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Ethnobotanical memory of *Cinchona* among the Sundanese in the highland of West Java, Indonesia

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Abstract. *Wiranova A, Mulyanto D, Iskandar BS. 2025. Ethnobotanical memory of* Cinchona *among the Sundanese in the highland of West Java, Indonesia. Asian J Ethnobiol 8: 332-346.* Following the decline of *Cinchona* as a commodity after the discovery of synthetic malaria drugs after the World War II, its plantations in the Dutch East Indies (now Indonesia) experienced a drastic downturn. Some were converted into upland agricultural fields producing subtropical vegetables, causing cultural ties to the species to largely diminish. Therefore, this study examines the ethnobotanical memory of *Cinchona* among Sundanese communities in West Java, Indonesia, within a post-plantation landscape that has undergone significant land-use transformation into upland subtropical vegetable fields. Using oral history supported by archival research, interviews were conducted with 29 residents divided into two groups: those who experienced the operational period of the plantation and those without direct exposure to it. Ethnobotanical memory is conceptualized as the dynamic interaction of emotional, sensory, and bodily recollections of plants within a community. Three categories of memory narratives were identified. The first reflects emotional memory, in which *Cinchona* is associated with childhood experiences and nostalgia. The second highlights bodily memory, represented by recollections of plantation production processes, from seed selection and grafting to bark harvesting and drying. The third emphasizes sensory memory, expressed through the bitter taste of decoctions once consumed for medicinal purposes. These memories reveal the intertwined relationship between biological species and cultural practices, yet intergenerational transmission has been limited, particularly among younger residents who have never encountered the species in their daily lives. The decline of *Cinchona* populations following land-use change has accelerated this process of forgetting. Moreover, conservation efforts remain absent due to the loss of commercial value and the community's reliance on faster-return crops such as vegetables. The findings underscore the vulnerability of ethnobotanical memory in post-plantation contexts and highlight the need to integrate cultural perspectives into biodiversity conservation strategies.

Keywords: *Cinchona*, ethnobotanical memory, medicinal plant, plantation, West Java

INTRODUCTION

The global widespread of various plant species was largely driven by the Columbian Exchange, which refers to the exchange of ideas, diseases, and biological species such as animals and plants from Europe to the America following the voyages of Christopher Columbus in 15th century, which was later facilitated through European imperialism and colonialism (Fosberg 1947; Crosby 2004; Cuvi 2011; González-Orozco et al. 2023). As a result, many plants originating outside their native geographical regions were introduced, later becoming naturalized and integrated into the natural habitats of colonial territories, including Indonesia (García et al. 2022; Aslam et al. 2023). One contributing factor that led to the naturalization of these exotic plants was the competition among colonial powers in trading economically valuable commodities, particularly plantation crops, especially during the 19th century. Prior to widespread cultivation, several exotic plant species intended for plantation commodities underwent a series of botanical trials at botanical gardens including at the Bogor Botanical Garden in Buitenzorg (now Bogor) and Cibodas Botanical Garden in Cianjur (Gorkom 1883; van der Hoogte and Pieters 2014). Some of these species later dispersed beyond the garden's confines—either through deliberate cultivation in other plantation units or as escapees growing wild around Cibodas, among them is *Cinchona* (Zuhri and Mutaqien 2013).

Cinchona is a Neotropical flora native to South America, especially the Andean regions of Peru, Ecuador, Colombia, and Bolivia. Commonly known in Sundanese as '*kina'*, this plant is also referred to by the same term in Dutch, derived from the word '*quina'* used by the Quechuan people of Peru (Gachelin et al. 2017; García et al. 2022). This plant belongs to the Rubiaceae family and the *Cinchona* genus, which consists of approximately 25 species. Originating from altitudes between 1,050 and 1,500 meters above sea level in the Andes, *Cinchona* thrives under an annual rainfall of 2,000-3,000 mm, temperatures between 13.5-21°C, and daily relative humidity of 68-98%. The optimal soil for its cultivation is fertile, friable, non-rocky, rich in organic matter, and has a pH of 5.8 (Gorkom 1883; Paniagua-Zambrana et al. 2020; Wasis and Sandra 2020). In 1820, the quinine alkaloid was successfully isolated from *Cinchona*, becoming the most

effective treatment for malaria (Goss 2014; Dubey and Singh 2021; Nair 2021).

Caused by the *Anopheles* mosquito, malaria was deadly and prevalent in tropical rainforests. The demand for *Cinchona* soared, prompting European powers—especially British India and the Dutch East Indies—to compete in producing it. In the Dutch East Indies, or currently primarily Indonesia, *Cinchona* cultivation expanded from Cibodas Botanical Garden to the Cinyiruan Plantation in Pangalengan, West Java in 1855. Eventually, the commercially cultivated species were *Cinchona ledgeriana* (syn. *Cinchona calisaya* Wedd.), valued for its high quinine content, and *Cinchona succirubra* (syn. *Cinchona pubescens* Vahl), known for its robust roots and used as understock for grafting (Sukasmono 1995; Maxiselly et al. 2018; Nair 2021).

By 1872, the success of this propagation method enabled the Dutch East Indies to dominate global *Cinchona* bark supply, surpassing British India (Gorkom 1883; Goss 2014). This success was reinforced by the liberal economic policy introduced through the 1870 Agrarian Law, which encouraged massive foreign European investment in the colony. As a result, *Cinchona* plantations flourished, particularly in the highlands of West Java (Gorkom 1883; Goss 2014; Mulyanto 2022). In 1913, the Quinine Agreement was established, which served as pharmaceutical cartel to preserve the Dutch monopoly over *Cinchona* cultivation and quinine production, making Java the source of over 90% of the global *Cinchona* supply (Fosberg 1947; Goss 2014; van der Hoogte and Pieters 2014).

