

THE ECOLOGICAL NICHE OF *DACRYODES BUETTNERI* (BURSERACEAE), A TIMBER TREE IN CENTRAL AFRICA

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TODOU G, ONANA JM, ACHOUNDONG, AKOA A, D'EECKENBRUGGE GC & JOLY HI. 2014. The ecological niche of *Dacryodes buettneri* (Burseraceae), a timber tree in Central Africa. *Dacryodes buettneri* is an important timber tree in Central Africa. Its wood, commercially called ozigo, is sold in domestic and international markets. The species is only occasionally planted, mostly in home gardens. It is locally threatened. To assist in management planning and sustainable in-situ conservation, a study of the geographic distribution and ecological niche of *D. buettneri* was conducted. Data from 218 georeferenced collections were used to describe the geographic distribution. Assimilations based on 19 climatic parameters were used in order to describe the areas where it grew and to determine optimal values of climatic factors. The results showed that there were more collections of *D. buettneri* from Gabon than from neighbouring countries, with only a few collections in southern Cameroon and southern Congo. The modelled optimal rainfall was between 1600 and 2000 mm year⁻¹ and the modelled optimal mean annual temperature, 23.8–25.8 °C. *Dacryodes buettneri* grows at low altitudes, from 0 to 750 m above sea level. The results of this study will be used to optimise strategies for in-situ conservation of populations of *D. buettneri*.

Keywords: Ozigo, potential geographic distribution, natural ecological niche, in-situ conservation

INTRODUCTION

Dacryodes buettneri belongs to the family Burseraceae. It is a species of the upper canopy of evergreen forests and is only occasionally planted in home gardens (Todou & Doumenge 2008). It can reach 50 m in height and 150 cm in diameter (White & Abernethy 1996). It is characterised by hairy leaflets, which are reddish-brown below, distinguishing it from other species of *Dacryodes*. The outer bark of the trunk is golden yellow and peeling in long, wide blades. *Dacryodes buettneri* is a source of timber (ATIBT 1986, Wilks & Issembe 2000). *Dacryodes buettneri* (commercially named ozigo) is considered as one of the top five timber trees. It is especially used for plywood (for boxes, packaging or furniture) and can be sawn into planks for interior joinery, furniture, carpentry, parquetry, interior stairs, vehicle bodies, boat hulls, boxes and poles. Locally, the wood is used for making canoes. It is suitable for papermaking. It is sold in domestic and international markets (Todou & Doumenge 2008). Gabon exported about 1000 m³ of sawn ozigo in 2004, at an average price of

USD243 m⁻³ and 1000 m³ in 2005 at an average price of USD277 m⁻³. In international trade, the wood is less valued and less traded than okoume or *Aucoumea klaineana* (Todou & Doumenge 2008). *Dacryodes buettneri* is also an important fruit tree in Gabon. Its fruits are drupes, purplish at maturity, edible, resembling those of *D. edulis* (Vivien & Faure 1985) but smaller and less valued by the local people. They are not much traded (Todou & Doumenge 2008). The bark and resin are locally used for medicinal purposes (Todou & Doumenge 2008).

Dacryodes buettneri is a gregarious species (Onana 1998). It is common to find up to 11.6 trees ha⁻¹ (Tutin et al. 1994). Due to its abundance, *D. buettneri* seems not threatened but in Cameroon this species is considered threatened due to overexploitation of the forest and the relatively small number of trees (Onana 2008, Todou & Doumenge 2008). At present, the distribution and ecological adaptability of *D. buettneri* are poorly understood. Thus, it is very difficult to envisage reliable in-situ conservation.

The main objective of this study was to assist scientific and technical forest managers and policy-makers in optimising in-situ conservation of *D. buettneri*. The specific objectives were to:

- (1) determine the actual and potential geographic distribution of the species as well as
- (2) study their ecological niche (forest cover, climatic factors and altitudinal preferences).

MATERIALS AND METHODS

Collection of georeferenced data and altitudes

Geographic coordinates (latitude, longitude, and altitude) were obtained from three different sources.

