The presence of potentially invasive alien plant species in Laiwangi-Wanggameti National Park and vicinity, Sumba, Indonesia

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Abstract. The study was aimed at providing data on the presence of potentially invasive alien plant species in Laiwangi-Wanggameti National Park and vicinity. The study was conducted using the taxonomic data collection methods, which took place in Laiwangi-Wanggameti National Park and vicinity, East Sumba, Indonesia. The plant material was collected for herbarium specimens and shipped to Herbarium Bogoriense for processing and identification. One hundred and four species of plants were collected in Laiwangi-Wanggameti National Park and vicinity. Of those collections, three invasive alien plant species were identified in the national park: Austroeupatorium inulifolium, Melastoma malabathricum, and Thespesia lampas. Another one was Jatropha gossypiifolia found outside the national park.

1. Introduction

Sumba Island is one of the members of Lesser Sunda Islands (LSI) located in the south part of Flores Island and administrated to East Nusa Tenggara Province, Indonesia. Sumba Island has a unique ecosystem because the area is dominated by savannas; however, several areas are covered by the lower-montane forest. Some areas of lower-montane forest are designated as a protected area, such as in Laiwangi-Wanggameti National Park (NP), East Sumba. This NP was appointed based on an Act of Forestry Ministers no. 576/Kpts-II/1998 on 3 August 1998, covering about 47,014-hectare areas [1]. This NP was reported having a relatively high plant diversity compared to other areas in Sumba Island. Some endemic floras of LSI were also reported occurring at this NP, for example, Dinochloa kostermansiana S.Dransf. [2–4] and Schizostachyum purpureum Damayanto & Widjaja [5].
Some spots of Laiwangi-Wanggameti NP area are occupied by enclave communities. Enclave is the ownership of third party rights in a forest area, which can be the settlements and/or an arable land [6] surrounded by forest. An enclave area usually consists of some open areas used for plantations and roads. An open area of the NP in Indonesia is always occupied by invasive alien plant species, and these invasive plants can eliminate the native species there [7].

Invasive alien species are plants, animals, microorganisms, and other organisms that are not part of the natural ecosystem, damage the ecosystem and environment, as well as with a negative impact on biodiversity and human health [8]. The impact of invasive species for the ecosystem is huge, dangerous and usually runs continuously [7]. Some invasive plants can be an inhibitor for a native plant to sprout and occupied a large area [9]. Besides, an invasive plant might release allelopathy, an inhibitor substance for the other plants to grow [10–12].

Study on invasive alien plant species in Indonesia has been conducted in several NPs such as in Tanjung Puting NP [7], Gunung Gede-Pangrango NP [13–17], Gunung Halimun-Salak NP [9, 17], Bali Barat NP [18], Ujung Kulon NP [19], Alas Purwo NP [20], Gunung Merapi NP [21, 22], Bukit Barisan Selatan NP [23–27], Baluran NP [28, 29] and Way Kambas NP [30]. There is no information on the presence of potentially invasive alien plant species in Laiwangi-Wanggameti NP, whereas this NP has the enclave communities. However, studies on flora diversity such as mosses, ferns, and bamboos have been conducted in this NP [5, 31–34]. The study was aimed at providing data on the presence of potentially invasive alien plant species in Laiwangi-Wanggameti NP and vicinity. This information can be used as preliminary data to prevent the invasion of invasive alien species in Laiwangi-Wanggameti NP in the future.

2. Materials and methods
The exploration took place in Laiwangi-Wanggameti NP and vicinity in April-May 2016. Laiwangi-Wanggameti NP is located in East Sumba, East Nusa Tenggara, Indonesia, and covers three sub-districts areas: Tabundung, Paberiwai, and Pinu Pahar [34]. Geographically, Laiwangi-Wanggameti NP is located at 9°58'S to 10°00’S and 120°00’E to 120°22’E [1] and reaches about 1,225 m above sea level.

The study was conducted using a taxonomic data collection method [35]. Through this method, materials of fertile plants were collected by exploring the research site along the forest trails. The plant materials were collected for herbarium specimens and supporting data (such as location, coordinate, altitude, local names, etc.) were also recorded. The plant materials were labeled, inserted in a newspaper, and moistened with rubbing alcohol before sent to the Herbarium Bogoriense (BO) for further processing [36] and deposited there. The herbarium specimens were identified by matching with literature and BO specimens. The presence of potentially invasive alien plant species was determined using some kinds of literature; [7–30, 37–43]. A map of the spot of the presence of the potentially invasive alien plant species in Laiwangi-Wanggameti NP and vicinity was provided using software ArcMap v.10.2 for Microsoft Windows [44].