The golden era of Dutch *Cinchona* plantations ended in 1942 during the Japanese occupation, when the Allied forces began developing synthetic quinine to replace the plant-based product (Goss 2014). Nonetheless, *Cinchona* plantations in Java continued operating after Indonesian independence. Following nationalization in 1959, these plantations were managed by state-owned *PT. Perkebunan Nusantara*. One of such estates was the *Rotterdamsche Kina Maatschappij Tji Kembang*, located in what is now Cikembang Village, Bandung District, West Java. The plantation lasted for a century before it was illegally occupied by local residents in 1998, carried out sporadically as a reflection of a wider political phenomenon stemming from disappointment over the failure of agrarian reform efforts during the New Order government. The area then underwent a land-use transformation, shifting from a state-run *Cinchona* plantation to privately managed upland farming of subtropical vegetables. This transformation marked the area as a post-plantation landscape, an area no longer dominated by plantation power.

The situation lends itself to analysis through a historical ethnobotany approach. This approach examines the evolving relationship between humans and plants over time, shaped by ecological and cultural dynamics. Through diachronic investigation, historical ethnobotany can reveal knowledge about plants in the past by paying attention to changes in the environment, explored through historical evidence (Medeiros et al. 2014; Medeiros and Alves 2018; Petran et al. 2020; Dafni et al. 2021; Kalle and Sõukand 2023). This past relationship between plants and humans can be explored through institutional archival documents (Kalle and Sõukand 2012; Kujawska et al. 2017; Petran et al 2020; Singh et al. 2020; Saraçi and Damo 2021), folklore and songs (Cardaño and Herrero 2014; Dafni et al. 2021; Fišer 2022), as well as old literary text (Jákl 2015, 2016; Dafni and Böck 2019; Mulyanto et al. 2023, 2024). Therefore, historical ethnobotany provides an avenue for investigation within geographic landscapes where the ecological presence of certain plant species has declined or even vanished, despite once playing a significant role in the lives of surrounding communities. Nevertheless, such conditions require a combination of historical sources and testimonies from actors living in the present as conducted in this study. Therefore, this study aims to (i) trace the memories held by local residents regarding *Cinchona* species that have disappeared from Cikembang Village, and (ii) understand the interdependence between biological species and the surrounding cultural practices in a post-plantation landscape. The research is grounded in the concept of ethnobotanical memory, which synthesizes emotional, sensory, and bodily memory related to certain plants within local contexts. Using oral history supported by archival documents, this study incorporates historical ethnobotany approach in plantation studies, which generally focused on socio-economic structures (Veale 2010; Barral 2014; Gibbon et al. 2014; Battle-Baptiste 2017; Li 2017b; Bastos 2020; Besky 2024).

MATERIALS AND METHODS

Study area

This study was conducted in Cikembang Village, Kertasari Sub-district, Bandung District, West Java, Indonesia (Figure 1). The area is located at the coordinates 7°12′42″ S, 107°41′19″ E, situated in the southeast of Mount Malabar and north of Mount Papandayan, with an average elevation of 1,583 meters above sea level and a total area of approximately 1,372 hectares. The region has an average annual temperature of around 23.8°C, with minimum temperatures reaching approximately 20°C and maximum temperatures around 30°C. The average annual rainfall is approximately 2,148 mm, with the highest precipitation typically occurring in December and April.

This area was once home to a private *Cinchona* plantation known as *Rotterdamsche Kina Maatschappij Tji Kembang* (Figure 2) (Nederlandsche Staatscourant 1883), which has since become part of what is now Cikembang. The plantation was established in 1882 with an initial concession area of 589 hectares (Algemeen Landbouw Syndicaat and Zuid en West-Sumatra Syndicaat 1938), which later expanded. By the early 20th century, the plantation produced approximately 325,000 kilograms of *Cinchona* bark annually, with quinine content consistently exceeding 5%. Most of the bark was sent to the *Bandoengsche Kininefabriek* in Bandung to be processed into malaria medicine (Java-Kinabast 1905).

In 1959, this plantation was nationalized by the Indonesian government under the name of Cikembang Plantation under Government Regulation No. 19 of 1959. In 1983, the plantation area was designated as a separate administrative unit, named Cikembang Village within Kertasari Sub-district, Bandung District. However, the plantation's success was short-lived. By the mid-1980s, *Cinchona* production declined, accompanied by the gradual dismantling of its processing factory facilities. The downfall peaked in 1998 when local farmers illegally occupied the plantation concession area, replacing *Cinchona* with commercial vegetables such as cabbage, carrot, and potato. The occupation of the plantation's concession land was carried out without a contractual agreement, while a small portion of other areas in the village fell under social forestry contracts. In 2013, the plantation officially shifted its cultivation from *Cinchona* to coffee, employing intercropping with vegetables grown by farmers within the concession area. Nevertheless, the intercropping policy was strictly enforced for no more than five years. It was recorded that since 2023, plantation concessions have accounted for 72% of the village's total area, with nearly all of them being occupied by farmers (Pemerintah Desa Cikembang 2023). While it legally exists, its performance is a shadow of its former glory, now employing only three staffs (a manager, clerk, and chief foreman) and fewer than 30 seasonal laborers. Despite the land-use changes in this area, residual botanical knowledge persists among the local population. This knowledge is manifested through the ethnobotanical memory of *C. calisaya* and *C. pubescens*, which were once plantation commodities that have since undergone a drastic population decline.

