Captive reproduction of timor monitor, *Varanus timorensis* (Gray, 1831) in Indonesia

E Arida1*, Mulyadi1 and N W Handayani2

1Museum Zoologicum Bogoriense (MZB), Indonesian Institute of Sciences (LIPI), Jalan Raya Bogor-Jakarta km 46, Cibinong 16911, Indonesia
2Directorate of Biodiversity Conservation(KKH), Ministry of Environment and Forestry Gedung Manggala Wanabakti Blok 1 Lantai 8, Jalan Jenderal Gatot Subroto, Jakarta 10270, Indonesia

* Corresponding author: evya001@lipi.go.id

Abstract. *Varanus timorensis* is an endemic species of Monitor lizards in Indonesia. Distribution areas of the species are restricted to a few islands in the Lesser Sundas and protection for conservation is given through a legal status in the Peraturan Pemerintah Nomor 7 Tahun 1999. Successful breedings have been reported outside Indonesia and we attempt for the first time to report efforts to breed this species in captive environments in Indonesia. We conducted inspections at five reptile breeding facilities in Java between 2017 and 2018. Using information and data obtained from interviews with owners and/or managers, we estimate production capacity for each facility and compare with export permit data. We found sufficient breeding infrastructure in all five facilities and parental stocks at F0 and F1 levels were recorded by legal documents issued by the Biodiversity Conservation Directorate of Ministry of Environment and Forestry to ensure no additional animals are stocked from the wild. Estimates of individuals produced in breeding facilities is lower than minimum estimates of production capacity. We found no breeding records were available during inspections. Therefore, Management and Scientific Authorities should carry out regular inspections and collect direct reproductive data, for example once or twice per year.

Keywords: breeding, captive, conservation, pet trade, reproduction

1. Introduction

The Timor monitor, *Varanus timorensis*, was first described as *Monitor timorensis* [1] and later revised to be as *Varanus timoriensis* [2]. The taxonomy of the Timor monitor remains to be resolved and yet a holotype needs to be assigned for this species, which is a close relative to the Australian *V. similis* and *V. scalaris* (Pianka et al., 2004) and the endemic *V. auffenberyi* from Rote, Indonesia. Known distribution areas for *V. timorensis* in Indonesia are the island of Timor and three small islands nearby, i.e Semau, Sabu, and Rote [3].

Because the Timor monitor is protected under Indonesian law, i.e Government Regulation Number 7/1999 with the updated list of species under protection in Decree of Minister of Environment and Forestry Number 20/2018,92/2018 and 106/2018, this species is only legally exported from a captive breeding programme. At least second generation (F2) individuals are allowed for exports. Otherwise,
first generation (F1) individuals produced in captivity in a manner of captive breeding programme may be traded internationally with legality.

Little is known regarding captive breeding programmes of the Timor monitor in Indonesia, although successful ones were reported previously from zoos and private collections in Europe and USA [4]. We report results from our observation of five reptile captive breeding facilities in West Java as a preliminary information on the efforts to breed Timor monitors in Indonesia.

2. Materials and methods

Our observations were conducted during a series of inspections at five nationally registered facilities between February and March 2018 and in October 2018 in West Java. In some of these facilities, the Timor monitor has been involved in captive rearing since 1995. Previous farm inspections had been performed in the past; however data collection was not undertaken until October 2017. The rarity of data collection is due to the bureaucratic intricacy in accessing captive breeding facilities for research purposes.

We obtained information on the reproduction of captive Timor monitors during our inspections at the facilities using the Data Collection Form recommended by CITES Secretariat (available at https://cites.org/sites/default/files/eng/prog/captive_breeding/E-InspectionGuidance-FINAL.pdf). Five reproductive parameters were applied during inspections, i.e number of adult females, number of clutch per year, number of eggs per clutch, percentage of breeding females, and percentage of surviving hatchlings. Because no breeding records were available at all five farms, we could not determine generation levels of parental stocks. Original parental stocks (F0) were documented in the breeding permits issued by KKH, whereas first generation (F1) individuals were reported periodically as they were produced. However, it was impossible to identify the generation groups as none of the individuals were tagged and animals were introduced to different mates or housed in communal enclosures. Therefore, we focused to look at potential production only.

Along with interviews with owners and/or managers, we checked several aspects of captive breeding requirement in each facility i.e enclosures, incubators, feed, medical care, and breeding records. We also asked facility responsibles to show legal documents for obtaining parental stocks.

We summarized results of our interviews and compared with available data from successful breeders in Europe (table 1). This information from facility owners/managers may be used as reference for the next inspections in the following years.

3. Results and discussion

3.1. Summary of information on captive reproduction in Indonesia

In general, mating seasons for Timor monitors in all five facilities occurs between May and August within a year, followed by a short period of 3-4 weeks when females lay their eggs at different times of the day. Incubation can take place for as long as 135 days (about 4.5 months) or shorter (table 1), depending on consistency of temperatures in the incubators of each farm. On the other hand, previous published reports have shown that Timor monitors breed at variable periods with possibly a pause around autumn and winter in the northern hemisphere. Females are likely stop laying their eggs in winter and have been observed to lay eggs in February [5], March, April and June [6], as well as between August and September [7]. These eggs hatched in June [4, 8], October [6], and December [7].