- (1) The geographical coordinates of herbarium specimens kept in six recognised herbaria (National Herbarium of Gabon; National Herbarium of Cameroon; Limbe Botanic Garden; Natural History Museum; Royal Botanic Garden, Kew; Herbarium Missouri) and those described in www.gbif.org were collected. For collections with coordinates not shown or were shown only partially, Google Earth, world-gazetteer.com and diva-gis.org were used to determine or complete these data.
- (2) Herbarium specimens cited in the literature (Aubréville 1962, Onana 2008) with their geographical coordinates were taken into account.
- (3) The geographical coordinates of samples of leaves collected for DNA extraction (stored in the laboratory of Montpellier, France) during missions to Cameroon and Gabon in the framework of the IFORA (Îles Forestières Africaines) project from 2006 till 2010 were considered. These leaf samples collected (with herbaria samples support) were identified using the identification key developed by Lam (1932) and considering the systematic work of Aubréville (1962), Pierlot (1996), Onana (1998, 2008), and Onana and Cheek (2003).

Samples which were multiple georeferenced or already cited in one of the sources were reduced to one. Complete geographical positions (latitude, longitude and altitude) of 218 specimens were compiled.

Analysis of data

Actual and potential geographical distribution

The actual distribution of *D. buettneri* was determined from georeferenced data assigned to each sample using DIVA-GIS software. The potential distribution of the species was modelled from its climatic preferences for the four countries where it occurred. For this, the model of 19 climatic parameters for *D. buettneri* (Table 1) extracted by means of BIOCLIM (Busby 1991) and DOMAIN (Carpenter et al. 1993), available at DIVA-GIS was used.

Ecological niche and environmental adaptability

The ecological niche of *D. buettneri* was determined on the basis of forest cover, climatic factors (annual precipitation and annual temperature) and altitude of collection sites. From these parameters, maps were made describing the vegetation cover in which the species could grow naturally. Graphs describing the ecological requirements were made on the basis of altitude and climatic parameters using STATISTICA software. Statistical processing was done by descriptive statistics and calculation of the correlation coefficient.

RESULTS AND DISCUSSION

Actual geographical distribution of Dacryodes buettneri

The actual distribution of *D. buettneri* was concentrated in Gabon. This species was characteristic of the centre of endemism of the lower Guinea, where it was observed in four countries (Figure 1). In Gabon, it occurred throughout the country. It was relatively abundant at the edge of the Mount Cristal and Mount Ndjolé. However, it was less common in the northern part of the country. In equatorial Guinea, some populations were present on the mainland, in Bata. In Cameroon, small populations were present in the southern region. They were found along the border with Gabon from Campo to Ambam and south of Djoum, and around the bend of the Dja River. In Congo Brazzaville, populations were found in the southern part of the country, in Conkouati and

Table I Climatic parameters favourable to *Dacryodes buettneri*

Climatic parameter	Mean
Annual mean temperature	24.66 ± 1.05
Mean monthly temperature	9.21 ± 1.10
Isothermality	73.11 ± 4.68
Temperature seasonality	107.10 ± 22.81
Maximum temperature of warmest month	30.91 ± 1.10
Minimum temperature of coldest month	18.27 ± 1.33
Temperature annual range	12.63 ± 1.55
Mean temperature of wettest quarter	24.91 ± 1.18
Mean temperature of driest quarter	23.20 ± 0.95
Mean temperature of warmest quarter	25.68 ± 1.13
Mean temperature of coldest quarter	23.10 ± 0.95
Annual precipitation	1910.84 ± 328.90
Precipitation of wettest month	345.66 ± 61.91
Precipitation of driest month	8.54 ± 12.18
Precipitation seasonality	69.51 ± 6.38
Precipitation of wettest quarter	813.26 ± 151.6
Precipitation of driest quarter	54.20 ± 53.67
Precipitation of warmest month	643.18 ± 119.49
Precipitation of coldest month	72.83 ± 15.26

Values were extracted from BIOCLIM (Busby 1991), available at DIVA-GIS

the sanctuary of Lésio-Louna. Considering the actual geographic distribution and the number of local populations of *D. buettneri* in natural forests of Gabon, the species did not seem threatened by genetic erosion. In Cameroon and Congo Brazzaville, however, few populations of *D. buettneri* were present. It seemed urgent to pay particular attention to keeping the remaining individuals.

The geographical distribution of *D. buettneri* was fairly similar to that of ogoumo (*Lecomtedoxa klaineana*, (Sapotaceae), a timber exploited simultaneously with ozigo in Gabon. However, this species was not found in Congo Brazzaville (Wilks & Issembe 2000). Okoumé (*Aucoumea klaineana*, Burseraceae) occurs naturally in the same region as ozigo. However, *A. klaineana* has also been planted for timber production (in Cameroon, Gabon and Côte d'Ivoire) and in trials (in Congo, Democratic Republic of Congo, Ghana, Madagascar and outside Africa) (Van Valkenburg 2008).