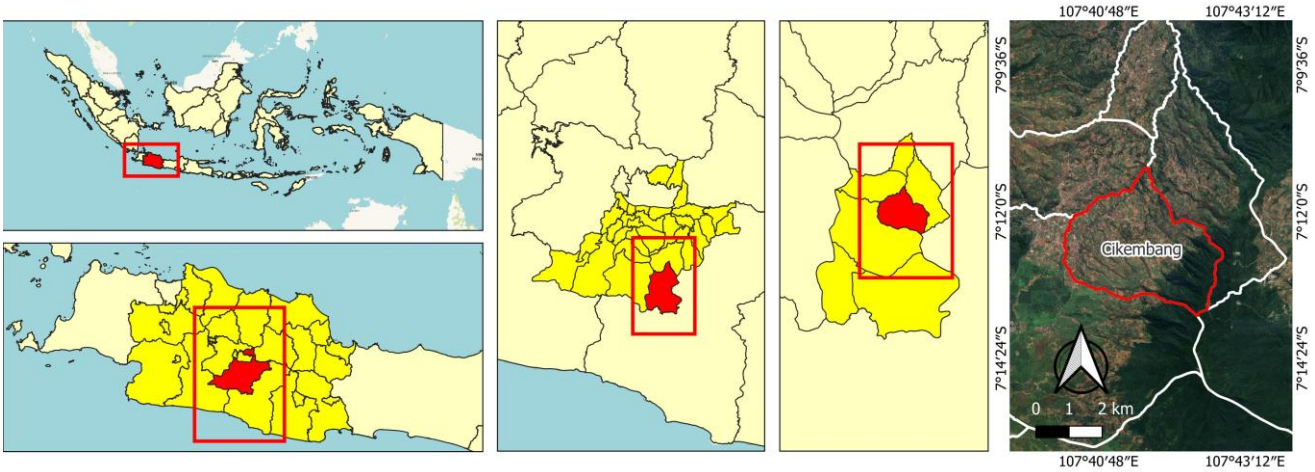

Figure 1. The map of the study area in Cikembang Village, Kertasari Sub-district, Bandung District, West Java, Indonesia

Figure 2. Cikembang *Cinchona* plantation in the colonial era. A. Aerial view of the highlands, 1932 (KITLV 408493); B. Rows of *Cinchona* trees in the plantation, 1932 (KITLV 408459); C. *Crotalaria usaramoensis* on a field where *Cinchona* will be planted later, 1923 (KITLV 408547), and D. Native foremen and laborers, 1932 (KITLV 408505)

Research procedures

This study employed a hybrid oral history method, which combines oral expressions with supporting sources in the form of historical archives (Medeiros et al. 2014; Sommer and Quinlan 2018). In the context of this research, oral expressions were obtained through interviews with informants, while historical archives consisted of textual documents such as newspapers and cultivation manuals, as well as photographic records depicting the plantation and related *Cinchona*. The research proceeded in the following stages:

Step 1. Informants were selected using the snowball sampling technique, based on recommendations from initial key informants. These key informants included the current head manager of the plantation and the village head, based on the assumption that both are stakeholder with an understanding of local context. Based on their recommendations, which further expanded through referrals from the next informants, a total of 29 residents were selected for interview. Informant recruitment was concluded once the data reached saturation, indicated by recurring testimonial narratives. The informants were then divided into the following two categories. (i) Seventeen informants who had lived alongside the actively operating *Cinchona* plantation. Of these, 12 had direct experience working on the plantation, ranging in age from 50 to 82 years old. They held various roles such as field laborers, foremen, drivers, nurses, and manager; and (ii) Twelve informants who had never been lived alongside the actively operating plantation, aged between 18 and 31 years old. This category was intended to examine the persistence of ethnobotanical knowledge among local residents whose lives no longer intersect with the presence of the *Cinchona* plantation, particularly after the disappearance of *Cinchona* from the area following land occupation beginning in 1998. All informants were asked for their consent to be interviewed and recorded, with assurances that their identities would be anonymized.

Step 2. Semi-structured interviews were conducted with the informants, guided by a prepared set of questions. This approach allowed informants greater flexibility in responding, based on their individual understanding and experiences. The questions were open-ended, covering the what, when, where, why, and how of the informants' recollections regarding *Cinchona*. These interviews were supplemented with photographic documentation from the 19th and 20th centuries, sourced from Dutch archival repositories such as KITLV (https://digitalcollections.universiteitleiden.nl) and Delpher (https://delpher.nl) and used as mnemonic devices to assist memory recall. The images presented included photographs of *Cinchona* species, scenes from the plantation during the colonial period, and tools used in production, which were subsequently identified with their corresponding local terms. This technique was employed in light of the socio-historical context surrounding the decline of the plantation, where the collapse of both the economic power and physical infrastructure of *Cinchona* cultivation led to the disappearance of supporting equipment and of *Cinchona* plants itself. Interviews and informant identification continued until data saturation was reached, indicated by the absence of new memory narratives.

Step 3. The informants' memory narratives were then categorized and coded based on the concept of ethnobotanical memory. This concept reflects a combination of emotional, sensory, and bodily memory, all of which connected to the local context of certain plants. Accordingly, the residents' memory narratives will be categorized based on these three themes. In this process, Microsoft Word and Microsoft Excel were used to facilitate the coding process and narrative writing. The scientific names of plants were validated using the Plants of the World Online (POWO) database (https://powo.science.kew.org) to ensure accurate nomenclature, including the verification of synonyms.

Data analysis

Following the in-depth interviews, the recordings were transcribed into interview transcripts. These transcripts were then categorized into codes based on specific topics and subtopics, including direct experiences of interacting with *Cinchona* plants, the informants' roles during the operational period of the *Cinchona* plantation, as well as the memories and emotions associated with the plant. The resulting codes were subsequently analyzed qualitatively and processed into narrative form through data triangulation involving cross-checking and synthesizing.

RESULTS AND DISCUSSION

Ethnobotanical memory in a post-plantation landscape

In recent academic discourse, the concept of botanical memory has emerged, integrating various theoretical frameworks including collective memory, sensory memory, and bodily memory. Botanical memory refers to a form of recollection that combines emotionality, sensuousness, and embodiment, manifested through inner imagery and reminiscence of plant life. The plant can be existed in the past or that currently exists but evokes past events or landscapes (Ryan 2013, 2017; Lugo-Morin 2022). This memory is not limited to individual recollection but extends to entire human communities who were or are exposed to specific flora. This aligns with the concept of collective memory which emphasizes individual memories shared by members of a community who have undergone similar experiences (Assmann and Czaplicka 1995; Linke 2001; Ryan 2013, 2017; Damanik 2020; Rosalina and Zuhdi 2020).

