Distribution record of the invasive drywood termite *Cryptotermes domesticus* (Haviland) in Riau Province, Sumatra Island, Indonesia

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Abstract. The domestic drywood termite, *Cryptotermes domesticus* (Haviland), has been referred to in past literature as a native species originating in the Southeast Asia region. The species come to prominence due to its destructive damage to a dried wood log by creating passages and nests inside the wood. Its economic importance makes the species one of the monitored species in inter-island transport as part of a biosecurity initiative by the Indonesian Government. In the present study, we collected drywood termites’ specimens from four locations in Riau Province, Sumatra Island, and conducted morphological identification. In the end, we verify the presence of *C. domesticus* in all four sites studied. This finding establishes the continued presence of the species in Sumatra, one of the areas reported as the native distribution of the species other than Java and Kalimantan following the Holmgren reports in 1913. We believe this report can be an addition to the current status of *C. domesticus* in Sumatra and also be an addition to the biosecurity initiative list of monitored species regarding the *C. domesticus* native range in Indonesia.

1. Introduction
The most invasive pest species of termites are generally those that have been introduced into new geographical areas, mostly as a result of anthropogenic activity [1]. Evans et al. [2] argued that wood-feeding drywood termites that nest and feed in a piece of wood are the most easily transported and spread globally since their presence inside wood is very difficult to detect and control [3, 4, 5, 6, 7, 8]. Drywood termites are known for the damage they cause on wooden material due to their nesting biology, which necessitates sprawling tunnel-building activity in the wood [9, 10]. This tunneling invariably impacts the wood, from weakening the overall wood structural strength to total destruction [11, 12, 13].
Drywood termites are also prevalent in Indonesia, with several of them, such as *Cryptotermes cynocephalus*, *C. domesticus*, and *C. dudleyi* originating in Indonesia or Southeast Asia in general [8, 14]. While no comprehensive assessment on the economic cost incurred by these species in Indonesia so far, its presence warranted monitoring oversight due to biosecurity concern which is handled by the Agricultural Quarantine Agency (Barantan) of the Ministry of Agriculture – Republic of Indonesia. Barantan’s species monitoring is based on the Quarantine Plant Pest Organisms (OPTK) regulation, which lists restricted or prohibited species to be transported into the country or inter-island transport. The list is divided into two categories; A1 category listed species that are not yet present in Indonesia, and the A2 category listed species that are present in only some parts of Indonesia, according to the regulation of the Minister of Agriculture (Permentan), Republic of Indonesia.

According to the Permentan Number 31 (2018), *C. domesticus* was enlisted to the A2 category with existing distribution in Java and Kalimantan (Borneo) but was not yet distributed in Sumatra (see the Permentan 31, p.1305, 2018). However, Holmgren [15] had reported in 1913 that *C. domesticus* was distributed in Sumatra, precisely in Deli, Eastern Sumatra, and Krakatau Island. Since then, some surveys have been conducted and recovered *C. domesticus* in Sumatra (table 1). Important reports on the presence of *C. domesticus* in Indonesian islands are presented in table 1.

**Table 1.** Selected reports on *C. domesticus* distribution in the Indonesian archipelago.

| Distribution in Indonesia | References                                                                 |
|---------------------------|---------------------------------------------------------------------------|
| Java                      | Kalshoven, 1960; Araujo, 1977; Abe, 1984; Abe, 1987; Thakur and Thakur, 1992; Ahmad and Akhtar, 2002 |
| Sumatra, Krakatau          | Holmgren, 1913; Oshima, 1923; Snyder, 1949; Tu, 1955; Roonwal & Matti, 1966; Araujo, 1977; Abe, 1984; Abe, 1987; Thakur and Thakur, 1992; Gathorne-Hardy, 2000a; Ahmad and Akhtar, 2002; Gathorne-Hardy, 2004. |
| Kalimantan (Borneo)       | Desneux, 1904 (Borneo, Malaysia); Holmgren, 1913; Bugnion, 1913; Kalshoven, 1960; Gay and Watson, 1982 (Sabah, Malaysia); Baccus, 1987 (Sarawak, Malaysia); Gathorne-Hardy, 2004 |
| Sulawesi                  | Gathorne-Hardy, 2000b                                                    |

Note: The list is curated from the *Treatise of Isoptera* [14]. The bold reference indicates an original survey was conducted in the area.