3. Results and discussions
One hundred and forty number collections of the plants were collected from Laiwangi-Wanggameti NP and vicinity. Of these collections, there were 104 species and 50 families identified. Only three species were identified as potentially invasive alien plant species in Laiwangi-Wanggameti NP [Austroeupatorium inulifolium (Kunth) R.M.King & H.Rob., Melastoma malabathricum L. and
Thespesia lampas (Cav.) Dalzell], while one species (Jatropha gossypiifolia L.) was found outside of the NP (Table 1).

All potentially invasive alien plant species found in Laiwangi-Wanggameti NP were reportedly invading some other national parks in Indonesia (Table 2). Austro eupatorium inulifolium, which was easily dispersal by the wind, was often found in national parks [9, 12, 15, 20, 24, 25] followed by M. malabathricum [7, 13, 24, 30]. Moreover, both species were also found outside the National Park [12, 40, 41]. Austro eupatorium inulifolium and M. malabathricum need special attention by national park staff for its eradication methods. It is found that the authorities of Laiwangi-Wanggameti NP need more attention to those species. Those species may invade the NP in the future. Unfortunately, there is no study conducted on the population density of those species at the sampling location because no ecology plot was made and observed. However, the appearance spot of the potentially invasive alien plant species in Laiwangi-Wanggameti NP and vicinity is provided on a map in Figure 1.

**Table 1.** Potentially invasive alien plant species in Laiwangi-Wanggameti National Park and vicinity, East Sumba, Indonesia.

| Species (Family)               | Location                                      | Native areas       | Local names | Habitat                                      |
|-------------------------------|-----------------------------------------------|--------------------|-------------|----------------------------------------------|
| Austro eupatorium inulifolium  | Katikui, surrounding Ampupu forest, 1.021 m  | Tropical America   | Taikabala   | Open area near the road, dry soil            |
| (Asteraceae)                  | alt, 10°04’44.5”S 120°14’14.5”E                |                    |             |                                              |
| Melastoma malabathricum       | Ds. Praing Kareha, along the road from        | Subtropical to     | -           | Open area near the river                      |
| (Malastomataceae)             | Loku Ahu River to Kakatua watching area,     | Tropical Asia and  |             |                                              |
|                               | 347 m alt, 10°03’54.2”S 120°04’19.9”E         | Australia          |             |                                              |
| Thespesia lampas              | Katikui, surrounding Ampupu forest, 1.021 m   | Asia               | Kauwau      | Open area near the road, dry soil            |
| (Malvaceae)                   | alt, 10°04’44.5”S 120°14’14.5”E                |                    |             |                                              |
| Jatropha gossypiifolia*        | Kec. Tabundung, Ds. Pindu Hurani Beach, 1 m   | Tropical America   | -           | Open area near the beach                     |
| (Euphorbiaceae)               | alt, 10°02’07.3”S 119°59’55.0”E                |                    |             |                                              |

* Outside of the Laiwangi-Wanggameti NP

The number of potentially invasive alien plant species in Laiwangi-Wanggameti NP is quite low compared to several national parks in Indonesia (Figure 2). So far, Alas Purwo NP was reported having the highest number of invasive alien plant species (50 species) in Indonesia [20]. The smallest number of invasive alien plant species found was in Ujung Kulon NP [19] with three species. Those data may not reflect the actual situation. Some explorations of invasive alien plant species in several Indonesian NPs have not been comprehensive because Indonesia has so many NPs and some of them are large and remote areas. There are at least 50 NPs that exist in Indonesia [1]. On the other hand, some remote areas of the NP are unexplored, and the invasive alien plants are under-collected, as well as it is occasionally challenging to conduct exploration in NP due to some regulations enforced.

