produced additional records from northern Lautém and Manatuto Districts, and new records from Baucau District (along the coastal road; USNM-HI 2831–33), Dili District (Timor Lodge Hotel; Locality 1; USNM-HI 2834), and Covalima District (northwest of Maubesi, near Tilomar; Locality 15; USNM 579389). Since this is a CITES protected species we have voluntarily limited our collecting to either tissue samples or road-killed specimens, where these were fresh enough to be sampled. Live specimens were collected, photographed *in situ* and released. The exception to this



**Figure 27** (A) Adult *Varanus timorensis* (not vouchered) displaying the characteristic morphology and coloration seen in individuals encountered all along the northern low-lying coastal habitats in Timor-Leste. (B) An unusual specimen we refer to as *V. cf. timorensis* due to its aberrant color pattern, habitat, and behavior. We found this specimen ca. 5 m high on a roadside tree at an elevation of 520 m (USNM 579389, Locality 15). Photo by Mark O'Shea.

was the specimen from Tilomar (Figure 27B), given that its morphology, color pattern, and occurrence at higher altitude (520 m) gave the appearance that it might be a specimen of *V. auffenbergi* Sprackland, 1999, a species described from neighboring Roti Island. However, according to Böhme (2003) and Moldovan (2007), the status of *V. timorensis* populations on Timor and neighboring Roti and Kisar is still unresolved. *Varanus timorensis*, inclusive of the unusually colored Tilomar specimen, is now known to occur in five mainland districts at an elevational range from 6 m to as high as 520 m.

**Natural history.** Most of our observations of this species have been fleeting glimpses of lizards dashing across roads, or through the examination of road-killed specimens. Lizards appear to be particularly abundant in the vegetation associated with active and unplanted rice paddies, but we believe them to be present in essentially any lowland habitat. Even in residential areas, such as the compound of the Timor Lodge Hotel in Dili (Locality 1), these lizards are able to make a living, perhaps attracted by the presence of small vertebrates and invertebrates associated with human habitations.

**Taxonomic comments.** Various varanids have been listed as present on Timor by previous authors, including *Varanus timorensis*, *V. indicus*, and *V. salvator*. *Varanus timorensis* is a tree monitor species present on both the northern and southern coasts but the species is also found further inland, although it has yet to be recorded at or above 600 m. The specimen from Covalima is the only specimen found an appreciable distance (approx. 12 km) inland and since this specimen differed slightly in appearance from the usual *V. timorensis* and is perhaps conspecific with *V. auffenbergi*, it was tentatively listed as *V. cf. timorensis*. *Varanus indicus* is probably recorded from Timor in error, as it is known to be a mangrove- and estuarine-dwelling species from New Guinea and the Moluccan islands of Aru, Kei, Seram, and Buru (Böhme, 2003). *Varanus salvator* is not known from the main island of Timor but a population of *V. salvator*-like lizards has been documented from Atauro Island (Kaiser *et al.*, 2013b).

## SNAKES (ORDER SERPENTES)

### Family Acrochordidae—Filesnakes

#### *Acrochordus granulatus* (Schneider, 1799) <sup>[VI]</sup>

**Common names.** (E) Little filesnake. (G) Indische Warzenschlange, Zwerg-Warzenschlange. (T) Samea kulit krukut (samea = snake, kulit = skin, krukut = rough).

**Identification.** Due to their excessively baggy, highly tuberculate skin, the three extant members of the genus

*Acrochordus* are instantly recognizable, and afforded common names such as “wartsnake,” “filesnake,” or “elephant’s trunk snake” (this latter the case for the larger freshwater species). *Acrochordus granulatus* (Figure 28A) is the smallest member of the genus, with a maximum length of 1.6 m (McDowell, 1979), although most specimens are less than 1.0 m long.

**Known distribution.** One historic locality record for the occurrence of *A. granulatus* exists for Timor-Leste (Table 4), documented from a single specimen collected by Francisco Newton, at “Dilly” (= Dili, Dili District, Locality 1), and reported by Bethencourt Ferreira (1898) as present in the Museu de Lisboa; this specimen was lost in the museum fire of 1978. *Acrochordus granulatus* is also known from West Timor (from Kupang and Tuakdale Lagoon; de Lang, 2011).

**New localities.** One individual (Figure 28B) was collected by AVR in the mangrove swamp at Metinaro (Dili District; Locality 3; USNM-FS 255498; field tag only, specimen to remain on exhibit in Timor-Leste; USNM-HI 2825).

**Natural history.** The unusual tuberculate skin is an essential aid for the identification of these snakes in Timor-Leste. *Acrochordus* are ambush predators or active foragers, that grasp and coil around their slippery fish prey, with the tubercles maintaining a strong and inescapable, constriction-like grip as the fish is maneuvered into a head-first ingestible position. It has also been suggested that the tuberculate skin may prevent the snakes from drying out if exposed to the air (Greer, 1997), and tubercles may also serve a sensory purpose in prey location (McDowell, 1979; Shine and Houston, 1993).

Filesnakes are completely aquatic, found in coastal, brackish and occasionally fresh water, being ill-adapted to movement on land due to their extremely small ventral scales and flabby bodies. What makes locomotion laborious and impossible in a terrestrial environment enables filesnakes to become efficient inhabitants of aquatic environments as the body can be flattened laterally as a broad ribbon for effortless swimming. Other notable external aquatic features include dorsally positioned valvular nostrils, small eyes, and a row of small, tight-fitting supralabial scales along the lips, perhaps to reduce water ingress into the oral cavity. More subtle physiological aquatic adaptations include a low metabolic rate and almost twice the blood content of terrestrial snakes of similar size, which, coupled with high levels of oxygen-carrying red blood cells, have enabled captive specimens of *A. granulatus* to remain submerged for up





**Figure 28** Individual of *Acrochordus granulatus* from Metinaro Swamp (USNM-FS 255438, Locality 3). (A) Photo taken by Agivedo Varela Ribeiro right after capture. (B) Specimen after preservation shows a color shift to brown, indicating the characteristic banding pattern of the species. Photo by Mark O'Shea.

to 139 minutes (Whitaker and Captain, 2004). Filesnakes may remain motionless for prolonged periods of time, whether resting or in ambush, using their prehensile tails to maintain an anchorage against prevailing currents.

*Acrochordus granulatus* is probably the most adaptable of *Acrochordus* species, occurring in marine, brackish, and freshwater habitats, and although there is one record of a specimen from an elevation of 90 m (McDowell, 1979), this is a low elevation species. Although it is most often associated with mangrove swamps and turbid river estuaries, this species is also encountered in shallow, crystal-clear coral reef environments (MOS, pers. obs.). *Acrochordus granulatus* is also the most widely distributed member of the genus, occurring from the western coastline of India, east to Indochina, southeast to northern Australia, and eastwards to the Solomon Islands.

It has been collected 10–15 km from shore and at a depth of 20 m (Stuebing and Voris, 1990; Voris and Glodek, 1980), but it is considered an inshore rather than an open water species.

Prey of *A. granulatus* is composed entirely of inshore or estuarine fish (McDowell, 1979); the presence of crabs or snails in gut contents is likely attributable to secondary ingestion (Greer, 1997). *Acrochordus granulatus* has been observed foraging actively, swimming and probing the substrate for hidden prey (Gorman *et al.*, 1981). Both the chemosensory forked tongue and tactile sensory bristles on the tubercles may be utilized in prey location and capture (Greer, 1997), resulting in the opportunistic capture of fish coming into contact with a resting filesnake as much as the active foraging for prey.

In contrast to its two larger, primarily nocturnal, relatives, *A. granulatus* is equally active both by day or night (Greer, 1997), although in our experience (MOS, pers. obs.) they are more frequently encountered surfacing for air in estuarine habitats after dark. *Acrochordus* is a viviparous genus, with female *A. granulatus* producing 1–12 neonates (McKay, 2006).

**Taxonomic comments.** In the historic literature, *A. granulatus* is frequently referred to as *Chersydrus granulatus* (e.g., Schneider, 1801; Merrem, 1820; Boulenger, 1893; de Rooij, 1917), distinct from the only other known species at the time, the much larger *A. javanicus* Hornstedt, 1787, which was itself split into two species by McDowell (1979): the freshwater-brackish Southeast Asian *A. javanicus* and the entirely freshwater Australo-Papuan *A. arafurae* McDowell, 1979.

Despite its huge geographical range, and the antiquity of the family, with species divergence times of 20–16 Mya, a recent study (Sanders *et al.*, 2010) found no evidence that *A. granulatus* might be a composite of several different species. The family and genus are remarkably species-poor with one extinct species, *A. dehmi* Hofstetter, 1964 described from Pakistan (Head, 2005; Hoffstetter, 1964).

#### Family Colubridae—Typical Snakes

##### *Coelognathus subradiatus* (Schegel, 1837) <sup>[VI–VIII]</sup>

**Common names.** (E) Lesser Sunda Racer, Lesser Sunda Trinket Snake, Timor Racer. (G) Indonesische Kletternatter. (T) Samea laho (samea = snake, laho = rat).

**Known distribution.** During Phases I and III we collected two specimens of *Coelognathus subradiatus* (Figure 29) in Baucau and Viqueque Districts, both on the outskirts of the towns bearing the districts' names (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012), and recorded a third specimen as a roadkill on the Atambua-Kefamenanu road in West Timor

**Table 4** Records of snake species for the districts of Timor-Leste. Black circles indicate previously known records, red circles denote new records. Black open circles are literature records. Records listed in grey denote literature records from West Timor, with closed circles representing road-killed specimens we found and open circles representing known museum specimens. Check marks denote encounters with positive identifications, but without voucher specimens.

| Taxon                                       | District |        |        |          |          |              |               |        |        |         |          |          |         | W. Timor | References* |            |
|---|----------|--------|--------|----------|----------|--------------|---------------|--------|--------|---------|----------|----------|---------|----------|-------------|------------|
|   | Aileu    | Ainaro | Baucau | Bobonaro | Covalima | Dili (Timor) | Dili (Atauro) | Ermera | Lautém | Liquiça | Manatuto | Manufahi | Oecusse |          |             | Viqueque   |
| <b>ACROCHORDIDAE</b>                        |          |        |        |          |          |              |               |        |        |         |          |          |         |          |             |            |
| <i>Acrochordus granulatus</i>               |          |        |        |          |          | ●            |               |        |        |         |          |          |         |          | ○           | 4,6,10     |
| <b>COLUBRIDAE</b>                           |          |        |        |          |          |              |               |        |        |         |          |          |         |          |             |            |
| <i>Coelognathus subradiatus subradiatus</i> |          |        | ●      |          |          | ●            | ●             |        | ○      | ●       | ●        |          |         | ●        | ●           | 1,2,4-6,10 |
| <i>Dendrelaphis inornatus timorensis</i>    |          |        |        |          |          | ○            | √             |        | ●      |         | √        |          |         | ●        | ○           | 1,5,6      |
| <i>Lycodon capucinus</i>                    | ●        |        | ●      | ●        | ●        | ●            | ●             |        | ●      |         |          |          |         | ●        | ●           | 1,2,4-6    |
| <i>Lycodon subcinctus</i>                   |          |        |        |          |          |              |               |        | ●      |         |          |          |         | ●        |             | 1,4,6      |
| <i>Stegonotus</i> sp.                       |          |        |        |          |          |              |               |        |        |         | ●        | ●        |         |          |             | 4          |
| <b>CYLINDROPHIDAE</b>                       |          |        |        |          |          |              |               |        |        |         |          |          |         |          |             |            |
| <i>Cylindrophis</i> cf. <i>boulengeri</i>   |          |        | ○      |          |          |              |               |        | ●      |         |          |          |         |          | ○           | 4,6,8      |
| <b>ELAPIDAE</b>                             |          |        |        |          |          |              |               |        |        |         |          |          |         |          |             |            |
| <i>Laticauda colubrina</i>                  |          |        |        |          |          | ●            | √             |        |        |         |          |          |         | ●        |             | 3,4        |
| <b>HOMALOPSIDAE</b>                         |          |        |        |          |          |              |               |        |        |         |          |          |         |          |             |            |
| <i>Cantoria violacea</i>                    |          |        |        |          |          | ○            |               |        |        |         |          |          |         |          |             | 6,7,10     |
| <i>Cerberus rynchops</i>                    |          |        | ●      | ○        |          | ○            |               |        |        |         |          |          |         | ●        | ○           | 1,2,4,6    |
| <i>Fordonia leucobalia</i>                  |          |        |        |          |          | ●            |               |        |        |         |          |          |         |          | ○           | 4,6        |
| <b>PYTHONIDAE</b>                           |          |        |        |          |          |              |               |        |        |         |          |          |         |          |             |            |
| <i>Liasis mackloti mackloti</i>             |          |        | ●      |          | ●        | ●            |               |        |        |         |          |          |         |          | ●           | 2,4        |
| <i>Malayopython reticulatus</i>             |          |        |        |          |          | ●            |               |        | ○      |         | ●        | ●        | ●       | ●        | ○           | 2-4,6      |
| <b>TYPHLOPIDAE</b>                          |          |        |        |          |          |              |               |        |        |         |          |          |         |          |             |            |
| <i>Indotyphlops braminus</i>                |          |        | ●      |          |          | ●            |               |        | ●      |         |          |          |         | ●        | ○           | 1,4,6      |
| <i>Indotyphlops incertae sedis</i>          |          |        |        |          | ●        |              | ●             |        |        |         |          |          |         |          |             | 1,4        |
| <i>Sundatyphlops polygrammicus</i>          |          |        | ●      |          |          |              |               |        | ○      |         |          |          |         | ●        |             | 4,6,9      |
| <b>VIPERIDAE</b>                            |          |        |        |          |          |              |               |        |        |         |          |          |         |          |             |            |
| <i>Trimeresurus insularis</i>               |          |        | ●      | ●        |          | ○            | ●             |        | ●      | ○       | ●        | ●        |         | ●        | ●           | 1,2,4,6    |