Recently, a report from Haryati in 2014 [16] also collected *C. domesticus* from Arun, Aceh. Tarumingkeng in 2000 [17] also stated that *C. domesticus* distribution is all over Indonesia. Together with the reports in table 1, these reports indicated that *C. domesticus* is already present in Sumatra for the past century.

To reconcile the Permentan Number 31 (2018) regarding *C. domesticus* and as a regular species monitoring, we surveyed and collected drywood termites’ specimens from four random locations in Riau Province, Sumatra Island, and conducted morphological identification to verify the distribution of *C. domesticus* in Sumatra. The data was expected to be an important reference to update the list of Quarantine Plant Pest Organisms (OPTK) A2 in Indonesia.

2. Materials and methods

2.1. Survey area and sampling process

The survey was conducted in four locations in November 2019, as described in table 2. The infested wood was chopped following the gallery route so that the termites’ individuals, especially soldiers, could be collected. Imago was also collected if it was discovered on site. The collected individual was put into 75% ethanol solution in a tube vial before being examined for its morphological characteristics to determine its species identity.
Table 2. Survey location sites.

| Location | Surveyed Area          | Coordinate         | Targeted wooden structure                                      |
|----------|------------------------|--------------------|----------------------------------------------------------------|
| 1        | Pinang Sebatang,       | Lat: 0.673664512   | Infested wooden chair and table in an abandoned workshop shed   |
|          | Tualang, Siak, Riau    | Long: 101,61905803 |                                                                 |
| 2        | Pinang Sebatang,       | Lat: 0.67919931    | Stacks of infested wood beam stored in a semi-outdoor shed       |
|          | Tualang, Siak, Riau    | Long: 101,61963613 |                                                                 |
| 3        | Pinang Sebatang Barat, | Lat: 0.74814319    | Infested wooden porch floor of an outdoor gazebo                 |
|          | Tualang, Siak, Riau    | Long: 101,63095414 |                                                                 |
| 4        | Mandi Angin, Tualang,  | Lat: 0.77279015    | Infested door and window's wood frames in an abandoned nursery   |
|          | Siak, Riau             | Long: 101,52290292 | office                                                            |

2.2. Species identification

The species identification process was conducted by matching the morphological characters observed under the light microscope. We assessed five random specimens for each location from our samples collection and then observed their morphological characters such as head and mandible dimension, antenna articles, and general head shape features. These characters were then matched with the available species termites’ keys.

The keys used in this study were Key to the Indomalayan Termites by Ahmad [18], A generic revision and phylogenetic study of the family Kalotermitidae (Isoptera) by Krishna[19], A taxonomic and biometric study of the genus Cryptotermes (Isoptera: Kalotermitidae) by Bacchus [20], and Termites of the genus Cryptotermes Banks (Isoptera: Kalotermitidae) from the West Indies by Scheffrahn & Krecek [21]. The overall figure comparison was also made by matching the sample figures with reports on *C. domestica* by Scheffrahn & Krecek [21] and Walker (termite database of Pest and Disease Image Library (PaDIL) on *C. domestica* published in 2006).

3. Results

All infested wood samples from the four locations surveyed in this study were positively confirmed to be infested with *C. domestica*. We also found another species of drywood termites from Location 2 (table 1), which was identified as *C. dudleyi* (specimen figures are not shown in this publication). The survey specimen figure representative from one of the locations, a validated specimen voucher figures of *C. domestica*, and the current specimen re-drawn figure are shown in figure 1.

These features are shown in figure 1, especially the subquadrate dark yellow head with the sharp drop of frontal flange and the prominent single tubercle/genal horn that is much larger, and the frontal horn distinguishes it from other *Cryptotermes* species. The rest of the features, such as the pentagonal labrum with a width longer than length, short-wide mandible with a pointed tip that bends inside, fit the key to this species. Darker coloration in our specimen was due to diluted preservation solution (ethanol 75%) caused by sample overabundance in a tube vial.