Potential geographical distribution of *Dacryodes buettneri*

Modelling the potential distribution of *D. buettneri* based on climatic preferences (Table 1) showed that central Gabon provided better conditions for the growth of the species than the rest of the country and neighbouring countries. By combining Figure 1 and the distribution of protected areas in Gabon, it appeared that the most favourable areas for *D. buettneri* were in the Lopé National Park, Waka National Park, Irvindo National Park and towards the coast in the forests of Loango and Mokalaba Doudou (Region Makokou). This analysis was consistent with the work of Tutin et al. (1994) who reported the existence of groups of several individuals in the Lope National Park. Since *D. buettneri* was not cultivated (Bourobou Bourobou 1994), the potential geographic distribution modelled from 19 climatic parameters roughly coincided with the actual distribution. However, the predicted

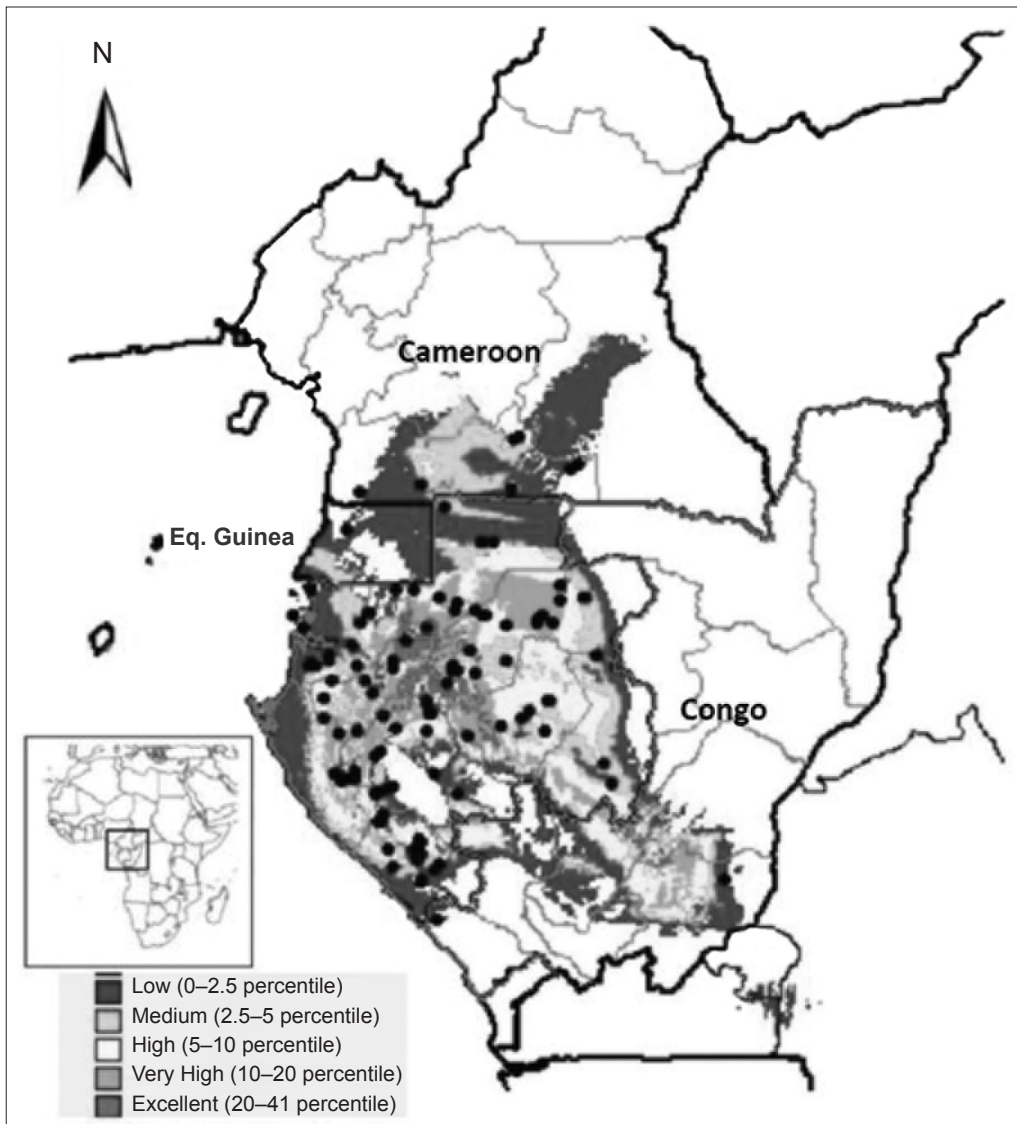


Figure 1 Actual geographic distribution of *Dacryodes buettneri*; red indicates the area that has the most favourable climatic parameters to the natural growth of *D. buettneri*, green represents areas where the probability of finding individuals is low, black points indicate the actual distribution