<sup>1</sup>References are identified numerically as follows: 1 = Kaiser *et al.*, 2011; 2 = O'Shea *et al.*, 2012; 3 = Sanchez *et al.*, 2012; 4 = this paper; 5 = Kaiser *et al.*, 2013b; 6 = de Lang, 2011; 7 = de Rooij, 1917; 8 = Forcart, 1953; 9 = Barbour, 1912; 10 = Bethencourt Ferreira, 1898.

(O'Shea *et al.*, 2012). A fourth specimen, from Atauro Island, was documented elsewhere (Kaiser *et al.*, 2013b). *Coelognathus subradiatus* was also reported from two Lautém locations, the towns of Lospalos and Muapitine, 7 km E of Lospalos (de Lang, 2011).

**New localities.** During Phase VII two further specimens were recorded, both as roadkills, one on the road from Baucau to Venilale, just south of Baucau (USNM-HI 2827), and on the road from Manatuto to Natarbora (USNM 580544), on the south side of the central

mountain range. In March of 2011, HK visited Timor-Leste and photographed a road-killed individual on the road between Dili and Railaco, in Liquiça District (USNM-HI 2826a-c). During Phase VIII, one specimen was collected near the Dili port (USNM 581171). This specimen, together with the Liquiça and Manatuto records, constitute first district records, bringing to seven the districts for which *C. subradiatus* has been confirmed (Table 4).

**Natural history.** *Coelognathus subradiatus* is a



**Figure 29** Adult male *Coelognathus subradiatus* collected at Palapasu, Dili (USNM 581171, Locality 1). Photo by Mark O'Shea.

crepuscular to nocturnal species that exhibits a considerable degree of habitat plasticity, occurring in a wide variety of environments across its Lesser Sunda range, which includes virtually every island from Lombok to Wetar and Timor, with the notable exception of Savu. Habitats range from coastal coconut plantations and low-lying steppe-grasslands to monsoon and montane rainforests, to elevations up to 1200 m (Schultz, 1996). Mertens (1930) also commented that this snake is often encountered in close proximity to human habitations, and this observation has been borne out by our own experiences on Timor (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012). Although Schultz (1996) considered *C. subradiatus* to be primarily terrestrial, we obtained one particularly dark specimen (USNM 579779) on Atauro Island (Kaiser *et al.*, 2013b) after it had escaped into a tree to a height of approximately 6 m, then leapt to the ground when pursued aloft.

The prey of *C. subradiatus* comprises primarily small mammals, such as rodents, which are killed by constriction by this relatively powerful, muscular species; birds may also be taken (Schultz, 1996). Auffenberg (1980) reported that juvenile Lesser Sunda racers on Komodo prey on geckos. A more catholic diet was reported by de Lang (2011), who listed "small mammals, birds, reptiles, amphibians, fish, and even insects." *Coelognathus subradiatus* is oviparous, but clutch size is largely unknown; Schultz (1996) discussed six hatchlings that emerged from a clutch of unknown size after having been laid in captivity by a wild-caught female.

When this species feels threatened it may elevate the anterior portion of its body into a vertical S-shape, inflate its neck, and make lunging strikes, biting freely if contact is made; being completely nonvenomous, this display is

largely bluff.

**Taxonomic comments.** Bethencourt Ferreira (1897) described *Coluber melanurus* var. *timoriensis* (a synonym of *C. subradiatus*) from Timor, presumably from the Portuguese eastern end of the island, now Timor-Leste. This specimen was collected by Francisco Newton, who failed to provide a precise locality; it was lost in the Museu Bocage fire of 1978.

In the Lesser Sunda Islands there appear to be two different forms, which are referred to as "Groups" by Schultz (1996). Group 1 comprises slender-bodied snakes that achieve total lengths of 1200–1600 mm whereas Group 2 includes the more heavily-built snakes that achieve total lengths of 1500–2200 mm. Differences in patterning were noted by both Schultz (1996) and de Lang (2011). Racers found on Timor and the neighboring islands of Roti and Semau would fall within Group 1, whilst all other Lesser Sunda specimens would be part of Group 2. However, these groups have no taxonomic status and are purely subjective. A population of racers from Enggano Island (402.6 km<sup>2</sup>), almost 1600 km west of the westernmost population of Lesser Sunda *C. subradiatus* on Lombok and separated by the island of Java, was for a time treated as a subspecies of *subradiatus*, *C. s. enganensis* (Vinciguerra, 1892), but it has lately been treated as a full species (Das, 2012; Wallach *et al.*, 2014).

#### ***Dendrelaphis inornatus timorensis* Smith, 1927<sup>[VI]</sup>**

**Common names.** (E) Timor Bronzeback, Lesser Sunda Treesnake. (G) Timor-Bronzenatter. (T) Samea kotuk kór kafé (samea = snake, kotuk = back, kór kafé = brown).

**Known distribution.** During the early phases of the project (2009 and 2010) *Dendrelaphis inornatus timorensis* (Figure 30) was documented for Lautém and Viqueque Districts (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012), whereas de Lang (2011) included Dili (Dili District) in its distribution. It is a species commonly documented in West Timor (Table 4).

**New localities.** The only voucher specimen of this species obtained during the later phases of the project was from the Betano "wet site" (Manufahi District; Locality 18; USNM 579378) on the southern coast. There were unconfirmed sightings of "treesnakes" tentatively identified as *D. i. timorensis* in the Nancuro coastal forest (Manatuto District; Locality 20) and on Atauro Island (Dili District) during Phases IV and VI respectively, but no vouchers were obtained.

**Natural history.** This is a fast-moving and highly elusive diurnal species that often evades capture, either through speed or its ability to blend in with the vegetation when motionless. It is the only member of the genus



**Figure 30** Individual of *Dendrelaphis inornatus timorensis* (sex not determined) collected from low shrubs by night (USNM 573686, Wailakurini, Viqueque District; see Kaiser *et al.*, 2011). Photo by Mark O'Shea.

*Dendrelaphis* to occur on Timor and one of only two found in the Lesser Sunda Islands. Elsewhere in the Indo-Malayan region this is a commonly encountered and fairly well represented genus with numerous species in Southeast Asia and the Philippines, where they are known as “bronzebacks,” and nine species occurring in New Guinea, the Kei Islands, Palau, the Solomon Islands, and Australia (van Rooijen *et al.*, 2015), where they are known as “treesnakes.”

Timorese *D. i. timorensis* inhabit wooded hill country with an understory of grass and often a geology of black limestone outcrops (de Lang, 2011), which is precisely the habitat in which one of us (AVR) observed a specimen that evaded capture on Atauro Island (Kaiser *et al.*, 2013b). Smith (1927) stated that *D. i. timorensis* occurred at elevations from 100–800 m, but we have found this species to be most abundant right at sea level in Loré, Lautém District (USNM 573687–88), where two additional specimens evaded capture (Kaiser *et al.*, 2011); another evaded capture at sea level in the coastal forest at Nancuro (Manatuto District; Locality 20).

Virtually no information exists regarding the natural history and biology of the Timorese subspecies. The Komodo population of the nominate form (Auffenberg, 1980) preys on geckos (*Hemidactylus*) and skinks (*Sphenomorphus*), whilst frogs (*Fejervarya*) are known from the diet of Sumbawa and Flores specimens (Mertens, 1930). All these potential prey genera occur on Timor. *Dendrelaphis inornatus* is an oviparous species with clutch sizes reported from 2–18 (de Lang, 2011), but no data exist specifically for *D. i. timorensis*.

**Taxonomic comments.** The subspecies *D. i. timorensis* occurs on Timor and the neighboring eastern Nusa Tenggara and southern Maluku islands of Roti, Semau,

Pantar, Alor, and Wetar. The nominate subspecies is found on the western islands of Nusa Tenggara, west of and including Lombok and Savu.

***Lycodon capucinus* (Boie, 1827)** <sup>[IV–VIII]</sup>

**Common names.** (E) Common (island) Wolfsnake. (G) Kapuzen-Wolfszahnatter. (T) Samea lobo (samea = snake, lobo = wolf).

**Known distribution.** During Phase I *Lycodon capucinus* (Figure 31) was recorded from Same (Manufahi District; Locality 17; Kaiser *et al.*, 2011), and as a roadkill on the Sakato-Atambua road in West Timor in Phase III (O'Shea *et al.*, 2012). During Phase VI it was also recorded as common on Atauro Island (Kaiser *et al.*, 2013b).

**New localities.** During Phases IV–VIII this species was encountered with increasing frequency, primarily as roadkills. We collected live specimens in Dili District (grounds of the Timor Lodge Hotel, Locality 1; USNM 579781); Lautém District (Com and Raça, Localities 26 and 27; USNM 579381–82, 579494–95); Manufahi District (Ladiki coffee forest near Same, Locality 17; USNM 579380); and Bobonaro District (degraded forest at Fiuren, near Balibo, Locality 9; USNM 580547). It was also reported to occur at Malahara (Lautém District; Locality 29; de Lang, 2011). Roadkills were documented, and sampled when possible, from Covalima District (north of Suai, Locality 13; USNM 579379); Baucau District (near Baucau; USNM 580546); Aileu District (near Lahae town); and Bobonaro District (on the Maliana-Balibo road; USNM 580548). *Lycodon capucinus* has now been recorded from seven mainland districts, and Atauro Island (Table 4).

**Natural history.** *Lycodon capucinus* is a very common and widespread, but nocturnal and secretive snake that is easily overlooked in cursory searches, although it may be encountered abroad at night, especially after heavy rain.



**Figure 31** Adult male *Lycodon capucinus* from the leaf litter at the ruins of the Portuguese *pousada* at Com (USNM 579494, Locality 26). Photo by Mark O'Shea.

We have found it in almost every habitat investigated, from townships to coffee forest, and from the ruins of a coastal *pousada* close to sea level, to elevations of over 1150 m (Ainaro District; Locality 16), greatly exceeding the 600 m documented for Komodo Island specimens (Auffenberg, 1980; Darevsky, 1964; Dunn, 1927). It appears to have adapted well to living alongside humans and is even found in major cities, such as the Indonesian capital at Jakarta (van Hoesel, 1959). This was easily the most frequently encountered snake species during our surveys to date, with 21 specimens documented, from juveniles to adults; two of these records were based on sloughed skins, which could be unequivocally identified to belong to individuals of this species based on scale counts and head scale morphology.