Botanical memory involves emotional recall, where certain plants elicit feelings of nostalgia or mourning, particularly in the context of biodiversity loss when compared with past environmental conditions. It also involves sensory memory, activated through vision, hearing, smell, taste, or touch and manifesting in recollections of a plant's color, aroma, flavor, and texture. It also encompasses bodily memory, such as the recollection of gestures like flower picking or nectar sucking (Ryan 2013, 2017). When combined with ethnobotanical approaches which emphasize local

knowledge and spatial embeddedness (Folke 2004; Hurrell and Albuquerque 2012; Anderson 2017), the concept of ethnobotanical memory emerges. Therefore, ethnobotanical memory can be defined as the collective memory of a community concerning the local knowledge and use of specific plants, expressed through sensory perception, bodily gestures, and emotional associations.

One of the key conditions for the formation of ethnobotanical memory is the transformation of biodiversity, such as the disappearance of a particular species. In the case of this study, ethnobotanical memory is held by the local residents of a former plantation area. For over a century, the community—predominantly composed of plantation laborers—was exposed to *Cinchona*, cultivated as a plantation commodity. Following the closure of the *Cinchona* plantation in 1998, this area experienced a land use transformation to upland agriculture, resulted in the massive decrease of *Cinchona* population. In the past, nearly the entire village landscape was covered by *Cinchona* forests, which today can only be found in small numbers in remote areas far from residential settlements. These circumstances have enabled the emergence of post-plantation landscape; wherein former plantation areas have undergone land-use transformations. This phenomenon does not seem to affect all plantation commodities, but rather only certain species deemed no longer commercially viable, due to declining market demand or shifts in political-economic policy (van der Hoogte and Pieters 2014; Ku 2016; Damanik 2020; Nuralia and Imadudin 2021; Li 2024). Such was the case with *Cinchona* and coca (*Erythroxylum novogranatense* (Morris) Hieron.) which once dominated Dutch East Indies plantation landscapes but experienced significant decline in the post-independence era (Bosman 2012; van der Hoogte and Pieters 2013). In post-plantation landscapes like these, commodity plant species may either disappear entirely, experience a drastic population decline leaving only a few remnants, or become escapees that grow wild. The species often going unrecognized by the local residents.

Meanwhile, studies on plantations have often emphasized the institution as a hegemonic and extractive force, comparable to military occupation (Li and Semedi 2022). It is frequently oppressing labor through mechanisms of control designed to ensure a continuous workforce, often maintained via intergenerational recruitment and paternalistic welfare regimes under the New Order and beyond (Barral 2012, 2014; Gibbon et al. 2014; Li 2017a, b, 2024). In the colonial period, this also involved physical boundaries and punishments imposed on workers (Stoler 1985; Breman 1989, 2015). While plantation studies have extensively explored political-economic dynamics, they have often neglected the relationship between human and the botanical commodities around them. This research addresses that gap by highlighting the residual ethnobotanical memory held by local residents of a post-plantation area, regarding a once-dominant plantation commodity that has since disappeared due to shifts in local land use.

Therefore, the following section will describe the ethnobotanical memory held by local residents of the village as part of a post-plantation landscape. The section begins by discussing local terminologies related to *Cinchona*, followed by three additional memory narratives. The categorization of these narratives draws on the concept of botanical memory as a combination of emotional, bodily, and sensory memory (Ryan 2013, 2017). These three narratives represent practices that took place in the past and now exist only as memories. In other words, the cultural practices associated with them are no longer carried out in the present. The following is a detailed explanation.

Local terminologies regarding *Cinchona*

The *Cinchona* genus cultivated at the study area consisted primarily of two species: *Cinchona pubescens* Vahl (Figure 3) and *C. calisaya* (Figure 4), each serving distinct roles. Their introduction to the plantation was part of broader trajectory of imperial botanical advancement that began in 1865, when Charles Ledger brought *Cinchona* specimens from Bolivia that was later classified as *C. calisaya* (syn. *C. ledgeriana*). This species was subsequently cultivated by the Dutch colonial government on plantations in the Malabar highlands, Preanger West Java. In 1872, small quantities of its bark were auctioned in Amsterdam, fetching higher prices than other *Cinchona* products sourced from Java, Sri Lanka, or India due to its quinine content exceeding 5% (Gorkom 1883; Cuvi 2011; Goss 2014; van der Hoogte and Pieters 2014).

Despite its high alkaloid concentration, *C. calisaya* had weak root systems and could only thrive in recently cleared primary forests. To address this, colonial scientists developed grafting techniques that combined *C. calisaya* as the scion with *C. pubescens* (syn. *C. succirubra*), a species known for its strong root systems as the understock. The resulting hybrid retained the high quinine content and the robust rooting capacity in the new individual (Gorkom 1883; Sukasmono 1995; Maxiselly et al. 2018).

This propagation method became widely adopted across *Cinchona* plantations in Java, including in this study area. As a result, both species remain etched in the local population's memory, as reflected in their use of specific local terminologies. *Cinchona pubescens* (syn. *C. succirubra*), the rootstock species, is locally referred to as '*sulibra'* or '*subsirubra'* (Figure 3), terms derived through phonetic metathesis from its Latin name. Meanwhile, *C. calisaya* is more broadly referred to as '*kina'* (Figure 4). The term *kina* also refers to the grafted hybrid individuals produced from both species, which means this term carries a dual meaning (Table 1).

Emotional memory: *Cinchona* and nostalgia of childhood

The concept of ethnobotanical memory allows a collective community to retain memories of specific plants that have been continuously present in their daily lives. These plant-related memories can take the form of emotional memory, which means memory that evoke certain emotional responses (Ryan 2013, 2017). In the context of this study, emotional memory of *Cinchona* is

evident in the sense of nostalgia that arises during the process of recalling the plant.

Local residents born in the 1970s and 1980s often associate *Cinchona* with their childhood years. Many recall spending their afternoons playing within the boundaries of the plantation, a restricted area that was off-limits to unauthorized individuals. The plantation's processing facilities and administrative buildings were strictly reserved for authorized personnel, such as workers and laborers. This spatial exclusivity effectively excluded local inhabitants who did not rely on plantation labor for their livelihoods, creating a distinct social boundary between plantation-affiliated and non-affiliated communities.