distribution showed expansions in eastern Cameroon and southern Congo Brazzaville, even though little or no samples had been collected. Surveys indicated favourable areas were necessary to determine the abundance of populations and, where necessary, preserve in-situ the species for sustainable use of this resource. Segura et al. (2003) utilised a similar approach for planning conservation activities of six species of *Passiflora* in the Andes. Similarly, Jarvis et al. (2005) identified six new populations of *Capsicum flexuosum* in Paraguay using the same approach.

Ecology of *Dacryodes buettneri* based on forest cover

Dacryodes buettneri mainly occurs in tropical evergreen forests (Figure 2). In southern Cameroon and Congo Brazzaville, on the other hand, it is very common to find *D. buettneri* in unclosed forest (Figure 2), for instance in association with *Musanga cecropioides* and *Xylopia aethiopica* or in plantations and around houses (Todou & Doumenge 2008). Bourobou Bourobou (1994) observed individuals in degraded forests in Gabon. Thus, he concluded that farmers had

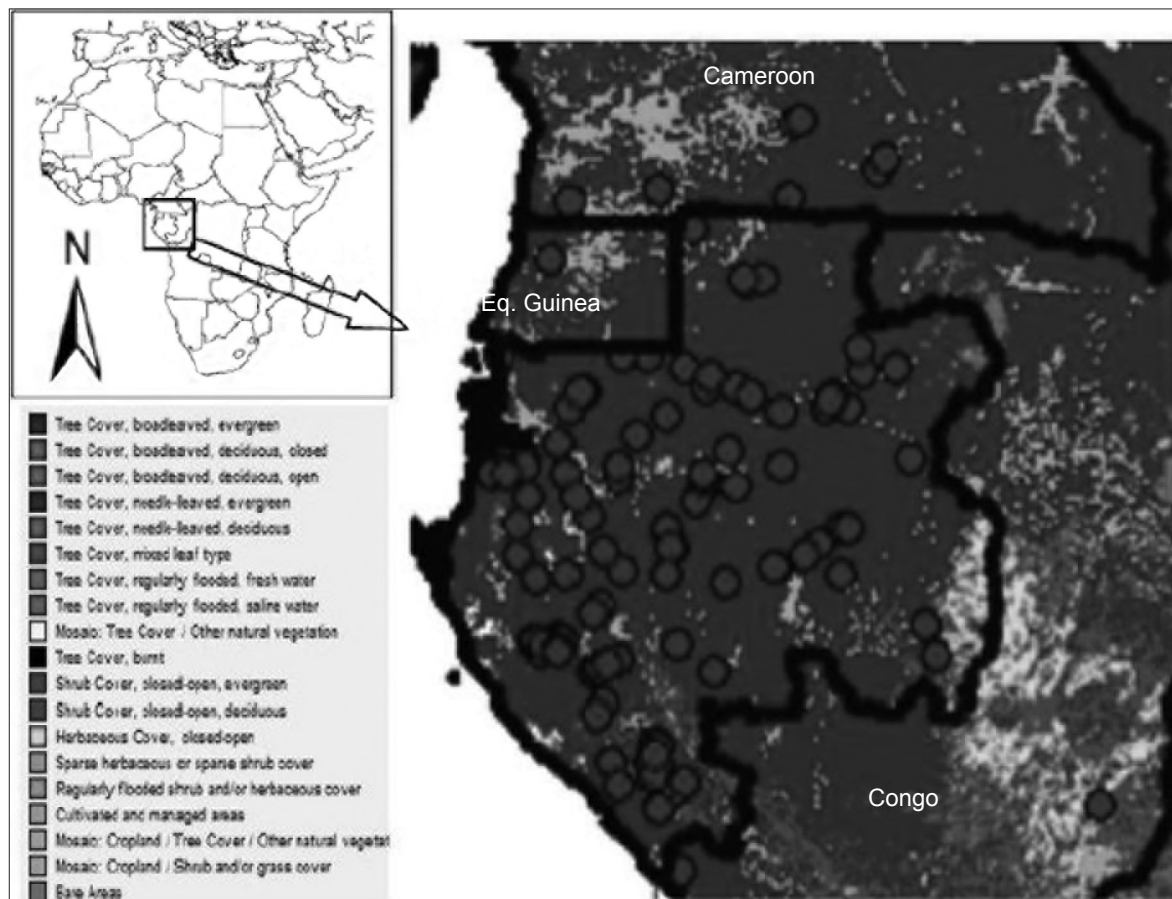


Figure 2 Distribution of *Dacryodes buettneri* and existing vegetation; blue points indicate actual distribution and the vegetation was extracted from DOMAIN (Carpenter et al. 1993) available at DIVA-GIS

individuals of existing *D. buettneri* when clearing for plantations.

Ecology of *Dacryodes buettneri* based on annual precipitation