*Lycodon capucinus* is a small species that rarely achieves a length in excess of 600 mm, although our highest elevation specimen (see above), a roadkill that was sampled for tissue only, had an SVL of 580 mm and a TTL of 720 mm. Although primarily a terrestrial species, *L. capucinus* is agile and may be encountered climbing in vegetation or on buildings. *Lycodon capucinus* will bite readily when handled.

Prey of *L. capucinus* comprises primarily geckos, especially perianthropic species of the genera *Hemidactylus* and *Gehyra*, but across its extensive range *L. capucinus* is reported to have taken the skink *Eutropis multifasciatus* (Kopstein, 1936) and even mice (Mertens, 1930). According to McKay (2006) it also eats frogs and reptile eggs. It is an oviparous species, and clutches of up to eleven eggs have been reported (David and Vogel, 1996). On Timor, it has been reported as being parasitized by tapeworms (Goldberg *et al.*, 2010).

**Taxonomic comments.** *Lycodon capucinus* was long treated as either a synonym or a subspecies of the widespread South and Southeast Asian *L. aulicus* (Linnaeus, 1758), to which it bears a striking resemblance, and only relatively recently has it been consistently treated as a distinct and separate species based on the work of Taylor (1965) and David and Vogel (1996). This nomenclatural history has caused considerable confusion when the geographical range of this species needed to be determined (Kaiser *et al.*, 2011).

***Lycodon subcinctus* Boie, 1827** <sup>[IV]</sup>

**Common names.** (E) Malayan banded Wolfsnake. (G) (Weiß-) Gebänderte Wolfsnatter. (T) Samea kadali (samea = snake, kadali = ring).

**Known distribution.** In the early phases of the project a single specimen of *Lycodon subcinctus* (Figure 32) was obtained, from Mirbuti village near Same (Manufahi

District; Locality 17), and close to the project's first collection locality for *L. capucinus* (Kaiser *et al.*, 2011).

**New localities.** A second specimen was obtained in Raça village (Lautém District, Locality 27; USNM 579382).

**Natural history.** Much less frequently encountered by us on Timor than its congener, *L. capucinus*, *L. subcinctus* is a secretive, nocturnal inhabitant of humid forests and dry woodlands, both in low-lying and montane locations up to elevations of 1660 m in Peninsular Malaysia (Smith, 1930) and 1800 m in Bali (McKay, 2006). It is also reported to occur in plantations, rice paddies and other agricultural habitats, and around human habitations (de Lang, 2011). The latter location agrees with the first of our two specimens, which we obtained when we were handed a badly damaged specimen that had been killed in a schoolyard near Same, Manufahi District (Locality 17; see Kaiser *et al.*, 2011).

*Lycodon subcinctus* is a larger species than *L. capucinus*, achieving total lengths of 800–1200 mm (de Lang, 2011). The larger size and semi-fossorial nature of this infrequently (on Timor) encountered species may be the basis for the “Timor krait” stories circulated by individuals who observed this species but who were perhaps familiar with banded kraits from other parts of Indonesia (including Bali in the Lesser Sundas). Indeed, its pattern of white bands on a black background, combined with the lack of a loreal scale, afford *L. subcinctus* a startling similarity to the highly venomous species *Bungarus candidus* (Linnaeus, 1758) and *B. fasciatus* (Schneider, 1801), with which *L. subcinctus* occurs in sympatry in other parts of its range.

Although species in the genus *Lycodon* are primarily terrestrial, *L. subcinctus* is also arboreal (McKay, 2006), with prey consisting of geckos and skinks (de Lang, 2011). Females are oviparous, laying from 5–11 eggs (de Lang, 2011).

**Taxonomic comments.** Three subspecies of the widely distributed *L. subcinctus* have been described. The nominate race is found through most of Southeast Asia and it is to this taxon that Lesser Sunda populations belong.

***Stegonotus* sp.** <sup>[IV, VII]</sup>

**Common names.** (E) Timor Groundsnake. (G) Timor-Schiefermatter. (T) Samea rai kór-kafé (samea = snake, rai = ground, kór-kafé = brown).

**Known distribution.** There were no previous records for the genus *Stegonotus* (Figure 33) from Timor, the nearest known populations being those of *S. florensis* on Flores and Sumba (Daan and Hillenius, 1966; de Rooij, 1917; Forcart, 1954).

**New localities.** The first specimen of the genus *Stegonotus* from Timor was obtained during Phase IV, from the coastal forest at Nancuro, near Natarbora, 8 km south of Umaboco (Manatuto District; Locality 20; USNM 579383). A second specimen was collected by one of us (LLA) during a personal survey, part of a research project from Timor-Leste's national university, at Betano "wet site" (Manufahi District; Locality 18; USNM 579384). Two further specimens, one adult and one juvenile, were collected, in close proximity to each other and close to the original collection point in the Nancuro coastal forest, during Phase VII (USNM 580549–50). *Stegonotus* sp. is now known to occur in southern low-lying coastal forests in two districts (Table 4).

**Natural history.** Individuals of this species were found exclusively in moist coastal forests within a short distance of the southern coast of Timor-Leste (> 2 km). At Nancuro, one adult specimen was spotted moving through the leaf litter, while another was found in the hollow portion of a decaying log. The juvenile was found unexpectedly, in a vertical position, under loose bark of a standing tree. Whereas the adult in the log attempted to escape by retreating further into the rotting wood, the juvenile remained motionless when the bark was removed and was easily captured.

*Stegonotus* is a common and well-represented genus in Papua New Guinea (PNG) and one well familiar to MOS, who identified it immediately upon capture of the first (Nancuro) specimen. In PNG members of this non-venomous genus are rarely encountered abroad during the day, most being found on roads or on the ground in the bush during the evenings and at night, or discovered hiding under logs or other debris during daylight hours (MOS, pers. obs.). Small specimens have also been encountered inside ant plants (Myrmecophyta), presumably hunting the skinks that also inhabit ant plant chambers. Such microhabitats should be investigated, should these tropical Southeast Asian-Melanesian trees occur in Timor-Leste. Papuan *Stegonotus*, particularly the large *S. cucullatus* (Duméril *et al.*, 1854), will bite with vigor and little provocation (O'Shea, 1996), and some Timorese specimens exhibit similar behavior. Members of the genus *Stegonotus* are oviparous.

**Taxonomic comments.** The genus *Stegonotus* currently comprises ten species (Uetz and Hošek, 2014), distributed throughout New Guinea (four species, at least one also occurring in northern Australia), the Bismarck Archipelago (one species), the d'Entrecasteaux Archipelago (one species), the Maluku Islands (one species), Borneo (one species), the Philippines (one



**Figure 32** Adult male *Lycodon subcinctus* from the leaf litter at the limestone caves near Raça (USNM 579382, Locality 27). Photo by Mark O'Shea.



**Figure 33** Adult female *Stegonotus* sp., collected from the inside of a rotting log in coastal wet forest at Nancuro (USNM 579383, Locality 20). Photo by Mark O'Shea.

species), and the Lesser Sundas (one species reported from Flores and Sumba). This latter taxon, *S. florensis* (de Rooij, 1917), is the only member of the genus occurring close to Timor.

Comparison of Timor specimens with the type material of *S. florensis* and a variety of museum specimens representing the other known species of *Stegonotus*, has allowed us to determine that the Timor specimens belong to an undescribed species based on scale counts and head scale morphology. We have also been able to recognize that the *S. florensis* material represents more than one species, with those from Sumba most likely warranting the resurrection of *S. sutteri* from synonymy (see Forcart, 1954). Beyond these comparisons, we have uncovered many inconsistencies in how names have been applied to *Stegonotus* populations throughout the range of the genus, and this topic is currently the subject of a comprehensive investigation (Christine Kaiser, unpubl. data.).

**Family Cyliodrophiidae—Asian Pipesnakes*****Cylindrophis* cf. *boulengeri***<sup>[VII]</sup>

**Common names.** (E) Boulenger's Pipesnake, Timor Pipesnake. (G) Boulenger-Walzenschlange. (T) Samea ulun rua (samea = snake, ulun = head, rua = two). This snake is locally known as the "two-headed snake," given that the body morphology and defensive behavior of pipesnakes do not allow for a ready identification of the head and make it appear as if both ends of the snake might pose a threat.

**Known distribution.** *Cylindrophis* cf. *boulengeri* (Figure 34) is recorded from Timor-Leste based on eight specimens collected by Prof. A. Bühler in 1935 at Baguia (Baucau District, no further data) and now deposited in the Naturhistorisches Museum Basel, Switzerland (NHMB 12908–15). Our visit to Baguia during Phase VII (2012) failed to produce any specimens or any recognition from the local population and villagers; when questioned and shown photographs, locals were unfamiliar with the snake (O'Shea and Kaiser, 2013).

**New localities.** In late 2012 one of us (AVR) obtained a specimen of *C. cf. boulengeri* in Lospalos, Lautém District (USNM-FS 255499; field tag only, specimen remaining on exhibit in Timor-Leste; photo vouchers USNM-HI 2835a–c), the first specimen of the taxon discovered in 77 years. We subsequently captured another specimens in a banana plantation at the confluence of the Comoro and Bemós Rivers on the Aileu District side (Locality 6; USNM 581170). This secretive snake is now known from three districts in Timor-Leste (Table 4).

**Natural history.** Pipesnakes of the genus *Cylindrophis* are nocturnal, semi-fossorial, and secretive. This lifestyle is the reason for our poor knowledge about the biology of the species currently recognized within the genus. One of the specimens we collected, at the confluence of the Comoro and Bemós Rivers (Aileu District: Locality 6) was found on the ground under a banana leaf. We had previously considered this type of habitat unproductive, with only a few striped treefrogs (*Polypedates* cf. *leucomystax*) being collected, and therefore had ignored such habitats during surveys. This is an excellent example for how collector's bias can influence collecting results.

Almost nothing is known of the natural history of Timorese *Cylindrophis*, although it may be presumed that they prey on blindsnakes (*Indotyphlops* and *Sundatyphlops*), and possibly cylindrical skinks (*Eremiascincus*) or invertebrates such as earthworms. All species for which reproductive biology is known are described as being ovoviviparous (Greene, 1997), a condition we consider to be a form of livebearing

(Blackburn, 1994). However, examination of museum specimens by one of us (SM) revealed that some populations of *Cylindrophis*, which likely represent distinct species based on morphology, may be egg-laying.

*Cylindrophis* exhibit an unusual defensive behavior, during which they hide the head in the coils of their body and elevate their tails, flashing the bright or contrasting ventral pattern in the process, a behavior reminiscent of Asian coral snakes (e.g., *Calliophis intestinalis* [Laurenti, 1768]).

**Taxonomic comments.** The populations historically associated with *C. boulengeri* Roux, 1911 are known from 12 specimens collected in the early 20<sup>th</sup> Century, eight from Baguia, Baucau District (Forcart, 1953; see above), one from an unspecified location in West Timor (de Lang, 2011), and three from Wetar (Brongersma, 1933b; Roux, 1911), an island in the Indonesian province of Maluku to the northeast of Timor and the type locality of the species. We have been unable to locate additional museum specimens that may belong to this species. A specimen collected on Babar Island to the east and originally referred to *C. boulengeri* (Brongersma, 1933a) may represent a distinct and undescribed species of *Cylindrophis*. Two other species occur in the vicinity of Timor: *C. opisthorhodus* Boulenger, 1879 on Sumbawa, Flores, and Lombok to the west, and *C. yamdena* Smith and Sidik, 1998 on Yamdena Island in the Tanimbar Island group, to the east (Smith and Sidik, 1998). Until we have completed a study now underway (Kieckbusch *et al.*, in prep.), we conservatively consider Timor material as *C. cf. boulengeri*.

**Family Elapidae—Cobras and their allies*****Laticauda colubrina* (Schneider, 1799)**<sup>[VII]</sup>

**Common names.** (E) Yellow-lipped sea krait, Colubrine sea krait. (G) Nattern-Plattschwanz, Gelblippen-Seeschlange. (T) Samea-tasi kor kadeli (samea-tasi = sea snake, kor = color, kadeli = ring).