This exclusivity was maintained through regular security patrols by plantation guards, who monitored the area to prevent trespassing and potential crime. These patrols, in turn, became part of the collective memory of childhood for those who grew up near the plantation. Children, most in their early teens or younger, often spent their afternoons playing around the *Cinchona* field, until they were either called home by the evening *adhan* (Muslim call to prayer) or chased away by security guards for entering restricted zones. The presence of these guards added an element of excitement to their games, intensifying the thrill of the childhood experience (Table 1).

Nostalgic memories of *Cinchona* also refer to the physical presence of the tree itself. Residents vividly recall the tall perimeter fence surrounding the processing plant, constructed entirely from debarked *Cinchona* trunks. These imposing wooden posts, nearly matching the height of the processing facility, reflected the substantial size of *Cinchona* trees at the time, estimated to have reached 10 to 15 meters in height. Thus, botanical memory in this context is more than an emotional attachment; it also functions as a recollection of botanical scale and material use, where trees once cultivated for their bark became structural elements in the landscape.

The memory of childhood games in restricted plantation areas also reflects the broader social exclusivity embedded within plantation society. At the time, plantation workers were often perceived as living somewhat separate, even elite, lives compared to their non-plantation neighbors. This perceived exclusivity was, in part, an outcome of the plantation institution's role as an agent of economic development in frontier regions (Li and Semedi 2022), fostering a sense of occupational pride among plantation workers. However, it was also shaped by the paternalistic structure of plantation governance, which offered selective welfare benefits in exchange for compliance and labor continuity (Barral 2012, 2014; Gibbon et al. 2014). Such policies entrenched the exclusivity of plantation life, fostering distance—both literal and symbolic—between plantation laborers and non-affiliated villagers. These dynamics make clear that botanical memory, especially in the case of *Cinchona*, extends beyond the species itself. It encompasses emotional sentiments, nostalgic reflections, and the broader social and political conditions surrounding the plant's cultivation. In short, memories of *Cinchona* serve as an entry point into understanding the lived experiences of plantation life and the lingering residues of institutional control within a post-plantation society.

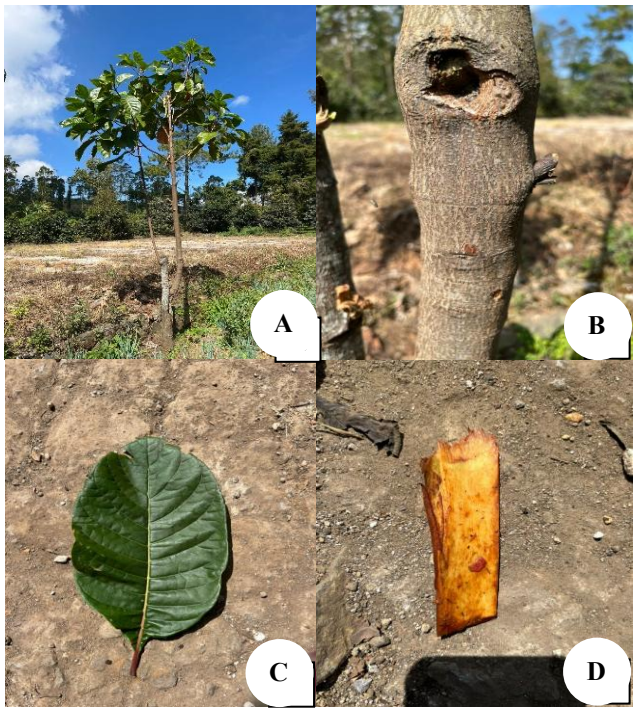

Figure 3. The escapee of *Cinchona pubescens* Vahl (red bark), consists of: A. Tree, B. Trunk, C. Leaf, and D. Bark

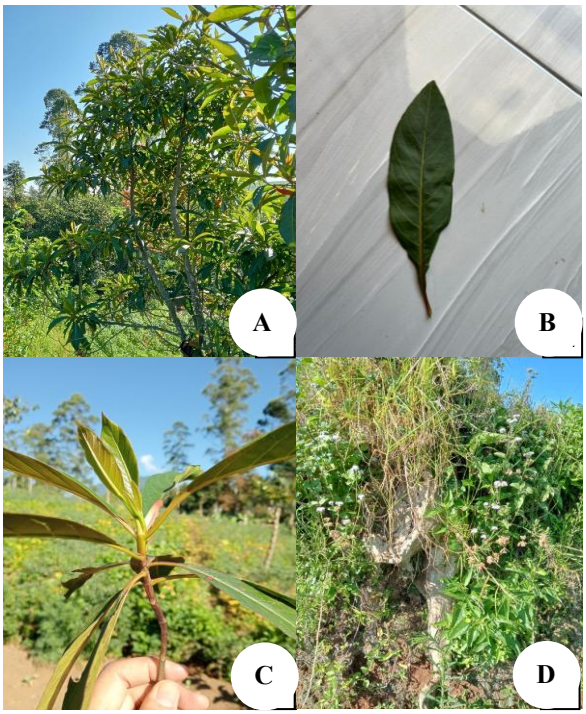

Figure 4. *Cinchona calisaya* Wedd. (yellow bark), consists of: A. Tree, B. Leaf, C. Shoot, and D. Understock resulting from grafting with *Cinchona pubescens* Vahl.

Bodily memory: plantation production stages of *Cinchona*

Ethnobotanical memory also manifests as bodily memory, referring to recollections of events that are closely tied to physical movements (Ryan 2013, 2017). In the context of this study, bodily memory of *Cinchona* emerges through memories of the plantation production stages before being sent to the pharmaceutical factory in Bandung City, for processing into malaria medication. These memories are generally held only by former workers of the plantation and are often recounted alongside physical gestures, especially when describing certain stages of the process. Below is a detailed description of each stage of *Cinchona* production in study area, supported by photographic documentation obtained from Dutch archival sources.

The plantation production stages of *Cinchona* were divided into seven distinct phases (Figure 5). First was the selection of *C. pubescens* seeds. The seed selection process was carried out using chicken feathers due to its small size, which required fine and delicate materials. Viable seeds were identified by their perfectly round shape and brownish-green color. In this stage, patience and manual dexterity in separating each individual seed were essential. The second stage involved sowing the seeds in a designated area known as *ikupan* or *bedengan* (covered seedbed in Sundanese). Seedlings were initially grown to approximately 10 cm in height, after which they were transplanted into new nursery beds and cultivated until they reached 40-50 cm. This process could take up to four years.