Assimilations in DIVA-GIS based on annual precipitation of different collection sites indicated that the optimal precipitation of *D. buettneri* was 1600–2000 mm year⁻¹, with confidence interval (95%) of 1500–2550 mm year⁻¹ (Figure 3). According to the model, the species can grow under precipitations of 1000–2600 mm year⁻¹ (Figure 3). These limits were considered the limits of the critical zone. Some individuals were found to grow in areas with a precipitation of up to 3200 mm year⁻¹. However, according to the model, these individuals were considered to be outside the critical zone of annual precipitation. The mean annual precipitation modelled from these data was 1911 ± 329 mm. According to Todou and Doumenge (2008), this species can

grow well on well-drained soil in equatorial or subequatorial climates with an average annual rainfall of 2000–3000 mm.

Ecology of *Dacryodes buettneri* based on mean annual temperature

Assimilations in DIVA-GIS based on mean annual temperatures of different collection sites showed that the optimal mean annual temperatures of *D. buettneri* were between 23.8 and 25.8 °C, with confidence interval (95%) ranging from 23 to 26.2 °C (Figure 4). The calculated mean annual temperature was 24.7 ± 1.05 °C. The critical zone was calculated to range from 21 to 28.5 °C. No individual was observed beyond these limits.

Ecology of *Dacryodes buettneri* based on altitudinal preferences

Figure 5 shows the relationship between altitude and number of observations of *D. buettneri*.