**Known distribution.** The sea krait *Laticauda colubrina* (Figure 35) was recorded from only one location and one specimen during the survey (Table 4), the old military wharf at Pante Macassar, Oecusse District (Sanchez *et al.*, 2012). One of us (SM) observed an individual in the water near the shore on Ataúro Island (Dili District), but was unable to capture it.

**New localities.** Our second specimen was obtained by AVR on the rocky headland at Cristo Rei, near Dili (Dili District; Locality 1; USNM-HI 2837) and subsequently released.

**Natural history.** *Laticauda colubrina* is an amphibious snake, equally at home on land as in the ocean. Being

oviparous, unlike true seasnakes, it is essential that *L. colubrina* be able to move onto land in order to lay its clutch of 6–20 eggs (Greene, 1997). This species is so capable on land that it may be encountered at the top of cliffs, aloft in low bushes, or in the center of small islands (O’Shea, 2005). At first glance, a sea krait even resembles a terrestrial elapid with its regular, imbricate, smooth scales arranged in transverse rows, and its large ventral plates for locomotion on land, but it is also highly adapted for life in the ocean with the laterally flattened, paddle-shaped tail typical of marine snakes, laterally positioned valvular nostrils (Wilson, 2005), and tight-fitting supralabial scales around the mouth.

Prey of *L. colubrina* comprises entirely fish, including those species that seek protection by mimicking *Laticauda*, such as the colubrine snake eel (*Myrichthys colubrinus*), which is taken frequently (O’Shea, 1996; Wilson, 2005). Although a front-fanged venomous elapid, *L. colubrina* is placid and does not attempt to bite even when handled.

**Taxonomic comments.** Two species of the genus *Laticauda* are reported from the seas around Timor, but only *L. colubrina* has been positively recorded. The other species, *L. laticaudata* (Linnaeus, 1758), could be mistaken for *L. colubrina* by a person unfamiliar with the characteristics that define the two species, and it is also possible this species does not occur this far west.

#### Family Homalopsidae—Oriental and Australasian Mudsnakes

##### *Cerberus schneiderii* (Schlegel, 1837) [IV, VII–VIII]

**Common names.** (E) Schneider’s dog-faced watersnake, Schneider’s bockadam, (G) Hundskopf-Wassertrugnatter, (T) Samea natar (samea = snake, natar = rice paddy).

**Known distribution.** During the early phases of the survey *Cerberus schneiderii* (Figure 36) was found to be relatively common in the low-lying paddy field east of Baucau town (Baucau District). This species was reported by de Lang (2011), from Bidau, Dili (Dili District), and Lake Be Malae, Batugade (Bobonaro District), also on the north coast. We were also informed of a large specimen reportedly killed in the grounds of the Chinese Embassy in Dili, which is located on the seafront, but were unable to confirm this report.

**New localities.** During the phases covered by this report we collected an extra voucher specimen, as a relatively fresh roadkill, from close to the original Baucau paddy-field location, and one of us (LLA) obtained a specimen from the Betano “wet site” (Manufahi District; Locality 18; USNM 579392), the first southern coastal record of the species from Timor-Leste, although de Lang (2011)

listed records from the south coast of West Timor. In addition we collected four specimens in the mangrove swamp at Metinaro (Dili District; Locality 3) where they were found to occur in sympatry with *Fordonia leucobalia* (see below). Including the records of de Lang (2011), this species is now reported from four districts of



**Figure 34** Adult *Cyliodrophis* cf. *boulengeri* (sex not determined) from a banana plantation near the confluence of the Comoro and Bemos Rivers (USNM 581170, Locality 6). Photo by Mark O’Shea.



**Figure 35** Adult sea krait (*Laticauda colubrina*) from a ruined wharf (USNM 579241, near Pante Makassar, Oecusse District; Sanchez *et al.*, 2012). Photo by Mark O’Shea.



**Figure 36** Adult *Cerberus schneiderii* from the mangrove swamp at Metinaro (USNM 581173, Locality 3). Photo by Mark O’Shea.



Timor-Leste, and confirmed with voucher specimens from three (Table 4).

**Natural history.** Populations of snakes in the genus *Cerberus* are usually associated with inshore marine or brackish habitats, such as mangrove swamps and estuarine mud-flats, but all species are able to survive in freshwater and may be found in freshwater creeks or rivers flowing into these brackish environments (Murphy, 2007; Murphy *et al.*, 2012); the Philippine *C. microlepis* Boulenger, 1896 is the only land-locked freshwater lake dweller (Murphy, 2007). *Cerberus schneiderii* is also able to move from saltwater to freshwater habitats, but while we have collected it in brackish mangrove swamps on the north coast at Metinaro (Dili District; Locality 3) and on the south coast at Betano (Manufahi District; Locality 18) we have found it in larger numbers in freshwater rice-paddy habitats, on the north coast at Baucau (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012). Several specimens were found at Metinaro (USNM 580525–26, 581173–76), of which one was found during the late afternoon sheltering in a mud lobster (*Thalassina anomala*) burrow, while others were found in shallow muddy rivulets.

It has been suggested that *Cerberus* feed almost entirely on small fish (McKay, 2006; Murphy, 2007), including lizardfish (Synodontidae: *Synodus*) and gobies (Gobiidae: *Amblygobius*), although other authors (e.g., Auffenberg, 1980; Voris and Murphy, 2002) reported crustacean remains from the guts of some specimens. Whether these were the intended prey or secondarily ingested prey-of-prey is impossible to determine. *Cerberus* is a rear-fanged venomous genus possessing Duvernoy's glands, which contain toxic secretions to dispatch struggling prey. Since *Fordonia* is carcinophagous this would enable the two species to partition resources and survive in sympatry. However, we suspect that the *C. schneiderii* living in the rice-paddy habitat at Baucau may also be feeding on tadpoles and juveniles of the abundant population of rice-paddy frogs (*Fejervarya*).

No reproductive data currently exist for *C. schneiderii*, but the genus is known to be livebearing, as are most obligatorily aquatic snakes, and litter sizes for Australian *C. australis* have been quoted as 6–8 (Shine, 1991a) or even as high as 26 (Gow, 1989), while de Lang (2011) provides a maximum litter size for *Cerberus* of 47 neonates.

**Taxonomic comments.** The taxonomy of homalopsid snakes formerly known as *Cerberus rynchops* (Schneider, 1837) was recently revised (Murphy *et al.*, 2012). The taxon had previously been divided into an Australo-Papuan population, recognized as *C. australis* (Gray,

1842), and a localized Philippine population, now known as *C. microlepis* (Murphy, 2007). The taxon *C. rynchops* was then used for all other populations until the latest revision restricted *C. rynchops* to populations on mainland Asia and the Andaman Islands. A new name was proposed for Palau populations (*C. dunsoni* Murphy *et al.*, 2012) and the name *C. schneiderii* was resurrected for all other island and Southeast Asian populations.

In most respects, Timor specimens fall within the characters given by Murphy *et al.* (2012) for *C. schneiderii*, although there are some differences, notably in the dorsal head scalation. Since few specimens have been collected from this southeastern corner of the *C. schneiderii* range, the precise taxonomic status of the intervening Wallacean populations may require additional research, especially as *C. schneiderii* is believed to be a species complex (John Murphy, *pers. comm.*).

***Fordonia leucobalia* (Schlegel, 1837)** <sup>[VI, VIII]</sup>

**Common names.** (E) White-bellied mangrove snake, Crab-eating mangrove snake. (G) Krebs-Wassertrugnatte. (T) Samea parapa kabun-mutin (samea = snake, parapa = mangrove, kabun-mutin = white belly).

**Known distribution.** *Fordonia leucobalia* (Figure 37) was not previously recorded for Timor-Leste and only a single record exists for its presence in West Timor (Peters, 1876), where it was collected in the mangrove swamp at Atapupu, located on the northern coast between Timor-Leste and the Oecusse exclave (Table 4).

**New localities.** During Phase VI a single specimen was collected from the mangrove swamp at Metinaro (Dili District; Locality 3; USNM 579780), the first specimen of the taxon from Timor-Leste, only the second from Timor, and the first from Timor in 135 years. We were able to obtain another specimen in the same locality during Phase VIII (USNM 581177).

**Natural history.** *Fordonia leucobalia* is an inhabitant of mangrove and estuarine mud flats but it may be found considerable distances upstream in tidal rivers and up to 850 km upstream in freshwater watercourses. Nocturnal in habit, it shelters by day in the burrows of fiddler crabs (*Uca* spp.) or mud lobsters (*Thalassina anomala*), only venturing onto the surface of the mud at night when the tide is returning. *Fordonia* is a carcinophagous species, preying primarily on crabs. Crustaceans recorded in the diet of *Fordonia* (Gow, 1989; Murphy, 2007; Shine, 1991b; Voris and Murphy, 2002) include the crabs *Uca* sp. (Ocypodidae), *Macrophthalmus* sp. (Macrophthalmidae), *Dotillopsis brevitarsis* (Dotillidae), *Sarmatium germaini*, and an unidentified crab genus (Sesarmidae), and the mud lobster *Thalassina anomala* (Thalassinidae). Prey

is grasped and dismembered with the legs broken off before the body is swallowed, although Voris and Murphy (2002) suggest that struggling crabs may autotomize their own legs. *Fordonia* is technically a rear-fanged venomous snake possessing Duvernoy's glands and enlarged, grooved rear-teeth, and its fangs are long enough to penetrate the carapace of decapods, and the venom is toxic to crabs (Kopstein, 1931; Savitzky, 1983; van Hoesel, 1959). *Fordonia* is a livebearing species, females producing litters of 2–17 neonates (Murphy, 2007).

**Taxonomic comments.** Currently *Fordonia* is a monotypic genus occurring from mainland Asia (Bangladesh) to the northern Philippines (Luzon) and south into the Australo-Papuan realm (Murphy, 2007).

#### Family Pythonidae—Pythons

##### *Liasis mackloti* Duméril and Bibron, 1844 <sup>[IV]</sup>

**Common names.** (E) Macklot's water Python, White-lipped Python. (G) Timor-Wasserpython, (T) Fohorai-atan (fohorai = python, atan = slave). We have been unable to learn the origin of the peculiar Tetun common name.

**Known distribution.** During Phase III *Liasis mackloti* (Figure 38) was documented from a single live specimen in Dili (Dili District) and roadkills in Baucau and northern Manatuto Districts (O'Shea *et al.*, 2012). De Lang (2011) also reported a specimen from Dili. This species was also encountered as roadkills in West Timor, enroute and returning from the Oecusse exclave (O'Shea *et al.*, 2012). Given our records and those shown on the distribution map in de Lang (2011), we consider the distribution of this species to be near-coastal and ranging throughout Timor in low-lying wetland habitats.

**New localities.** During Phase IV *Liasis mackloti* was encountered with some frequency, unfortunately only as roadkills, on the roads east and west of Suai (Covalima District; Locality 13; USNM 579390; USNM-HI 2782–83; two of these specimens, Christine M. Dwyer field numbers 802–03, deposited in the USNM Biorepository, are tissue vouchers only). Five roadkills were documented, photographed, and locality data were recorded; specimens that were not in a too advanced state of decomposition were sampled for tissue. *Liasis m. mackloti* has now been confirmed from four mainland districts (Table 4).

**Natural history.** *Liasis mackloti* is a water python that inhabits inundated lowland habitats such as rice paddies or overgrown coastal creeks. Snakes are most frequently encountered in the wet season, when many become road-killed casualties when traveling across their fragmented habitat.

The nominate subspecies *L. m. mackloti*, found on



**Figure 37** Adult *Fordonia leucobalia* from a mud lobster burrow in the mangrove swamp at Metinaro (USNM 579780, Locality 3). Photo by Mark O'Shea.



**Figure 38** Unvouchered adult *Liasis mackloti* collected from beneath a container adjacent to the seafront in Dili (Locality 1). Photo by Mark O'Shea.