The head dimension and the antenna measurement also closely matched the reference prescribed in the keys. These measurements are shown in table 3. It seems that small differences in a range of head length and width in our specimens compared to the reference measurement can be attributed to regional cases of different growth patterns, and for some extent, the mandible position during measurement can also affect the measurement. However, as specimen figures had shown in figure 1
and its overall features matching the reference specimen, it is clear that the specimen recovered in this survey belongs to *C. domesticus*.

![Figure 1](image)

**Figure 1.** (A) A representative specimen of soldier caste termites recovered from one of the surveyed areas with the specimen head’s features from left-to-right: dorsal, lateral, and front-lateral with features annotation. (B) Above: *Cryptotermes domesticus* soldier head’s features with detail from left-to-right: dorsal, lateral, and front-lateral as showed by Scheffrahn & Krecek [21]. Below: The same detail but from Pest and Disease Image Library (PaDIL) by Walker (2006) with the picture taken by N. Heather det. F. Gray in 1964 in Tulagi, Solomon Island (C) Re-drawn figures of the *C. domesticus* soldier caste head, from top-to-bottom: dorsal and lateral view. The scale bar is 1 mm in length.

### Table 3. Head and pronotum dimension comparison for *C. domesticus*.

| Measurement                        | Reference | Loc.1       | Loc.2       | Loc.3       | Loc.4       |
|------------------------------------|-----------|-------------|-------------|-------------|-------------|
| Head length (HL)                   | 1.77-1.80 | 1.713 ± 0.056 | 1.668 ± 0.090 | 1.685 ± 0.082 | 1.695 ± 0.060 |
| with the mandible (mm)             |           |             |             |             |             |
| Head length (HL) (mm)              | 1.35-1.61 | 1.365 ± 0.041 | 1.303 ± 0.071 | 1.317 ± 0.091 | 1.370 ± 0.035 |
| Head width (HW)(mm)                | 1.03-1.35 | 1.249 ± 0.030 | 1.245 ± 0.071 | 1.191 ± 0.072 | 1.247 ± 0.032 |
| The ratio of HW/HL                  | 0.91-1.02 | 0.915 ± 0.018 | 0.956 ± 0.014 | 0.905 ± 0.010 | 0.911 ± 0.028 |
| Pronotum length (mm)               | 0.6-0.7   | 0.685 ± 0.035 | 0.655 ± 0.081 | 0.657 ± 0.031 | 0.703 ± 0.012 |
| Pronotum width (mm)                | 1.1-1.3   | 1.233 ± 0.074 | 1.159 ± 0.107 | 1.150 ± 0.085 | 1.216 ± 0.049 |
| Antenna articles                   | 11 to 14  | 11 to 13    | 11 to 12    | 11 to 14    | 12 to 14    |

Note: The measurement is in mean ± standard deviation format. All measurements from the four locations were from 5 individuals except for Location 2 which had only four individuals. Reference measurement and dimension were composite with HL+ mandible, pronotum length, and width from Hozawa in Ahmad [18]. HL, HW, and the ratio for HW/HL come from Bacchus [20].
4. Discussion
Our study confirmed a long-standing finding since Holmgren’s report regarding the presence of *C. domesticus* in Sumatra [15]. As six past studies had indicated on the presence of *C. domesticus* in Sumatra for the past 100 years, see bolded reference for Sumatra in table 1, and what our current survey had recovered in Riau province, the presence of *C. domesticus* in Sumatra is not a recent phenomenon with the species already established in the area for a long period. This finding established that monitoring *C. domesticus* in wood commodities coming from other islands to Sumatra as part of category A2 pest species is not viable since the species is already established and considered native species in Sumatra, as reported by past studies [14].

The results from this study were important as a factual verification of the current distribution of *C. domesticus* in Sumatra to update the list of Quarantine Plant Pest Organisms (OPTK) category A2, which was outlined in the Regulation of the Minister of Agriculture (Permentan) Number 31 (2018). In light of this study and past literature review, the Regulation of the Minister of Agriculture (Permentan) Number 25 (2020), which is the updated regulation of the Permentan Number 31 (2018), had removed *Cryptotermes domesticus* from category A2 OPTK list due to the consideration that the species is a native species across Sumatra, Java, Kalimantan, and Sulawesi. This study can also be presented to reflect the importance of science-based policy and how intra-governmental offices communicate to create updated policies and regulations.

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