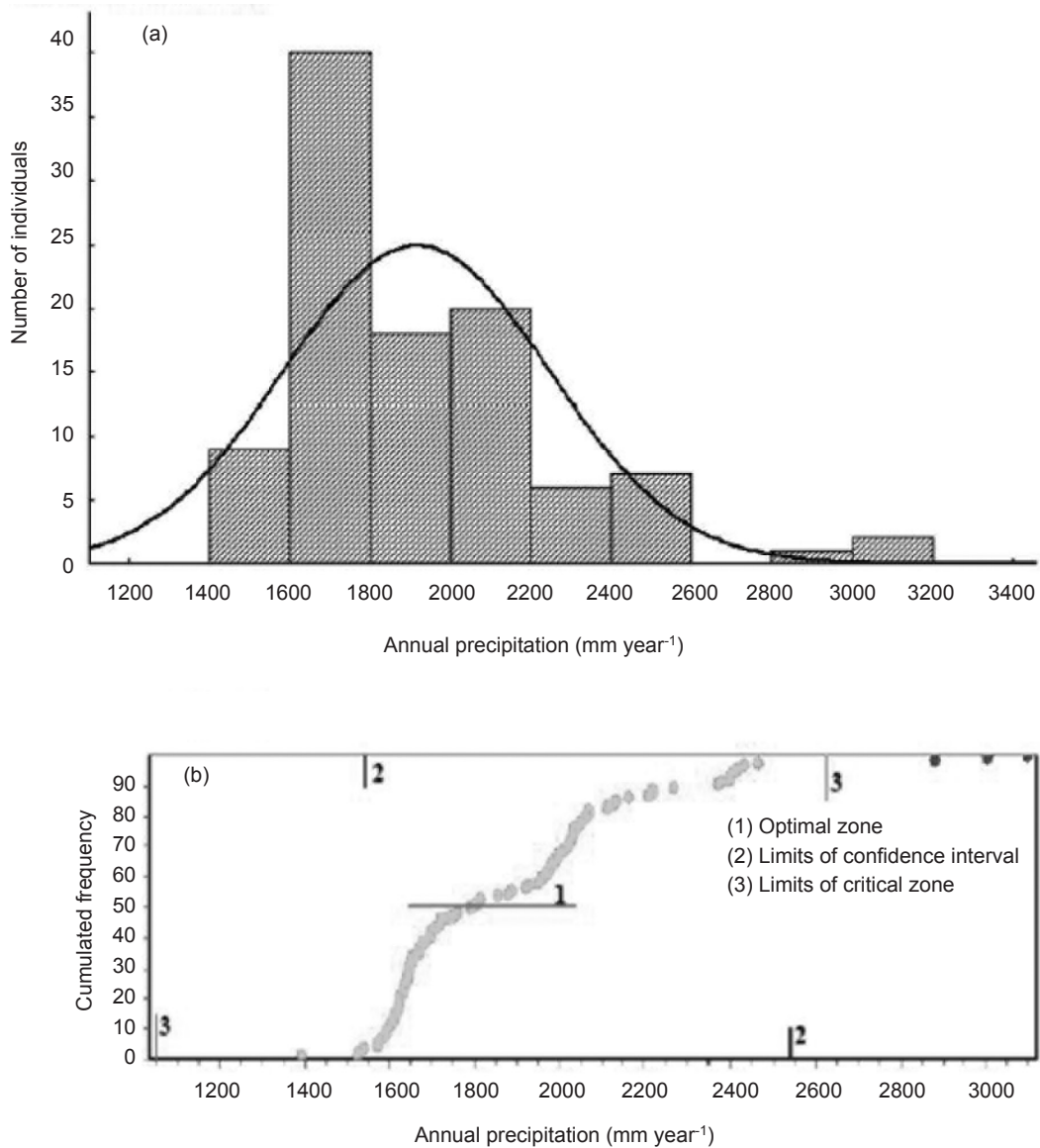


Figure 3 Distribution of annual precipitation of collection sites of *Dacryodes buettneri* based on (a) number of individuals and (b) cumulated frequency

This species grows at low altitudes, from 0 to 750 m above sea level. No individual was observed above 750 m altitude. Samples were collected near the coast and on sandy soil in Libreville and in the Pongara and Akanda National Parks in Gabon, where the altitude was less than 10 m above sea level. The highest collection sites were in the Koumounabouali foothills in the Bikourou region. The optimal altitude range was 250–420 m, while mean altitude was 335 ± 192 m. These altitude preferences were comparable with those of *Dacryodes igaganga* (Vivien & Faure 1988, Todou & Doumenge 2008).

CONCLUSIONS

The study of the actual distribution of *D. buettneri* using georeferenced data of collections showed that the species mainly occurred in the forests of the Lower Guinea centre of endemism. Modelling the potential geographic distribution using 19 climatic parameters showed that the best climatic conditions to natural growth of *D. buettneri* were to be found in Gabon, fortunately also in some protected areas. Optimal ecological parameters were annual precipitation of 1600–2000 mm, mean annual temperature of 23.8–25.8 °C and altitude of 0–750 m above sea level.