Timor, is a relatively large snake that can achieve a maximum length of approximately 1.6 m, intermediate between the smaller *L. m. savuensis* and the larger but otherwise rather similar *L. m. dunni* Stull, 1932. It is a relatively powerful constrictor capable of subduing small- to medium-sized mammals and water birds. Various authors (e.g., de Lang, 2011) have included bird eggs, reptiles, and even frogs and fish in the diet of *L. mackloti* but there have been no studies of this species' diet in nature. The possibility that it may represent a climax predator in shallow freshwater habitats is supported by the feeding ecology of its close relative, *L. fuscus*, which is documented to take small crocodiles in southern New Guinea and northern Australia (Parker, 1982; Wilson and Swan, 2003). All pythons are oviparous, and females of *L. mackloti* have been reported to produce clutches of 8–14 eggs in captivity (Ross and Marzec, 1990).

**Taxonomic comments.** *Liasis mackloti* has three described subspecies, with only the nominate form, *L. m. mackloti*, occurring on Timor. The other subspecies are *L. m. durni* from Wetar, northeast of Timor, and *L. m. savuensis*, from Savu, southwest of Timor. *Liasis mackloti* is very closely related to *L. fuscus* of northern Australia and southern New Guinea (Rawlings *et al.*, 2004), so much so that southern Papuan water pythons were originally treated as *L. mackloti* (Parker, 1982). Water pythons in the Northern Territory, Australia, were found to be more closely related to Indonesian water pythons than eastern Australian/New Guinea *L. fuscus* (Rawlings *et al.*, 2004) but the authors of this finding did not commit to referring to this population as *L. mackloti*.

***Malayopython reticulatus* (Schneider, 1801)** <sup>[IV, VII]</sup>

**Common names.** (E) Reticulated Python. (G) Netzpython. (T) Fohorai-boot (fohorai = python, boot = big).

**Known distribution.** During Phase III we encountered a number of captive adult reticulated pythons around Dili (Dili District) and juveniles in Viqueque District (O'Shea *et al.*, 2012) (Figure 39). A captive specimen in Oecusse District was reported elsewhere (Sanchez *et al.*, 2012). De Lang (2011) also reported specimens from Laleia (northern Manatuto District) and Malahara (Lautém District).

**New localities.** During Phase IV a locally caught specimen was photographed and its tissue sampled at the Convent of St. Antony d'Lisboa (Manufahi District; Locality 19), and during Phase VII a dead specimen was encountered on the road between Natarbora and Fatucahi, approximately 6 km NE of the convent. This specimen was not a roadkill, there was evidence it had been killed elsewhere and dragged onto the road. The condition of the cadaver made tissue sampling impossible but a voucher photograph was taken (USNM-HI 2788). *Malayopython reticulatus* has now been confirmed for six mainland districts (Table 4).

**Natural history.** *Malayopython reticulatus* is the longest snake species in the world, the largest potentially reliable account being that of a 9.98 m specimen killed and measured with a surveyor's tape in Sulawesi in 1912 (Murphy and Henderson, 1997). Other large specimens have been reported from the Philippines, Malay Peninsula, Borneo, and Sumatra, but individuals on small islands are often considerably smaller, perhaps due to island miniaturization or due to the hunting pressure on larger individuals (McKay, 2006). The largest Timorese specimen encountered during the survey was a captive from Becora (Dili District; Locality 2), with a total length

just over 3.5 m.

*Malayopython reticulatus* is an inhabitant of rainforests and monsoon forests, particularly in close proximity to watercourses, where young specimens sleep on overhanging branches and plunge into the water below if they detect the approach of a potential threat (O'Shea *et al.*, 2004). This vegetated habitat also affords pythons the cover required to function as ambush predators of vertebrates, such as mammals. The species is also often found in bat caves, with these mammals providing a constant food source (McKay, 2006). However, reticulated pythons may also be found in cultivated or agricultural habitats, such as plantations (O'Shea, 2007), and individuals have been known to enter towns and even large cities (Cox, 1991). Several Timorese specimens were reportedly captured by locals on the outskirts of the capital, Dili. The species may occur at elevations from sea level to at least 1500 m (Malkmus *et al.*, 2002; Manthey and Grossmann, 1997).

The prey of *M. reticulatus* is composed primarily of mammals, with birds and large lizards occasional prey items (Malkmus *et al.*, 2002). The size range of mammals consumed by reticulated pythons is astounding: small or young pythons prey on rodents, but at 3–4 m body length their preference changes and they are documented to prey upon much larger and potentially more difficult or dangerous mammals, such as pangolins, porcupines, monkeys, wild pigs, mouse deer (Shine *et al.*, 1998), goats and adult deer (Taylor, 1922), sun bear (Fredriksson, 2005), and, on rare occasions, even humans (McKay, 2006). There exist anecdotal reports of leopards being killed, and one of us (MOS) encountered an injured *M. reticulatus* of approximately 3.0 m total length in Thailand that had obviously come off badly in an encounter with



**Figure 39** Unvouchered captive individual of *Malayopython reticulatus* from the Convent of St. Antony d'Lisboa (Locality 19). Photo by Mark O'Shea.

a large feline. Shine *et al.* (1998) reported that females shift their attention to large prey species at a smaller size than males. *Malayopython reticulatus* is oviparous, with females of 5.5–6.0 m body length producing clutches of up to 100 eggs (McKay, 2006).

**Taxonomic comments.** For most of the two centuries following its description by Johann Gottlob Schneider (1801), the reticulated python remained in the Afro-Asian genus *Python*. However, the species is morphologically and biochemically quite distinct from all other members of this genus, with the exception of *M. timoriensis*. Rawlings *et al.* (2008) determined that the taxa *reticulatus* and *timoriensis* were sufficiently distinct phylogenetically from other species in the genus *Python* to warrant separate generic recognition. In a recent paper, Reynolds *et al.* (2014), provided the genus name *Malayopython* in recognition of the type locality for the species *M. reticulatus* as the Malay Archipelago (*vide* Alfred Russel Wallace). By using the genus name *Malayopython*, we follow the recommendations of Kaiser *et al.* (2013a).

*Malayopython reticulatus* is the most widely distributed python in Asia. The island of Timor lies at its extreme southern limit but the species has been recorded from virtually the entire Indo-Malayan and Philippine Archipelagos, east of Lydekker's Line and as far north on mainland Southeast Asia as Myanmar. The northernmost limit of its range is currently Itbayat Island (N 20.75°, E 121.83°), in the northern Philippine Batanes Group, only 200 km south of Taiwan, China (O'Shea and Lazell, 2008). Despite this extensive geographical range only two subspecies are currently recognized as distinct from the nominate form, *M. r. jampeanus* (Auliya *et al.*, 2002) and *M. r. saputrai* (Auliya *et al.* 2002), both from isolated islands south of Sulawesi (Auliya *et al.*, 2002); all other proposed subspecies have no scientific validity (Kaiser *et al.*, 2013a). Even so, it would be presumptuous to assume that all other populations belong to the nominate subspecies *M. r. reticulatus*, and for that reason no subspecific designation is used to distinguish the Timorese population below the species level.

**Conservation.** *Malayopython reticulatus* is a species listed on CITES Appendix II and therefore protected from international trade. However, unlike the smaller *Liasis mackloti*, it is being harvested for skins, meat, and gall bladders (e.g., Iskandar and Erdelen, 2006), and this highly destructive activity may exert a much greater pressure on wild populations than the exportation of live specimens to the trade. Despite its abundance in other parts of its range *M. reticulatus* does not appear to be a commonly encountered species on Timor.

### Family Typhlopidae—Blindsnakes

#### *Indotyphlops braminus* (Daudin, 1803) <sup>[IV-VII]</sup>

**Common names.** (E) Brahminy blindsnake. (G) Blumentopfschlange, (T) Samea matan delek isin lotuk (samea = snake, matan delek = blind, isin lotuk = small body).

**Known distribution.** During Phase I we collected vouchers of this widespread, parthenogenetic species (Figure 40), two from Ladiki, near Same Manufahi District, and one from Loihuna, Viqueque Districts (Kaiser *et al.*, 2011).

**New localities.** During the later phases of the survey, six specimens of *I. braminus* were collected and vouchered. Three were taken in the gardens of the Pousada de Maubisse (elevation 1495 m; Ainaro District; Locality 16; USNM 579373–75), our highest record for a snake in Timor-Leste. Given the means by which the ancestral stock of this population probably arrived at this location, in plant pots, we do not consider this a naturally occurring elevation record. At much lower altitudes individual specimens were collected at the Timor Lodge Hotel, Dili (Dili District; Locality 1; USNM 579778) and in the ruins of the Pousada de Com (Lautém District, Locality 26; USNM 579496), both north coast localities. A specimen was also vouchered at the Convent of St. Antony d'Lisa, Fatucahi (Manufahi District; Locality 19; USNM 565896) after it was found protruding from the cloaca of a Black-spined toad (*Duttaphrynus melanostictus*; see O'Shea *et al.*, 2013). *Indotyphlops braminus* has now been documented from six mainland districts.

**Natural history.** One commonly used vernacular name for *Indotyphlops braminus* is “Flowerpot Snake,” (German: *Blumentopfschlange*) a name that these pencil-thin, small snakes (total length up to 180 mm) earned because they are often found either in the root balls of plants in plant pots, or in the humid darkness underneath plant pots. A close association with tropical plants exported during trade is likely the secret to how *I. braminus* became the most widely distributed snake in the world. It is the only known obligatorily parthenogenetic snake species (no male has ever been documented; see Booth *et al.* 2014 for a review of facultative parthenogenesis in pythons), and as such only a single adult specimen is required to colonize a new habitat. Since these snakes often inhabit the soil of tropical plant root balls, they can easily be transported internationally within plants and establish colonies wherever they arrive. Snakes tend to be more resistant to the effects of plant quarantine than insect larvae or other invertebrates, and thus a bridgehead can easily be established. This is



**Figure 40** Specimen of *Indotyphlops braminus* from the leaf litter at the Portuguese pousada at Com (USNM 579496, Locality 26). Photo by Mark O'Shea.

undoubtedly how the population of *I. braminus* became established at an uncharacteristically high elevation in the gardens of the former Portuguese Governor's *pousada* at Maubisse. *Indotyphlops braminus* is an oviparous species, producing clutches of 1–8 eggs (de Lang, 2011; McKay, 2006).

Like all blindsnakes, *I. braminus* is a fossorial species that is more commonly found on the surface when flooded out of burrows by heavy rain. Its rudimentary eyes are simple pigmented areas under translucent scales that warn the snake when it has been uncovered, and this triggers the response to burrow rapidly. Prey comprises soft-bodied invertebrates, primarily termite and ant larvae and eggs (de Lang, 2011). This small snake may itself become the prey of many larger vertebrates, including the pipesnake *Cylindrophis* cf. *boulengeri* and the introduced bufonid *Duttaphrynus melanostictus* (O'Shea *et al.*, 2013).

**Taxonomic comments.** The genus *Indotyphlops* was recently erected by Hedges *et al.* (2014) to accommodate the South Asian blindsnake clade. Prior to this revision, the species *braminus* was placed in the genus *Ramphotyphlops*, which is now restricted to Western Pacific taxa.

***Indotyphlops* spp.** [IV, VI–VII]

**Common names.** (E) Blindsnakes. (G) Wurmschlangen, Blindschlangen. (T) Samea matan delek (samea = snake, matan delek = blind).

**Known distribution.** A series of seemingly aberrant *Indotyphlops* were collected on Ataúro Island and were documented elsewhere (Kaiser *et al.*, 2013b) as *Ramphotyphlops* sp. 'Ataúro'.

**New localities.** A striped *Indotyphlops* (Figure 41A) collected at an altitude of over 905 m in a rock pile on the

Tilomar road in Covalima District (Locality 15; USNM 579376) during Phase IV, could not be attributed to either *I. braminus* or *Sundatyphlops polygrammicus* (see below) and is recorded here as *Indotyphlops* sp. 'Tilomar'. Similarly, an unusual *Indotyphlops* with a bluish body coloration (Figure 41B) was collected on the trail to Mt. Mundo Perdido, Viqueque District (Locality 21; USNM 580542) at an elevation of 1162 m; we recognize it here as *Indotyphlops* sp. 'Mundo Perdido.' We considered that the coloration of this individual might be due to incipient ecdysis, but examination of the two injured areas and the head, as well as of the specimen after several months in preservative, do not support this idea. Both of these mainland specimens, as well as the series from Ataúro Island, await closer examination. Currently all three are *incertae sedis* within *Indotyphlops*.