Based on some of these reports, the incubation period in captivity may take 3 to 4 months [5-7]). More specifically, wild-caught animals kept in a private collection in Europe hatched after about 4 months or 117 days at 29°C of incubation temperature [8].
Table 1. Summarised information on captive reproduction of Timor monitors in Indonesia.

| Range (literature) | Reproductive parameters | Range (this study) |
|--------------------|-------------------------|--------------------|
| 1                  | clutch number per year  | 1-2                |
| 3-14               | clutch size (eggs per female) | 5-11            |
| 0-4                | number of hatchlings per female | 1-7            |
| December-January   | breeding season         | May-August        |
| 93-186             | incubation period (days) | 90-135           |
| 27-34              | incubation temperature (°C) | 29-32          |

There were no eggs at all five farms during our visit in early 2018 presumably because it coincided with period before mating season started (table 1.). We found juvenile specimens that hatched in December 2017 were available for inspection (figure 1). Presence of these juveniles in captivity suggest that eggs were laid as early as in August 2017 for an incubation period of about 135 days, and as late as in September 2017 for a shorter incubation period of about 90 days.

![Figure 1. (a) Juveniles of 3 month-old in a holding box (b) A juvenile with formulated feed.](image)

We took a note that between August and September females laid their eggs in all five facilities, where enclosures for this species are furnished with various materials for substrate and shelters. Females laid their eggs anywhere on the substrate in the enclosures (figure 2), such as in dry bark or inside artificial shelters made from bamboo stems or plastic buckets filled with sand and covered with a sheet of plywood. Eggs were collected by farm staff and kept in an incubation room at relatively constant temperatures that range from as low as 29°C in one farm and as high as 32°C in another. Juveniles were exported at about 2 weeks old, when they started to feed on crickets. Export managers of the farms stated that some of the specimens were larger than hatchling-size when exported, with an age estimate of 2-3 months old.

Following interviews with all five breeders, we noted that reproduction for captive Timor monitors in Indonesia can occur up to twice per year (table 2). Two clutch per year may increase production capacity for these facilities, which was assessed for their possibility of production. Captive reproduction data were calculated in table 2 using the Production Capacity Calculator in the Guidance for Inspection of Captive Breeding and Ranching (downloaded from https://cites.org/sites/default/files/eng/prog/captive_breeding/E-InspectionGuidance-FINAL.pdf), in order to estimate minimum and maximum production for each breeder in 2017.
Figure 2. (a) An adult with eggs in an enclosure (b) and (c) Eggs in a box in incubator room.

Table 2. Reproductive characteristics of Timor monitor in captive breeding facilities in Indonesia.

| Breeder | # Adult females | # Clutch /year | # Eggs /clutch | % Breeding females | % Hatchling survival | Total production in 2017 |
|---------|-----------------|----------------|---------------|-------------------|----------------------|------------------------|
| BTA     | 15              | 1-2            | 8-11          | 95                | 90                   | 100                    |
| BSO     | 28              | 1              | 6-10          | 60                | 90                   | 23                     |
| SWI     | 90              | 1-2            | 8-10          | 75                | 80                   | 282                    |
| ASU     | 7               | 1-2            | 7-11          | 60                | 90                   | 12                     |
| DGU     | 22              | 1              | 5-10          | 85                | 85                   | 40                     |
| Mean    | 32.4            | 6.8-10.4       | 75            | 87                | 91.4                 | 55.92                  |
| ±SE     | 16.57           | 0.65-0.27      | 7.70          | 2.23              |                      |                        |

Results are presented in table 3 and compared with Production Plan (Renpro) as another estimate of production, in addition to the number of Export Permits (EP) issued by KKH of Ministry of Environment and Forestry serving as CITES Management Authority in Indonesia in the same year.

Table 3. Production estimates and export permits of Timor monitor from Indonesia in 2017.

| Breeder | Production Capacity (PC) | Production Plan (Renpro) | # Export Permits (EP) | Total Production (TP) in 2017 |
|---------|--------------------------|--------------------------|-----------------------|-----------------------------|
|         | Min | Max | 150 | 90| 100  |
| BTA     | 103 | 282 |     |    |      |
| BSO     | 91  | 151 | 99  | 40 | 23   |
| SWI     | 288 | 1152| 262 | 262| 282  |
| ASU     | 26  | 83  | 50  | 18 | 12   |
| DGU     | 79  | 159 | 163 | 15 | 40   |
| total   | 587 | 1827| 724 | 425| 457  |