Third, the stage of grafting or *stek sambung*. A small patch of bark from *C. pubescens* was carefully peeled away, then grafted with a shoot from *C. calisaya*. The two were bound together using melted wax and bamboo twine. Occasionally, plastic bags were used for binding, though less frequently due to concerns about suffocation. After 3-4 months post-grafting, new shoots would emerge. This marked the transformation into what was locally recognized as a true *kina* tree, a fusion of *C. pubescens* rootstock and a *C. calisaya* scion. Fourth was bark-stripping, the primary objective of cultivation, as the bark of the *kina* tree—harvested from both trunk and branches—contained high concentrations of quinine (Gorkom 1883; Goss 2014; Gachelin et al. 2017; Maldonado et al. 2017). Trees were typically ready for harvest after 6 to 15 years. Workers employed a method called *pekprek* or *mekprek*, striking the bark with a blunt wooden tool until it produced a *"prek!"* sound, allowing it to be peeled off, an action rooted in embodied, bodily memory. Alternatively, a finer quality bark was extracted using sharp tools, though this method was more labor-intensive. Stripped trunks and branches were repurposed as firewood for *belong* (smoking kilns), building materials for workers' housing, and fencing around processing areas.

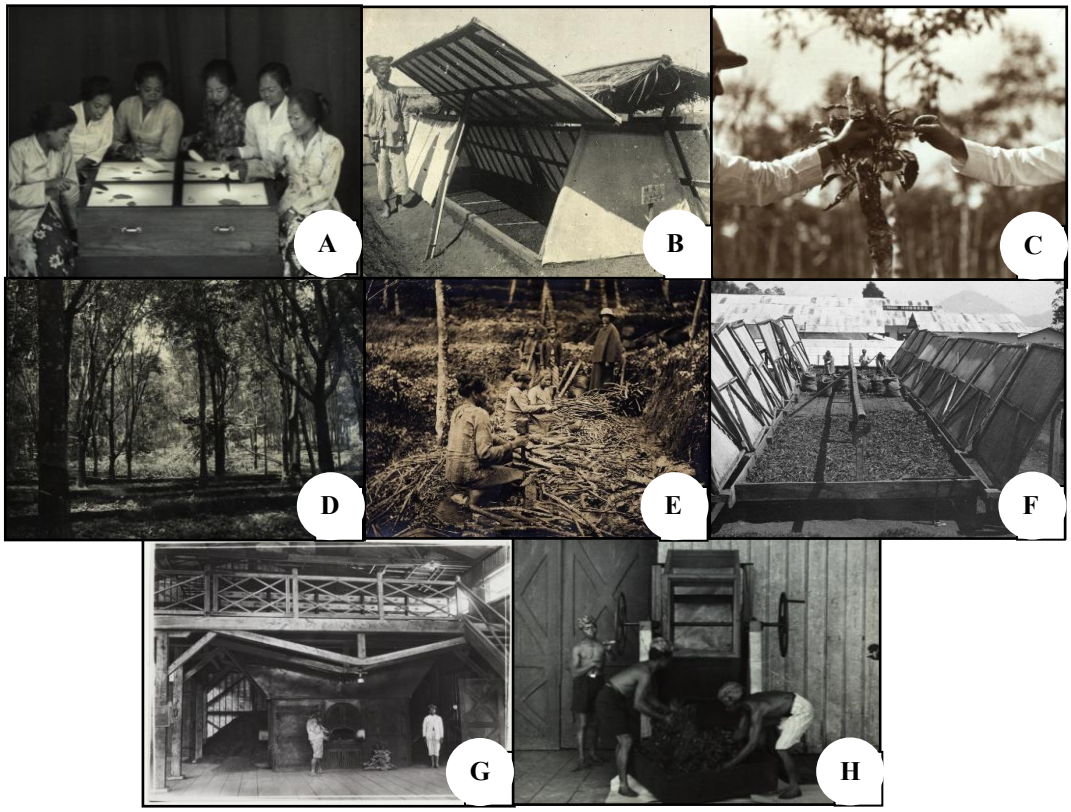

Figure 5. Steps of *Cinchona* production. A. Selection of seeds suitable for planting using chicken feathers (KITLV 408739), B. Seed germination in beddings called *ikupan* (KITLV 408831), C. Grafting cuttings (KITLV 408543), D. Mature trees ready for harvest (KITLV 408459), E. Peeling bark from its trunk and branch using a method called *pekprek* (KITLV 183810), F. Sun-drying the barks on rack named *paratag* (KITLV 500358), G. Smoking the dried bark in a chamber called *belong* (KITLV 34637), and H. Bark grinding into powder form (KITLV 408753)

Fifth was sun-drying the bark, placed on a tray-like structure with an iron frame and two zinc roofs, locally known as *paratag*. The drying process typically lasting one to two weeks, depending on weather conditions. When it rained or during the night, the zinc sheets were repositioned to cover the bark. The term *paratag* may derive from *parat*, which in Sundanese means "to have a through-passage". The word also appears in the expression *liang parat*, meaning a tunnel or an open channel with a clear passage from one end to the other (Rigg 1862), resembling the structure formed by the zinc sheets when closed over the platform. In contemporary Sundanese, *parat* can also mean "to pass through", "until it's finished", or "to completion".

Sixth was bark-smoking. Once adequately sun-dried, the bark was moved from *paratag* to *belong*, a type of furnace used to smoke the bark. The purpose was to make the bark easier to grind during the milling stage. The bark was placed on trays in the upper chamber of the furnace and smoked until its texture changed. The firewood used in the *belong* often came from the stripped trunks or branches of the *kina* tree. Finally, the milling process transformed the dried bark into powder. The smoked bark was transferred to a grinding machine, and in some cases, ground together with rice grains. The resulting product was referred to as *tepung kina* (*Cinchona* flour). This flour was packed into sacks (*bal)* and delivered to the manufacturing factory in Bandung City (formerly the *Bandung Kininschefabriek* before nationalization), where it was processed into quinine pills used for antimalarial treatment. The description of memories related to the plantation production stages is often conveyed through a series of body gestures by the informants (Table 1).