**Natural history.** No natural history notes are available for the two aberrant *Indotyphlops* specimens from Tilomar (USNM 579376) and Mt. Mundo Perdido (USNM 580542), although they were both found sheltering under rocks at relatively high elevations, 905 and 1162 m respectively, the highest recorded for any



**Figure 41** (A) Aberrant specimen of *Indotyphlops* from under a rock pile at Tilomar (USNM 579376, Locality 15, elevation 905 m). The fine lined pattern along the body indicates that this individual is not conspecific with *I. braminus*, and we refer to it as *Indotyphlops* sp. 'Tilomar.' (B) Aberrant specimen of *Indotyphlops* from the path to Mt. Mundo Perdido (USNM 580542, Locality 21, elevation 1162 m), showing injuries and a bluish, presumably pre-ecdysis, coloration. Photos by Mark O'Shea.

Timorese typhlopids, excluding the artificially introduced *I. braminus* at Maubisse (see above). Both locations where these two snakes were found are remote, at the end of a road into a highland area and along a mountain trail, respectively, and it seems unlikely that either of these snakes were transported to their respective locations by the agencies of man.

***Sundatyphlops polygrammicus* (Schlegel, 1839)** [IV, VII]

**Common names.** (E) Timor blindsnake. (G) Timor-Wurmschlange, Timor-Blindschlange. (T) Samea matan delek isin baibain (samea = snake, matan delek = blind, isin baibain = normal body size).

**Known distribution.** No specimens of *Sundatyphlops polygrammicus* (Figure 42) were collected during Phases I–III, although Forcart (1953) reported eight specimens, now in the Basel collection (NHMB 12888–95), collected by Prof. A. Bühler near Baguia (Baucau District).

**New localities.** During Phase IV, a large specimen of *Sundatyphlops polygrammicus* (Figure 42) was collected, in heavy rain as it climbed a sandstone cliff-face near a path, on the Trilolo River, close to Same (Manufahi District; Locality 17). A second specimen was collected during Phase VII at the “*Carlia* site” at Afacaimau (Baucau District; Locality 23; USNM 580543).

**Natural history.** *Sundatyphlops polygrammicus* is an infrequently encountered species, with only two specimens collected in eight survey phases. As with most blindsnakes, *S. polygrammicus* is rarely seen on the surface except during or following heavy rain. Our Trilolo River specimen (USNM 579377) was collected as it climbed a sandstone cliff-face besides the path down to the river, the only reptile or amphibian encountered by the entire team during an evening search in heavy rain.

Like other typhlopids snakes, *S. polygrammicus* is a predator of soft-bodied invertebrates, primarily the larvae and eggs of termites and ants, but its larger size (larger than species such as *I. braminus*) should place adult ants and termites, and possibly also beetle larvae, within its dietary range. Large numbers of prey items may be consumed in rapid succession, from 50 to over 500 termites (de Lang, 2011). However, the majority of natural history notes available for this species relate to the former populations from Queensland, Australia, and Western Province, Papua New Guinea, which are now treated as a separate species in a different genus, *Anilios torresianus* (see Taxonomic comments below).

**Taxonomic comments.** The genus *Sundatyphlops* was recently erected by Hedges *et al.* (2014) to accommodate a clade of exclusively Lesser Sunda blindsnakes. Prior to this revision, the species *polygrammicus* was placed

in the genus *Ramphotyphlops*. While this most recent taxonomic arrangement will still need to stand the test of time, *Sundatyphlops* is the most current available name for *polygrammicus*, and our use of this name here should not be misconstrued as a taxonomic endorsement but merely an acknowledgment of acceptable research. *Sundatyphlops polygrammicus* is currently believed to contain five subspecies distributed throughout the Lesser Sunda Islands, with the nominate form present on Timor (de Lang, 2011; Hedges *et al.*, 2014). With three of the other subspecies endemic to Sumba, Lombok, and Flores, and a fourth reported from Sumbawa and neighbouring Komodo and Moyo, it is unlikely that the rest of this considerable range is inhabited by just the nominate subspecies. This is a taxon clearly in need of revision. As formerly recognized, *S. polygrammicus* was a polyphyletic species and caused Hedges *et al.* (2014) to resurrect *torresianus* (now in the genus *Anilios*) for Queensland and southern Papuan populations, and to confine *S. polygrammicus* to Lesser Sunda populations.

**Family Viperidae—True Vipers and Pitvipers**

***Trimeresurus (Trimeresurus) insularis* (Kramer, 1977)** [IV–VIII]

**Common names.** (E) Lesser Sunda Island Pitviper, Island Pitviper, Lesser Sunda White-lipped Pitviper. (G) Insel-Bambusotter, Wetar-Bambusotter. (T) Samodok (a proper noun).

**Known distribution.** During the first three research phases, *Trimeresurus insularis* was documented from three mainland districts (Baucau, Lautém, Viqueque; see Kaiser *et al.*, 2011; O’Shea *et al.*, 2012). It was also reported from Ataúro Island (Kaiser *et al.*, 2013b). Bethencourt Ferreira (1898) reported a juvenile specimen from Aipello (Liquiça District), and de Lang (2011) included Dili (Dili District) and additional localities in Baucau and Lautém Districts, bringing to five the number of districts where this pitviper has been recorded. *Trimeresurus insularis* is also common and widely distributed in West Timor, with specimens being documented enroute and returning from the Oecusse exclave (Sanchez *et al.*, 2012).

**New localities.** The later phases produced additional live specimens from Lautém District at Raça village (Locality 27; USNM 579386–87) and Com (Locality 26; USNM 579493); from Manufahi District at Betano (“wet site,” Locality 19; USNM 579385); from Manatuto District (Nancuro coastal forest, Natarbora, S of Umaboco, Locality 20; USNM 580551; Figure 43); and a road-killed specimen from Bobonaro District on road between Bobonaro and Maliana road (near Locality 12). The Bobonaro specimen was in too poor a condition to

voucher, and we instead documented it photographically (USNM-HI 2791). *Trimeresurus insularis* is now known to occur in eight mainland districts and on Atauro Island, but thus far not at elevations over 900 m.

**Natural history.** With its lithe body shape and prehensile tail, the island pitviper *T. insularis*, is usually considered an arboreal species, but most specimens encountered during our surveys have been found on the ground, at night in relatively wet habitats, waiting in ambush for prey. Prey appears to consist largely of frogs, particularly rice-paddy frogs (genus *Fejervarya*; HK, pers. obs.) but it is possible that small mammals or lizards may also be taken on occasion, as reported by de Lang (2011) from other islands in the archipelago. The most common color phase is green but cyan coloration is known from Komodo (de Lang, 2011; MOS, pers. obs.), and bright yellow occurs on Wetar and Timor-Leste (USNM 581178). As with most pitvipers, *T. insularis* is a livebearing species. This species (under the generic name *Cryptelytrops*) was recorded as a paratenic host of spargana tapeworms (Cestoda) by Goldberg *et al.* (2010).

At this point in time this is the only terrestrial snake known to occur on Timor or in Timor-Leste, which includes Atauro Island to the north, capable of delivering a lethal bite to a human. Deaths following the bites of *T. insularis* are on record in Timor-Leste and at the very least a bite and ensuing envenomation can be an unpleasant experience (MOS, pers. obs.).

**Taxonomic comment.** Until recently, we referred to this species as *Cryptelytrops insularis* (e.g., Goldberg *et al.*, 2010; Kaiser *et al.*, 2011). We here follow the nomenclature proposed by David *et al.* (2011), which we believe to be correct after a careful reading of their assessment. According to these authors, *Trimeresurus viridis* Lacépède, 1804 (= *T. albolabris insularis* Kramer, 1977) is the true type species of the genus *Trimeresurus*, and not *Coluber gramineus* Shaw, 1802, as previously believed. Rearrangement of the nomenclature requires that the species *insularis* bear the generic name *Trimeresurus*, with the optional use of the subgeneric name *Trimeresurus* to preserve added taxonomic information. The genus *Cryptelytrops* Malhotra and Thorpe, 2004 is now considered a junior synonym of *Trimeresurus*.

#### Family Crocodylidae—Crocodyles

##### *Crocodylus porosus* Schneider, 1801 <sup>[IV-V, VIII]</sup>

**Common names.** (E) Saltwater crocodile, Estuarine crocodile, Naked-neck crocodile, Indo-Pacific crocodile. (G) Leistenkrokodil, Salzwasserkrokodil. (T) Lafa'ek tasi (Lafa'ek = crocodile, tasi = sea).



**Figure 42** Individual of *Sundatyphlops polygrammicus* from under a flat rock in a disturbed area south of Baucau (USNM 580543, Locality 23). Photo by Mark O'Shea.



**Figure 43** Adult female *Trimeresurus insularis* (green phase) found in ground vegetation in coastal wet forest at Nancuro (USNM 580551, Locality 20). Photo by Mark O'Shea.

**Known distribution.** During earlier phases we documented free-living crocodiles in the Malailala River (Lautém District), and captives caught locally at Uma Boot (Viqueque District). One captive (Figure 44) from the south coast near Betano (Manufahi District; near Locality 18) has been kept in an enclosure in the town of Aileu (Aileu District) for nearly a decade, while a juvenile was kept in an old oil drum nearby (Kaiser *et al.*, 2009, 2013c).

**New localities.** During Phase IV we documented another captive crocodile on the Fatucahi to Betano road (Manufahi District; Table 5), which local residents had confined to an old oil drum. During Phase V a large adult crocodile was seen stalking water buffalo calves on the southern shore of Lake Ira Lalaro at Malahara (Lautém District; Locality 29; USNM-HI 2798). In 2012, a specimen was photographed at Tibar, a popular beach area west of Dili (Liquiça District; USNM-HI 2836). In

2013 (Phase VIII), we documented crocodiles on riverine sand banks along the north coast road in Lautém District (USNM-HI 2828).

**Natural history.** The saltwater crocodile is the most widely distributed crocodile in the Australasian region and the largest crocodylian in the world, achieving lengths of over 6.0 m (Wilson, 2005) and weights in excess of 1300 kg (Alderton, 1991; Steel, 1989). It is the climax predator wherever it occurs. This species is the only crocodylian found in Timorese waters where it has achieved mythological status as part of the island's creation story (Kaiser *et al.*, 2009; Morris, 2011). Many local people respect the crocodile, but this respect is not reciprocated, as crocodiles are responsible for an increasing number of human fatalities, usually fishermen or children near the water's edge, every year (B. Sidelau, *pers. comm.*). Reporting of such incidences is not universal, and the real impact on the human population is as yet unknown (HK and MOS, *pers. obs.*). Crocodiles are most common in estuarine river mouths or mangrove swamps, where the turbid water obscures their presence. We have observed them lingering under bridges along the coast roads, basking on riverine sandbanks, and resting nearly submerged in water among mangrove roots, but they may also arrive on sandy beaches close to major towns or tourist locations (J. Ramos-Horta, *pers. comm.*). There

exists a land-locked population, estimated to number in excess of 300 individuals, in Timor-Leste's largest lake, Lake Ira Lalaro (Lautém District: Locality 29; Middleton *et al.*, 2006; M. Mendes and C. Trainor, *pers. comm.*).

**Taxonomic comments.** It is interesting to note that the population in Lake Ira Lalaro, a freshwater catchment in a limestone polje, is isolated by distance (9 km by air to the nearest coastline, with the 934 m high Paitxau Mountain range in the way) and altitude (at an elevation of nearly 500 m) from other saltwater crocodile populations. Therefore, this isolate may be considered a population of interest for studies of isolated crocodile populations.