The number of EPs issued in 2017 is lower than minimum estimate of Production Capacity (PC), suggesting a lower export volume than expected in terms of minimum PC for each breeder. A conservative approach towards export volumes for this species is shown by the total number of EPs issued in 2017 (425) than Total Production (TP) in 2017 (457). On the other hand, Production Plans (Renpros) for Timor monitors are mostly higher than minimum estimate of Capacity, except for one breeder (SWI, table 3). Renpros were higher than minimum capacity because it is calculated by including stock specimens from production in the previous year [9]. In this case, Renpros is a means to regulate export volumes by its setting as the maximum number of specimens allowed for export. A
3.2. Requirements for captive breeding

3.2.1. Enclosures. In general, all five facilities have the required captive breeding settings. All five facilities are established with tall fences, wherein enclosures are provided to house individuals with access to health care by a veterinarian as well as regular maintenance by keepers, such as maintenance of security from predator or escape, thermoregulating sites (shelter and basking platform), food, and water.

Enclosures at CV. Terraria Indonesia dan CV. Pasundan were set in a compound, whereas single enclosures at CV. Prestasi and PT. Alam Nusantara Jayatama were set in rows without a large roof to integrate them into a compound (figure 3). The latter was similar for PT. Mega Citirindo but the single enclosures were arranged as in a garden of a zoological park. Most enclosures were provided with plants and a platform, in order to allow some cover and basking area for lizards during thermoregulation. Additionally, they were also equipped with a climbing area as well as a water bowl and a basin to place their feed. However, lizards may be kept in large plastic containers with a lid that has holes for exchange of air.

3.2.2. Incubators. All five facilities have incubator rooms with controlled temperature and humidity (figure 4). After hatching, emerging juveniles were kept in a separate room close to their incubator.
3.2.3. **Feed.** Timor monitors were provided with insects as they are at juvenile stage; however, after two months they take formulated feed that are made of kitchen waste. Adult individuals were fed with mice or at CV. Pasundan alternatingly with formulated feed (Figure 5). All feed types were produced in house.

![Food items provided for Timor monitors were produced at the farms: (a) mice (b) mealworm (c) crickets.](image)

**Figure 5.** Food items provided for Timor monitors were produced at the farms: (a) mice (b) mealworm (c) crickets.

3.2.4. **Breeding records.** No breeding records were available during our inspections at all five facilities. Therefore, implementation of the law on guidance for generating breeding records, i.e Peraturan Dirjen KSDAE Nomor P.4/ 2017 is being recommended in order to better track the different generations produced in captivity. Additionally, regular reporting to both Management and Scientific Authorities is crucial as an external control mechanism for consistency of production in each farm.

3.3 **Export data and CITES source code “C”**

Fifteen destination countries for export of Timor monitors include those in the Americas, Europe, East Asia, Southeast Asia, and Africa. The source code “C” used by Indonesia is a great concern for European countries on two levels, i.e likelihood of Indonesian companies to produce captive bred animals is low and reported number of exported specimens were falsified [10]. Suspicion on laundering of wild-caught animals seems to have been put forward for various species of animals exported from Indonesia, including the Timor monitor that are being traded in high volumes for many years. Our assessment shows possible signs of captive breeding for this species in Indonesia. Firstly, sufficient breeding infrastructures are available in all five facilities, i.e. suitable enclosures, variable feedstock, incubators/incubation rooms, and separate rooms to keep hatchlings. Secondly, parental stocks at F0 and F1 levels were recorded by legal documents issued by KKH of Ministry of Environment and Forestry. Thirdly, the number of total production in 2017 is lower than minimum estimate of production capacity (minimum PC). It seems that all five farms can basically produce captive bred individuals. More specifically, mass production is supported by enclosure settings that are manipulated to allow for random parental animals to pair at any time of the year. Successful captive breeding in Europe for this species probably used a few deliberately paired parental animals. The likelihood of farms to produce offspring in captivity combined with conservative allowances for export shown by EPs for each farm (table 3) seems to be irrelevant to false reporting. However, there are some discrepancies in the source of data being reported and perception of source codes, as exemplified in table 4. The significant difference between importer’s and exporter’s trade volume data is likely due to the different sources of data used, namely actual head counts by the importers and gross number of issued export permits by Indonesia as the exporting country. Nevertheless, importers’ data on animals with source code “F” still require a justification.
Table 4. CITES reports of international trade in live Timor monitors from Indonesia.

| year | importer | exporter |
|------|----------|----------|
|      | C  F  | C  F  |
| 2014 | 410  25 | 800  0 |
| 2015 | 572  24 | 599  0 |
| 2016 | 626  0  | 832  0 |

4. Conclusion

Production of captive bred Timor monitors in five inspected reptile breeding farms in West Java is a possibility that needs further investigation. For the time being, it is unlikely to verify status of individuals as being produced in captivity. Given information on the reproduction of this species from owners and/or managers of these farms, we need to sample all five facilities at least during breeding seasons as well as at the periods when eggs will be hatching. We propose that breeding records are compulsory for tracking down yearly productions as well as parental status of individuals produced in captivity. Multiple samplings during future inspection series will be necessary before a conclusion of captive breeding for this protected species in Indonesia.

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