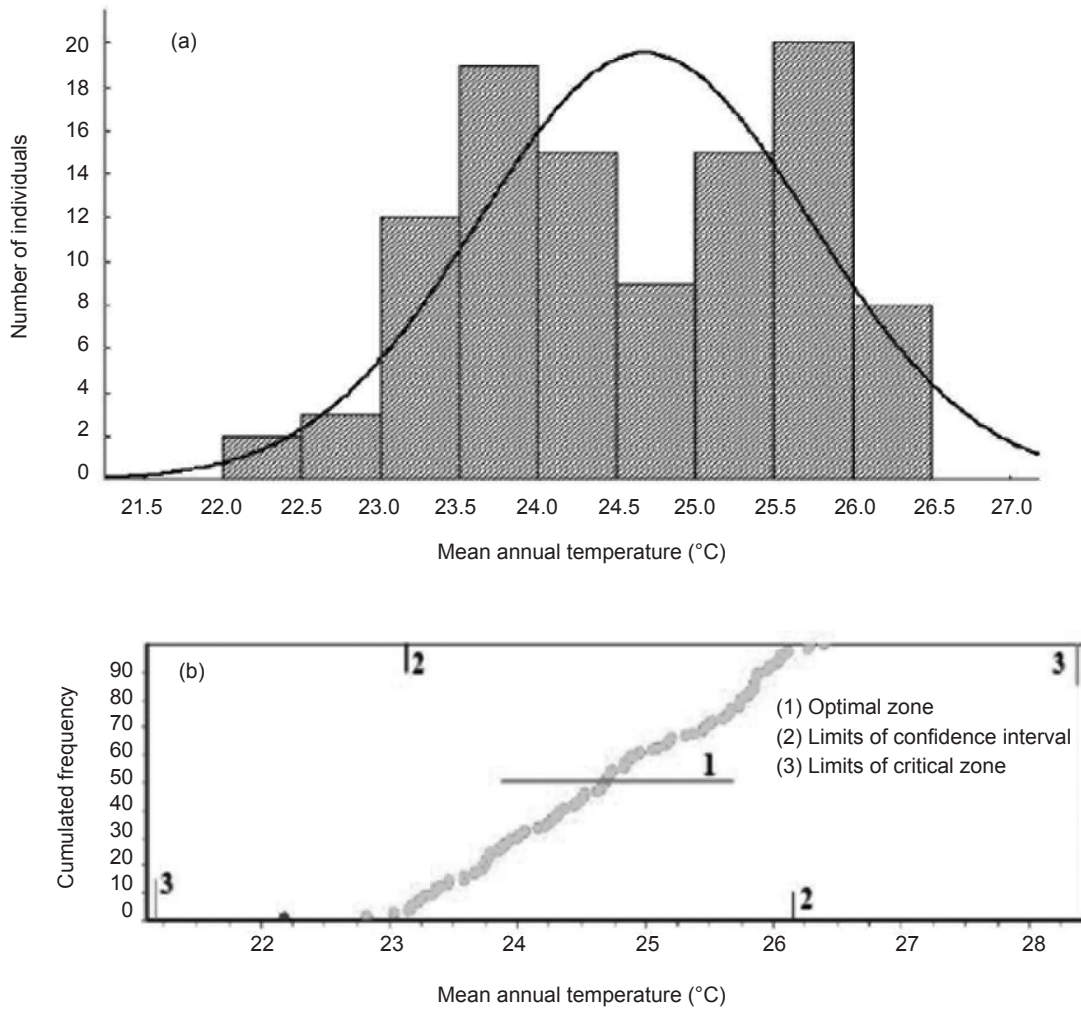


Figure 4 Distribution of mean annual temperatures of collection sites of *Dacryodes buettneri* based on (a) number of individuals and (b) cumulated frequency

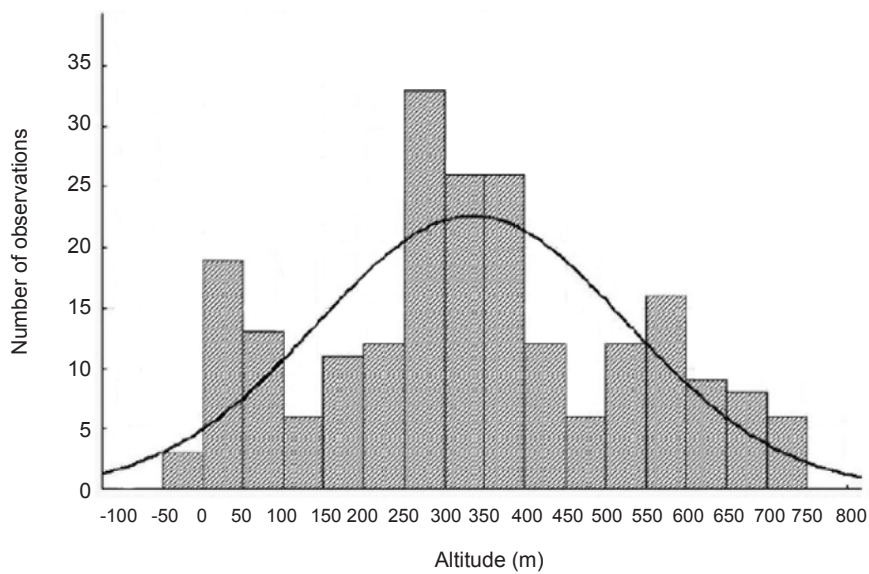


Figure 5 Frequency distribution of altitudes of collection sites of *Dacryodes buettneri*

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