**Crocodile attacks.** As human activity along the coastline and the shores of Lake Ira Lalaro has increased, reports of crocodile attacks including numerous human fatalities have risen dramatically. While there are currently no formal statistics on these attacks, we have heard reports with greater frequency during every research phase, and there is increased awareness on the part of the government that this might need to be considered an important public health issue (HK, *pers. obs.*). It appears to us that in the mindset of the Timorese populace, a people that has experienced great violence in the recent past and which is fighting to emerge from extreme poverty, such attacks may simply be considered a fact of normal life, akin to motorcycle accidents or falls

**Table 5** Records of crocodylians and turtles for the districts of Timor-Leste. Black circles indicate previously known records, red circles denote new records.

| Taxon                               | District |        |        |          |          |              |               |        |        |         |          | References* |          |         |          |
|-------------------------------------|----------|--------|--------|----------|----------|--------------|---------------|--------|--------|---------|----------|-------------|----------|---------|----------|
|                                     | Aiteu    | Ainaro | Baucau | Bobonaro | Covalima | Dili (Timor) | Dili (Atauro) | Ermera | Lautém | Liquiça | Manatuto |             | Manufahi | Oecusse | Viqueque |
| <b>CROCODYLIDAE</b>                 |          |        |        |          |          |              |               |        |        |         |          |             |          |         |          |
| <i>Crocodylus porosus</i>           |          |        |        |          |          |              |               |        | ●      |         |          | ●           |          | ●       | 1–4      |
| <b>CHELIDAE</b>                     |          |        |        |          |          |              |               |        |        |         |          |             |          |         |          |
| <i>Chelodina mccordi timorensis</i> |          |        |        |          |          |              |               |        | ●      |         |          |             |          |         | 1        |
| <b>CHELONIDAE</b>                   |          |        |        |          |          |              |               |        |        |         |          |             |          |         |          |
| <i>Chelonia mydas</i>               |          |        |        |          |          |              |               |        | ●      |         | ●        |             |          |         | 1,2      |
| <i>Eretmochelys imbricata</i>       |          |        |        |          |          |              |               |        | ●      |         |          |             |          |         | 2        |
| <b>GEOEMYDIDAE</b>                  |          |        |        |          |          |              |               |        |        |         |          |             |          |         |          |
| <i>Mauremys reevesii</i>            |          |        | ●      |          |          | ●            |               |        |        |         |          |             |          |         | 1,6      |
| <b>TRIONYCHIDAE</b>                 |          |        |        |          |          |              |               |        |        |         |          |             |          |         |          |
| <i>Pelodiscus sinensis</i>          |          |        |        |          |          |              |               |        |        |         |          |             |          |         | 5        |

\*References are identified numerically as follows: 1 = Kaiser *et al.*, 2011; 2 = this paper; 3 = Kaiser *et al.*, 2009; 4 = de Rooij, 1917; 5 = Bethencourt Ferreira, 1898; 6 = Kaiser *et al.*, 2010.





**Figure 44** Captive *Crocodylus porosus* in an enclosure at Aileu (see Kaiser *et al.*, 2009, 2013c). Photo by Mark O'Shea.

from coconut palms. However, crocodile attacks do not have to be part of a valiant, post-conflict socioeconomic struggle. In an earlier report (Kaiser *et al.*, 2009), we outlined some of the challenges resulting from the interactions between humans and crocodiles, as well as some of the misconceptions about living with crocodiles as neighbors. While there are no simple solutions, it does not appear that any systematic evaluation of the issue has taken place. We therefore propose that the Government of Timor-Leste make reports of crocodile attacks compulsory (including name and age of the victim as well as the locality, and the activity during which the attack occurred) and form an inter-ministerial task force, to include members from departments handling public health, internal security, environment, and tourism, to create and implement an educational plan so that the risk of death from crocodile attacks can be minimized.

#### Family Cheloniidae—Sea Turtles

##### *Chelonia mydas* (Linnaeus, 1758)<sup>[iv]</sup>

**Common names.** (E) Pacific Green Sea Turtle. (G) Suppenschildkröte, Grüne Meeresschildkröte. (T) Lenuk tasi kór-matak (lenuk tasi = sea turtle, kór-matak = green).

**Known distribution.** There have not been any confirmed records of *Chelonia mydas* for Timor-Leste. However, it is listed in the IUCN Red List of Threatened Species (Seminoff, 2004) as native in that country.

**New localities.** During Phase IV we found a dismembered carapace of *C. mydas* above the shoreline in the Nancuro coastal forest, Natarbora, S of Umaboco (Manatuto District; Locality 20; Table 5). The carapace was reconstructed using beach sand for support and a voucher photograph was obtained (Figure 45, USNM-HI 2792).

**Natural history.** This turtle may achieve a carapace length of 1.5 m (Wilson, 2005) and weights up to 200 kg (Spotila, 2004). *Chelonia mydas* migrates long distances between breeding beaches, the open ocean, and shallow, inshore, clear water bays with sea grass where they

graze on algae and other marine vegetation. Adults are primarily, if not totally, herbivorous, but juveniles do include marine animals in their diets (Wilson, 2005). The lifespan of this turtle may exceed 50 years (Zug and Balazs, 1985).

**Taxonomic comments.** Some authors recognize two, others three, subspecies of *C. mydas*. The population on the coast of Timor could be attributed to either *C. m. agassizi* (Bocourt, 1868) or *C. m. japonica* (Thunberg, 1787).

**Conservation.** *Chelonia mydas* is an endangered species that was harvested well into the 20<sup>th</sup> century as part of the natural products trade, for its eggs, and for its meat for turtle soup (the German name *Suppenschildkröte* = “turtle used for soup” refers to the usage of the species as part of human diet). Although such trade is now banned, it is very difficult to prevent further exploitation of this turtle or its nests in economically challenged countries where a specimen may represent a financial windfall. We have on at least three occasions observed individuals offering sea turtle eggs, of uncertain species affinity, for sale along the main coastal road in Dili, with neat displays of four eggs per order sold alongside of the day's catch of fish or octopus. Whereas this type of trade is illegal in Timor-Leste, timing hinders enforcement, given that one motivated buyer may take the proof and leave no grounds for legal action. This same comment regarding local exploitation equally applies to other sea turtle species, including *Eretmochelys imbricata*, the only other species so far identified during our surveys.



**Figure 45** Carapace of a hunted and killed specimen of *Chelonia mydas*, of which we found and reassembled all elements, just inland from the shore at the Nancuro Protected Area (Locality 20). Even though the remaining portions of the skeleton were missing, we were able to determine that there was human involvement by the presence of recent (i.e., not healed) harpoon damage. The flashlight (length = 146 mm) is provided as a scale. Photo by Mark O'Shea.

***Eretmochelys imbricata* (Linnaeus, 1766)** <sup>[V]</sup>

**Common names.** (E) (Pacific) Hawksbill (Sea) Turtle. (G) Echte Karettschildkröte. (T) Lenuk tasi eretmochelys (lenuk tasi = sea turtle,ibun = beak, makitik = hawk).

**Known distribution.** No confirmed records existed for *Eretmochelys imbricata* for Timor-Leste.

**New localities.** During Phase V the carapace of a juvenile specimen of *E. imbricata* was found on Jaco Island (Lautém District; Locality 30; Table 5). A voucher photograph was obtained (Figure 46, USNM-HI 2793).

**Natural history.** Adults of *E. imbricata* may achieve a carapace length of up to 1.0 m (Wilson, 2005) and a weight approaching 80 kg (Spotila, 2004). Although this highly migratory species may be encountered in a wide variety of marine habitats, from open ocean to mangrove swamps and estuarine river mouths, it is most often associated with the clear, shallow waters of coral reefs, where it feeds primarily on sponges (Porifera). Hawksbill turtles also prey upon molluscs (Mollusca), jellyfish (Scyphozoa), including highly venomous species, sea combs (Ctenophora), sea anemones and soft corals (Anthozoa), and marine algae (Ernst *et al.*, 1994). Juveniles are solely carnivorous (Wilson, 2005). Hawksbill turtles may live for 30–50 years (Ernst *et al.*, 1994).

**Taxonomic comments.** Two subspecies are recognized, with the Indo-Pacific populations belonging to *E. i. bisssa* (Rüppell, 1835).

**Conservation.** *Eretmochelys imbricata* is a critically endangered species that has suffered historically from harvesting for the turtle shell industry, a practice now outlawed but continuing. Given their size, they are also harvested for food, and their eggs are collected from nesting sites or from slaughtered females.

**Family Geoemydidae—Asian Hard-shelled Turtles*****Mauremys reevesii* (Gray, 1831)** <sup>[IV,VI]</sup>

**Common names.** (E) Chinese pond turtle. (G) Chinesische Dreikielschildkröte. (T) Lenuk kakorok riskadu (lenuk = turtle, riskadu = striped, kakorok = neck).

**Known distribution.** During Phase I we vouchered a specimen of *Mauremys reevesii* from Baucau (Baucau District; Kaiser *et al.*, 2010) and reported the presence of a population in Dili (Dili District; Kaiser *et al.*, 2011).

**New localities.** During Phase IV we were able to confirm the presence of a population of *Mauremys reevesii* in a kangkong (*Ipomoea aquatica*) patch in Becora, eastern Dili (Dili District; Locality 1; USNM 579393; see Kaiser *et al.*, 2013c). We also encountered a number of specimens kept as garden pets in Comoro, western Dili

(Table 5).

**Natural history.** *Mauremys reevesii* is an introduced turtle that probably arrived as a deliberate introduction from the Asian mainland, for food or to be used in traditional Chinese medicine, or as a totem associated with Chinese culture and long life. It appears to have been present in the Dili area for several decades (Kaiser *et al.*, 2010). As shown by the presence of a male individual in black breeding colors (Figure 47), the population is reproductively active and perhaps even self-sustaining in their human-maintained habitat.

**Conservation.** Even though the population found in Timor-Leste was introduced, it may be of significance in terms of the long-term conservation management of the species. In its native habitat in temperate and subtropical regions of mainland East Asia (China, North Korea, South Korea) *M. reevesii* has been severely exploited and has become very rare in the wild, having earned the IUCN status of Endangered A2bcd+4bcd (van Dijk, 2013). While populations also occur in Taiwan and Hong Kong of China, and Japan, these appear to have been exposed to hybridization with escapees from the trade (Taiwan, China; Fong and Chen 2010) or with *M. japonica* (Temminck and Schlegel, 1835), a close relative (Japan; Suzuki *et al.* 2011). Thus, the population in Timor-Leste, which by our findings appears to be a robust, self-sustaining population, may represent an important genetic reservoir of pure *M. reevesii*.

**Family Chelidae—South American and Australasian Side-necked Turtles*****Chelodina mccordi* Rhodin, 1994** <sup>[I]</sup>

**Common names.** (E) Timor Snake-necked Turtle. (G) McCord-Schlangenhalsschildkröte. (T) Lenuk kakorok ular (lenuk = turtle, kakorok = neck, ular = snake).

**Known distribution.** Snake-necked turtles on Timor are limited in distribution to Lake Ira Lalaro in Lautém District and the surrounding swampy grasslands (Table 5).

**New localities.** Although we have not personally encountered or even pursued *C. mccordi* after our initial survey in 2009, we received several reports regarding their presence. These primarily came from local residents of Malahara village, at Lake Ira Lalaro's southern shore, from forest guards working in the vicinity of the lake, and from expatriates working in Timor-Leste. They lead us to conclude that *C. mccordi* exists in all near-shore habitats around the lake (Kuchling *et al.*, 2007).

**Natural history.** *Chelodina mccordi* (Figure 48) is regarded as one of the world's 25 most endangered turtle species (Rhodin *et al.*, 2011). Amongst the reasons for this designation are its highly localized populations



**Figure 46** Carapace of a juvenile *Eretmochelys imbricata* from Jaco Island (Locality 30). The dollar bill (length = 156 mm) is provided as a scale. Photo by Mark O'Shea.



**Figure 47** Adult male *Mauremys reevesii* from the kangkong paddies at Balide, a part of the city of Dili (USNM 579393, Locality 1; see Kaiser *et al.*, 2013c). Photo by Mark O'Shea.