Sensory memory: Local consumption of bitter *Cinchona* for medicinal purpose

Ethnobotanical memory also appears as sensory memory, refers to recollections tied closely to the senses (Ryan 2013, 2017). In the context of this study, sensory memory is expressed through the bitter taste detected by the sense of taste during the traditional practice of consuming *Cinchona* decoctions for medicinal purposes, a practice that is no longer carried out today. The laborers had the habit of secretly taking the bark that was being dried on *paratag*, bringing it home, then brewing it. This brew was then consumed with the purpose of curing all kinds of diseases, from fever, chills, itching, to internal diseases. However, when asked what type of internal disease was meant, each informant seemed confused in answering. This multifunctional brew was consumed approximately one glass, once or twice until the body felt more vigorous and taste extremely bitter. Informants often times described it as the most bitter solution ever consumed during their lifetime, leaving a clear trace in the mouth cavity and throat, often caused nausea afterward. Therefore, to rinse away this bitter taste, residents were accustomed to drinking palm sugar solution water (Table 1).

The story about how bitter the solution tasted seemed quite reasonable and not exaggerated, considering that quinine-type alkaloids serve as a standard reference commonly used in expressing a bitter taste (Mahomoodally and Ramalingum 2015). The tendency of local communities to utilize bitter plants for medicinal benefits is also occurs in various places and groups, for instance among traditional societies like the Inga Indians (Zuluaga 2024), Pakistani migrants in England (Pieroni et al. 2008), or rural people in Italy (Pieroni 2001). Local utilization of bitter plants for medicinal purposes is a relatively new matter in the physiology of taste science. Living beings have a genetic predisposition to identify bitter taste from food (including plants) as toxins or decaying food, so there is a tendency to refuse consuming them (Behrens et al. 2018; Zuluaga 2024). Nevertheless, over time through trial-and-error efforts, human realized that not all bitter foods are poisonous, thus including them in their diet menu. Tolerance for bitter taste from consumed plants can be highly adaptive, depending on the consumers. If a community is continuously exposed to a particular plant, then their tolerance level for unpleasant tastes will be higher (Glendinning 1994; Kurihara et al. 1994; de Medeiros et al. 2015). Something similar occurs in the study area, where plantation laborers who are daily exposed to *Cinchona* are used to consume them for health benefits regardless of their prominent bitter taste, which instead becomes sensory memory.

Cases like this seem quite common within plantation contexts and can also be interpreted as a form of resistance effort by lower classes in obtaining benefits from plantation systems that quite suffocate them (Li and Semedi 2022). This *Cinchona* bark taking was done without asking permission from superiors. This 'stealing' behavior occurred at all times but was only found among field laborers and foremen. Meanwhile, positions above them with relatively more decent living standards did not recognize this habit. Similar practices were also carried out in Java and Kalimantan plantations since colonial times, for instance reflected through the habit of stealing coffee leaves to be brewed and enjoyed by laborers (Breman 2015; Li and Semedi 2022).

To facilitate the explanation of the ethnobotanical memory narratives of local residents in the study area regarding *Cinchona*, the following table provides summary of the findings (Table 1). The ethnobotanical memory narratives of *Cinchona* in the study area need to be understood within the context of a combination of emotional, bodily, and sensory memory, held by individuals within a community who share a common experience (Assmann and Czaplicka 1995; Linke 2001; Ryan 2013, 2017; Damanik 2020; Rosalina and Zuhdi 2020; Lugo-Morin 2022). These three types of memory can be observed in this study and compared with findings from similar research.

Table 1. Memory narratives, the remembering subject, and its descriptions regarding *Cinchona*

Memory narratives	**Subject**	**Summary**
Local terminologies regarding *Cinchona*	The majority of local residents, across various age groups, both those who have and have not lived in direct proximity to the *Cinchona* plantation during its operational period share this experience. Example: "Sulibra *or* subsirubra *is different from* kina. Sulibra *is the understock, and it's grafted with* kina. *The resulting hybrid is also named* kina." -DK, 60 years old, current senior plantation foreman. "Subsirubra *and* kina *is different. They're distinct types of trees.*" -CW, 29 years old, farmer.	*C. pubescens* (syn. *C. succirubra)* is referred to as '*sulibra'* or '*subsirubra'*. *C. calisaya* is referred to as '*kina'*. The term *kina* is also used to refer to grafted individuals from both species.
Emotional memory: *Cinchona* and nostalgia for childhood	Residents aged between 30 and 82 years who once lived in direct proximity to the *Cinchona* plantation. Example: "*We used to play almost every day in the* Cinchona *field. Actually, we weren't allowed to, because there was a security guard who patrolled regularly. But that made it even more exciting as a child."* -US, 39 years old, teacher. *"We'd turn the* Cinchona *branches into toy weapons, pretending they were guns."* -IO, 45 years old, farmer. *"There was a fence made from* Cinchona *trunks in front of the factory. Each section of the fence came from just one tree, not joined together. And they were really tall, probably over 10 meters."* -IS, 41 years old, farmer.	Evokes feelings of nostalgia and longing for childhood, indicated by childhood habits of playing around and the estimation of the tree size.
Bodily memory: plantation production stages of *Cinchona*	Generally, from the category of former *Cinchona* plantation workers. Example: "*The job of* mekprek *would often make your arms sore, because you had to keep hitting the bark repeatedly. Sometimes, the bark was also hard to peel off."* -NK, 77 years old, former plantation laborer. "*I remember when selecting* sulibra *seeds, we had to be very careful. But once your hands got used to it, you could separate the seeds quickly."* -MJ, 79 years old, former plantation laborer. *"Why is it called* pekprek? *Because the movement kept making a '*prek!*' sound over and over."* -AM, 73 years old, former plantation foreman.	The production stages begin with the selection of the seeds, followed by grafting, harvesting, and processing until becomes powder form.
Sensory memory: local consumption of *Cinchona* for medicinal purpose	Generally, from the category of former plantation workers, particularly low-ranking laborers who worked in the field. Example: *"When* Cinchona *bark is brewed, its benefits can treat nearly every illness. If you have a fever, drink it. If your body aches, chest hurts, even itching, it can cure them. Just drink one glass, maybe twice, and the fever usually goes away immediately."* -JB, 74 years old, former plantation laborer. *"We'd drink a palm or white sugar solution after consuming* Cinchona. *But palm sugar had a stronger taste, so it helped get rid of the bitterness better."* -MT, 70 years old, former plantation laborer. *"We used to secretly take the bark from* paratag *while it was being sun-dried. We only took a little, so it didn't cause any real loss to the plantation."* -EM, 79 years old, former plantation laborer.	Decoctions made from *Cinchona* bark were consumed to treat various diseases.