Austro eupatorium inulifolium (Figure 3a) was found in many places in highland areas [12]. In Laiwangi-Wanggameti NP, A. inulifolium was found in the Katikui area with an altitude of 1,021 m. The habitat of A. inulifolium in this NP was along the road near Katikuwai Shelter and found in...
open areas with dry soil. The habit of this species is shrubs about 2 m high (up to 6 m high [12]) with a white flower. The vernacular name of this species in East Sumba is taikabala (Wanggameti Village). Meanwhile, this species is known as daun tanah (Sumatra and Indonesia) [24], nampong, ki papatong, or ki rinyuh (Sudanese) in Java [12].

Table 2. Invasive alien plant species (A. inulifolium, M. malabathricum, T. lampas, and J. gossypifolia) in Indonesian National Parks.

| Species            | National parks                          |
|--------------------|-----------------------------------------|
|                    | Bukit Barisan Selatan | Gunung Gede-Pangrango | Gunung Halimun Salak | Alas Purwo | Way Kambas | Tajung Puting | Baluran |
| A. inulifolium     | ✓                        | ✓                      | ✓                    | ✓          | -          | -            | -       |
| M. malabathricum   | ✓                        | ✓                      | ✓                    | ✓          | ✓          | ✓            | -       |
| T. lampas          | ✓                        | -                      | ✓                    | ✓          | -          | -            | ✓       |
| J. gossypifolia    | -                        | -                      | -                    | -          | -          | -            | ✓       |

Figure 1. Spot of the presence of the potentially invasive alien plant species in Laiwangi-Wanggameti National Park and vicinity.

Originally, A. inulifolium comes from tropical America [12, 20]. The native range of this species covers Argentina, Bolivia, Brazil, Colombia, Ecuador, Guyana, Panama, Paraguay, Peru, Uruguay, and Venezuela. Meanwhile, the alien range covers Australia, Indonesia, Philippines, Saint Helena, Sri Lanka, and Taiwan [45]. In Indonesia, A. inulifolium reportedly invaded Gunung Gede-Pangrango NP [12–14, 17, 46] and was dominant in the Bodogol resort of this NP [15]. This species also invaded the Wornojiwo forest at Cibodas Botanic Garden [39], Gunung Halimun Salak NP [9], Alas Purwo NP [12, 20] and Bukit Barisan Selatan NP [24]. Outside of the NP, this species was found in Bengkulu and West Sumatra [41] and mostly in at the high elevation area such as at West Java (Tajur, Bogor and Mt. Tangkuban Perahu) and Yogyakarta (Cangkringan and the foot of Mt. Merapi) [12].
Austroeupatorium inulifolium is an aggressive species that rapidly colonizes areas cleared for agricultural fields, wastelands, fallow fields, and roadsides [45]. Therefore, A. inulifolium can be a serious weed where it forms very dense thickets and threatens the seedling of native plants to get a place, nutrition, and light. Short-term eradication of A. inulifolium in forestry can be done by cutting the plant before flowering, and it needs to be conducted three times in good growth condition [45]. On the other hand, this species can be sprayed with a selective herbicide such as triclopyr. Species A. inulifolium that grows in dense stands can be killed with glyphosate. The mechanical removal is the last method for massive seed banks and the rapid growth of A. inulifolium on the disturbed ground, although this species is easily uprooted.

Melastoma malabathricum (Figure 3b) was reported occurring at an altitude of 1,400 m [13]. This species, however, was found at an altitude of 347 m along the road from Loku Aha River to Katakua watching area in Laiwangi-Wanggameti NP. The habit of M. malabathricum is shrub 1.5-3 m high or small tree up to 5 m high [47] with a purple flower. There was no vernacular name of this species in Sumba. Meanwhile, the vernacular name of this species is senduduk in Tanjung Puting NP [7] or sikeduduk in Jambi [40] and herendong in Bukit Barisan Selatan NP [24].

Taxonomically, the accepted name of M. malabathricum is quite complicated. Meyer [47] has sunk the Australian native Melastoma species, M. affine D.Don, into M. malabathricum on his work: “a revision of the Southeast Asian genus Melastoma.” This revision, however, is not accepted in Australia, where the only native species is considered to be M. affine [48]. On the other hand, Tjitrosoedirjo et al. [12] never use M. malabathricum as an accepted name on their work. Instead, they use M. affine.