**Figure 48** Unvouchered adult individual of *Chelodina mccordi* from Lake Ira Lalaro, Lautém District (see Kaiser *et al.*, 2011). Photo by Mark O'Shea.

(one in a single lake in Timor-Leste, one in two lakes on Roti Island), the uncertain population dynamics (e.g., population size, recruitment, density), and the high potential for extirpation due to local dietary and cultural customs or incipient exposure to international trade. Very little is known about the ecological parameters of *C. mccordi* in Timor-Leste, although a study has just commenced (*C. Eisemberg, pers. comm.*). Individuals of *C. mccordi* are most frequently encountered by local residents during the drier months of the year, when the waters of Lake Ira Lalaro recede and smaller patches of densely vegetated freshwater become isolated. Malahara villagers may have captured up to 30 specimens of *C. mccordi* from the environs of Lake Ira Lalaro during a single day (Kuchling *et al.*, 2007), likely in support of an annual cultural event. An educational booklet was recently produced and is now used in schools to encourage conservation of the species (Eisemberg and Perini, 2014).

**Taxonomic comments.** Even though McCord *et al.* (2007) described this population as a distinct species, their taxon was implicitly synonymized later that year by Kuchling *et al.* (2007), who considered the Lake Ira Lalaro population in Timor-Leste to be a subspecies of *C. mccordi* and gave it the name *C. m. timorlestensis*. The taxon name *timorensis* takes nomenclatural priority over *timorlestensis*, and thus this population should be referred to as *C. m. timorensis* (McCord *et al.*, 2007) if a subspecific name were to be used. Two other subspecies of *C. mccordi* are recognized, the nominate form from western Roti Island and *C. m. roteensis* McCord *et al.*, 2007 from eastern Roti Island (van Dijk *et al.*, 2014).

#### 4. Discussion

##### Species Distribution

The mosaic geological structure of Timor Island and the exploitation of organic natural resources during colonial times and throughout the Indonesian occupation (i.e., cutting of sandalwood and tropical hardwoods, development of coffee monoculture, rice farming and other large-scale agricultural practices, human settlement) inescapably lead to certain assumptions about the distribution of the local herpetofauna. Habitat disturbances and destruction are known to effect significant changes in species distributions (e.g., Gardner *et al.*, 2007; McKinney, 2002; Wolf *et al.*, 2013), and this is perhaps most pronounced in tropical environments. We are therefore pleased that the reports of our herpetofaunal surveys to date (Kaiser *et al.*, 2011, 2013b; O'Shea *et al.*,

2012; Sanchez *et al.*, 2012; this paper) appear to document much higher herpetofaunal diversity than we had expected, which includes a series of putatively single-island endemics (e.g., *Cyrtodactylus*, *Eremiascincus*, *Kaloula*, *Stegonotus*).

When considering species distributions, two of the most common ways to showcase diversity are to use political boundaries or habitat types. In Timor-Leste, the most convenient method is to use established political boundaries (Districts), especially since habitats are fragmented, disturbed, or otherwise not cohesive. It would be difficult to predict detailed countrywide species distributions for Timor-Leste based on the coverage of specific habitats due to the high degree of habitat degradation, the presence of habitat fragments of diverse types, sizes, and ecological qualities, and the existence of uncertain corridors between such habitats. Furthermore, it is clear that our sampling effort plays a significant role in how we can account for species distributions: while we have been able to sample in all 13 districts of Timor-Leste, some districts received a disproportionate amount of attention when sampling, entirely for logistical reasons. Whereas the political boundary method admittedly falls short of the most productive approach to make statements about species biology, it allows us to provide a geographic overview even while comprehensive studies of habitats are still very limited. The best available information regarding habitat distributions is still that provided by Trainor *et al.* (2007).

As expected, there does not appear to be any general signal in the species diversity when looking at political boundaries, with the exception of Lautém District (Table 6), which comprises the entire eastern end of Timor Island and includes Lake Ira Lalaro, the country's largest

body of freshwater. Even though we visited Lautém only three times during Phases IV–VIII, we found 31 species, among them 16 lizard and nine snake species. In contrast, all of our surveys begin and end in Dili District, and our species count there is 21 species, with seven lizards and ten snakes. Aileu and Ainaro are the only districts with a species count below ten, and this is due to a lack of sampling effort. With a number of diverse mountain habitats, it is all but certain that the diversity in these districts should match that reported for other mountainous districts (e.g., Manufahi; Table 6).

One other way to provide a general approach to species distribution patterns in Timor-Leste is to consider the north-south distribution, which largely reflects a dry-moist divide, respectively. The high mountains that form the spine of Timor act as a barrier to clouds from the south, effectively placing most of the habitats along the northern shore of Timor-Leste into a rain shadow. Portions of northern coastal Manatuto and Baucau Districts rank amongst the driest parts of Southeast Asia (Monk *et al.*, 1997). While some may consider lush tropical habitats to be those with the greater species diversity, perhaps due to the greater stratification of vegetation and the concomitant availability of niches, our data to date do not agree: species richness in the north is 34, in the south it is 35 species. As discussed above, we believe this to be a function of sampling effort, given that the south coast of Timor-Leste has limited infrastructure to support scientific surveys, rivers in places are unfordable even for 4 × 4 vehicles, and some areas are effectively isolated from study. This situation may improve as bridges are built or rebuilt, and other aspects of the infrastructure are improved. With increased access to the more remote areas we expect the list of Timorese reptiles and amphibians

**Table 6** Known species diversity of amphibians and reptiles in the districts of Timor-Leste.

| Taxon        | District |          |           |           |           |              |               |           |           |           |           |           |           |           |
|--------------|----------|----------|-----------|-----------|-----------|--------------|---------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|              | Aileu    | Ainaro   | Baucau    | Bobonaro  | Covalima  | Dili (Timor) | Dili (Ataúro) | Ermera    | Lautém    | Liquiça   | Manatuto  | Manufahi  | Oecusse   | Viqueque  |
| Frogs        | 2        | 1        | 4         | 3         | 3         | 3            | -             | 5         | 2         | 3         | 4         | 4         | 3         | 3         |
| Lizards      | -        | 3        | 11        | 5         | 5         | 7            | 10            | 7         | 16        | 7         | 12        | 10        | 9         | 6         |
| Snakes       | 1        | -        | 8         | 3         | 3         | 10           | 4             | -         | 9         | 1         | 4         | 9         | 2         | 6         |
| Turtles      | -        | -        | 1         | -         | -         | 1            | -             | -         | 3         | -         | -         | -         | -         | -         |
| Crocodylians | -        | -        | -         | -         | -         | -            | -             | -         | 1         | -         | 1         | -         | -         | 1         |
| <b>TOTAL</b> | <b>3</b> | <b>4</b> | <b>24</b> | <b>11</b> | <b>11</b> | <b>21</b>    | <b>14</b>     | <b>11</b> | <b>31</b> | <b>11</b> | <b>21</b> | <b>23</b> | <b>14</b> | <b>16</b> |

to continue to grow. The same can be expected for some of the more inaccessible mountainous areas. We also expect that the Department of National Parks of Timor-Leste will begin to conduct surveys for amphibians and reptiles independently of our own effort in the coming years, particularly in the Protected Areas and Nino Konis Santana National Park, and that this work will result in a more equitable sampling effort throughout the 13 districts of the country, as well as across the north-south divide.

### Endemism

Our surveys uncovered a significant amount of single-island endemism. Before we began our surveys, the number of single-island endemics stood at eight (*Limnonectes timorensis*, *Litoria everetti*, *Draco timoriensis*, *Carlia peronii*, *C. spinauris*, *Eremiascincus antoniorum*, *E. timorensis*, *Chelodina mccordi timorensis*). For frogs, we have ascertained that at least two species of *Fejervarya* coexist in Timor-Leste, neither one of which is conspecific with *F. verruculosa* (Roux, 1911), their geographically closest congener found on neighboring Wetar Island. Furthermore, the population of *Kaloula* from the southern coast of Manatuto and Manufahi is a species distinct from *K. baleata sensu stricto* as well as from the recently described *K. indochinensis* and *K. latidisca*. This more than doubles the number of endemic frog species, with all of the new discoveries linked by a Southeast Asian biogeographic ancestry. Endemism is even more pronounced in lizards, and in their case the ancestry is a mixture of cis- and trans-Wallacean elements. Whereas *Cyrtodactylus* (as many as six putative new species), *Hemiphyllodactylus* and *Draco* are certainly taxa of Southeast Asian origin, *Carlia* (up to five putatively new species) and *Sphenomorphus* (up to four putatively new species) are Indo-Papuan, and *Eremiascincus* (up to four new species) is Australian. The snake fauna also includes endemics, and some are still being recognized. In addition to the known endemics, *Sundatyphlops polygrammicus* and *Dendrelaphis inornatus timorensis* (the latter of which may deserve recognition at the species level; Gernot Vogel, *pers. comm.*), we have discovered at least one new species from the Australo-Papuan realm (genus *Stegonotus*), and perhaps two new species of *Indotyphlops*. Given our relatively patchy sampling effort in both geographic and temporal terms, we are certain that our estimate of endemism for Timor, the largest Lesser Sunda Island, is still conservative. Our findings therefore contradict those of Malcolm Smith, who stated, "from a herpetological point of view, Timor is one of the most disappointing places that one can visit" (Smith 1927:199).

### Timor-Leste's Herpetofaunal Diversity in the Literature

Only four historical publications exist that are entirely devoted to the herpetofaunal diversity of the land area now called Timor-Leste (Bethencourt Ferreira, 1898; Manaças, 1956, 1972; Themido, 1941), and each of these is very limited in scope. Several other publications focus on the western part of Timor Island (e.g., Smith, 1927; van Lidth de Jeude, 1895) or on the entire island as part of more general surveys (e.g., Barbour, 1912; de Rooij, 1915, 1917; van Kampen, 1923). Where erroneous records were presented, either because of misidentification or due to errors perpetuated via faulty taxonomy, we corrected these in our earlier papers (Kaiser *et al.*, 2011; O'Shea *et al.*, 2012).

### Conservation

The newly identified high degree of endemism provides both a challenge and an opportunity for species management and conservation. The challenge lies with the landmass itself and the economic development of a population whose free market economic drive has been regulated for centuries by external forces. The landscapes in Timor-Leste are made of extremes, both in terms of terrain (much of the habitat is steeply sloped) and climate (dry spells may be long and devastating, rains may be torrential and destructive). As a consequence, any reporting on species diversity and distribution will retain a certain geographic and temporal patchiness. While the Government of Timor-Leste has set aside a significant portion of Lautém District as Nino Konis Santana National Park and has formally protected nearly 30 key areas (as *Areas Protegidas*), the establishment and implementation of management plans for these locales is only being realized very slowly due to issues with both capacity-building and governmental priorities. It is easy to enforce environmental policies in the absence of poverty, but it is nearly impossible or desirable when a family's next meal must come from the land of a protected area. As a consequence, the quickly developing market economy of Timor-Leste cannot and should not be curbed by copying environmental legislation from elsewhere; we feel that education about diversity and conservation, as well as the scientific use of the protected areas, is the best initial step to promoting broad-scale conservation in the country. It is fortunate that, based on our own experience with government leaders, the country is beginning to take these steps.

The opportunity for species management and conservation arises through the potential scientific utility of the national park and the protected areas. Currently,

these areas are staffed by a cadre of forest guards (*Guarda Florestal*), and several individuals may be assigned to serving a single protected area. The national park also has a special office in Lospalos, Lautém District, which houses the administrative base for the area. At this point, forest guards are under-utilized in their activities and represent hidden scientific potential. Once educated and equipped, these individuals could readily be assigned repeatable tasks, including: (1) twice daily recording of basic environmental data (e.g., temperature, precipitation, humidity, cloud cover, etc.); (2) conducting digital camera-assisted visual encounter transects (Heyer *et al.*, 1994) in their area; and (3) filing monthly reports of photo-vouchered species encounters. In a few years, Timor-Leste, with its existing protected area network and personnel infrastructure, could perhaps become one of the best-researched tropical countries in Southeast Asia.

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