Melastoma malabathricum originally comes from Asia and becomes an invasive species in the world [13]. This species was reported occurring in Mauritius, Seychelles, South and Southeast Asia, South China, Taiwan, South Pacific Ocean (Micronesia, Melanesia, and Polynesia) and Australia [47]. In Indonesia, M. malabathricum was reported being invasive at Pondok Ambung area in Tanjung
Puting NP [7], Gunung Gede-Pangrango NP [13], Bukit Barisan Selatan NP [24], Way Kambas NP [30] and Taman Hutan Kenali, Jambi [40]. Author (IPGPD) also found this species during the exploration to Riau Archipelago (the Islands of Kera, Baran, Sugi and Karimun Anak) and Banggai Kepulauan (Peleng Island). This species is an aggressive pioneer plant due to the ability to germinate quickly and invade open places, landslides, roadside, and paths in the forest [40]. Moreover, this species easily grows in disturbed places (river banks and secondary forests), fallow land, or grasslands [47]. This species also reportedly grows like weeds on agricultural, rubber, coconut, oil palm, and teak fields [40]. This species, however, is known as an Al accumulator plant species [49] and grows well in an open or shade area [40]. There is no information available on the eradication of this species. Borer *Selca brunella* Hampson (Lepidoptera: Arctiidae) obtained from Malaysia and Singapore were introduced to Hawaii in 1966 to control *M. malabathricum* there [50]. Davis & Krauss [50] then reported that *M. malabathricum* and its closely related species sustained severe damage by that borer, and much dieback has been noted, as well as, the flowering and fruiting process of this species has been inhibited in some localities.

![Image](image-url)

**Figure 3.** (a) *Austroeupatorium inulifolium* (b) *Melastoma malabathricum*, (c) *Thespesia lampas* and (d) *Jatropha gossypifolia*, inset: flowers. Photos: (a) V L Y Ngoh, (b) Y M Mambrasar, (c) J D A Stainton and (d) Supriatna.
Thespesia lampas (Figure 3c) was found in the Katikuwai area with an altitude of 1,021 m at Laiwangi-Wanggameti NP. This species was found along the road in an open area with dry soil. The habit of this species is shrubs up to 2 m high with a yellow flower. The vernacular name of T. lampas in Sumba is kawau (Wanggameti). In Java, T. lampas is known as kapasan, kemiren (Javanese), or kapas utan (Indonesia) [8, 12, 24].

The origin of T. lampas is perhaps Asia [12]. This species has reportedly invaded Bukit Barisan Selatan [24] and Baluran NP [12, 41] that replaced the grasslands into a dense shrub in Baluran NP after eradication of another invasive plant: Vachellia nilotica (L.) P.J.H.Hurter & Mabb. [41]. This species was typically a light-loving plant found in Imperata field, teak forest, or secondary forest [51]. The conversion of grassland to dense shrub reduced the productivities of the grass of the animal feed [46]. There is no specific information available about the eradication of T. lampas. The mechanical technique, such as uprooted, is an effective method so far.

Jatropha gossypiifolia (Figure 3d) was found in the Pindu Hurani Beach, the outside area of Laiwangi-Wanggameti NP in an open area at an altitude of 1 m. The habit of J. gossypiifolia is shrubs up to 2 m high with purplish stem, red flower, and green fruit. There is no vernacular name of J. gossypiifolia in Sumba; however, this species is known as jarak ulung in Lampung or jarak merah and jarak kosta in Indonesia [8, 12].

Jatropha gossypiifolia is native to tropical America [12]. It has been introduced as an ornamental plant elsewhere, especially Malesia, and regularly escapes from cultivation [52]. In Indonesia, this species was distributed in Java, Madura, Timor, and Sulawesi [12]. In Sumba, this species may escape to Laiwangi-Wanggameti NP area because several areas of this NP is located near the beach, where this plant was found. Therefore, this species potentially invades the Laiwangi-Wanggameti NP. Jatropha gossypiifolia reportedly invaded Baluran NP [12]. This species can form dense stands that limit the regeneration of native plants [53]. It adapts to different types of habitats but prefers disturbed drylands, savannas, or pasture, and it is often regarded as a pasture weed. There is no information available about the eradication of this species so far. It is believed that the effective method to the eradication of this species is uprooted.

4. Conclusion

There were three potentially invasive alien plant species found in Laiwangi-Wanggameti National Park, namely Austroequatorium inulifolium (Asteraceae), Melastoma malabathricum (Melastomataceae) and Thespesia lampas (Malvaceae). Another one, Jatropha gossypiifolia (Euphorbiaceae), was found outside the national park

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