First, emotional memory in this study is evident in nostalgic sentiments and longing for childhood. Such nostalgia is similarly observed in the study of Ryan (2013), in which grief for the past arises from the extinction of shrub species in Perth, Australia and those experienced by Aboriginal people upon witnessing the disappearance of native vegetation including their totems. In memories of plants consumed during famine years, trauma and sorrow dominate the emotional landscape of survivors (Vorstenbosch et al. 2017; Rosalina and Zuhdi 2020; Ruiz 2024). However, this kind of sorrow is not commonly found in this study. The absence of sorrow over the extinction of *Cinchona* may be attributed to the transformation in land use that took place. It enabled residents to privately manage their own land through household-scale vegetable farming, rather than working solely as wage laborers under the dominant agrarian structure of the plantation.

Second, bodily memory in this study is revealed through memory narratives related to the plantation production stages of *Cinchona*. One such example is the physical demonstration by informants of the *pekprek* stage. This strong presence of bodily memory is also found in other studies, such as Archambault (2016) on backyard gardening routines among working class youth in Mozambique. This also evident in Ryan (2013) on childhood practices of sucking nectar from *Banksia* flowers using gestures like squeezing, chewing, and sucking. These comparisons show that bodily memory among local residents related to *Cinchona* is confined to production activities serving the economic interests of the plantation institution.

Third, sensory memory is found in the local consumption for medicinal purposes. The sense of taste plays a dominant role, as residents describe the decoction as the most bitter liquid they have ever consumed. It is said to linger in the throat, producing an unpleasant aftertaste that must be washed down with a solution of palm sugar. Similar forms of sensory memory appear in other studies. For example, the sweet taste of red drip from *marri* trees (*Corymbia calophylla* (Lindl.) K.D.Hill & L.A.S.Johnson) that gradually turns bitter (Ryan 2017), or the visual cue of overgrown grass in home yards signalling neglect in Detroit neighborhoods (Chenoweth 2017). It also evident in the scent of *khakibos* (*Tagetes minuta*), resembling mentholated ointment well known among Rastafarians in Matzikama, South Africa (Ellis 2018), the ripening of *chanar* fruit (*Geoffroea decorticans* (Gillies ex Hook. & Arn.) Burkart) marked by the chirping of shiny cowbirds (*Molothrus bonariensis* (Gmelin, 1789)) in Bolivia (Sugiyama et al. 2020), the garlic-like scent of *Banksia* flowers (Ryan 2013), the comforting smell of lavender that evokes memories of home and family (Ryan 2017), and the snapping sound of witch hazel (*Hamamelis virginiana* L.) (Walls 2017).

In addition to comparing the three types of memory, this study also needs to be contextualized within the broader body of research on *Cinchona*. It is difficult to find studies that apply a memory framework to the species. Typically, *Cinchona* is examined through the lens of local knowledge concerning its consumption, medicinal use, and cultivation methods (Philip 1995; Chakrabarti 2010; Crawford 2010, 2021; Júnior et al. 2012; Gachelin et al. 2017; Jäger 2018; Mekonnen et al. 2025; Rodriguez 2025). For example, in the precolonial period, *Cinchona* was reportedly widely used by native healers in the Andean regions as a medicinal plant, and by indigenous peoples as a remedy for shivering caused by exposure to humidity and cold (Philip 1995; Crawford 2010, 2021; Júnior et al. 2012; Gachelin et al. 2017; Jäger 2018). In Brazil, the identification of plants referred to as "*quina*" is done their distinct bitterness, and includes species from another genus such as *Solanum pseudoquina* A.St.-Hil. (*quina do Piauhy*) and *Strychnos pseudoquina* A.St.-Hil. (*quina do campo*) and used for medicinal purposes (Cosenza et al. 2013; Rodriguez 2025). A similar tendency can also be seen in the Rajahmundry region of India, where *Soymida febrifuga* (Roxb.) A.Juss. is used locally as a febrifuge and remedy for stomach ailments (Chakrabarti 2010). In addition, the plant was once explored as a potential remedy for COVID-19, a discourse also presents in the context of *Cinchona* plantations in Darjeeling, India (Middleton 2019, 2021, 2024).

From this body of literature on *Cinchona*, it is evident that studies employing an ethnobotanical memory framework are rare. Most rely on a local knowledge approach, emphasizing how communities understand and engage with plants in ways that are bounded to their local context (Crawford 2010, 2021; Júnior et al. 2012; Jäger 2018). Even so, there is potential overlap between the frameworks of local knowledge and ethnobotanical memory. As demonstrated in this study, the ethnobotanical memory of *Cinchona* contains elements of local knowledge, such as its uses and production stages. However, prior studies on local knowledge have not examined *Cinchona* as a former colonial plantation commodity situated within a landscape that has undergone land-use transformation.

In this research, each memory narrative identified can only emerge from the political-economic conditions that enabled the presence of *Cinchona* plantations in Indonesia. It is rooted in colonial and imperial histories, as well as scientific developments in botany during the late 19th to 20th centuries to serve demand for anti-malarial medicine. In sum, human memory of a particular plant species must be situated within broader global socio-economic contexts. This study offers a novel contribution by mapping the distribution of memory related to *Cinchona*. That distribution is reflected in the minimal intergenerational transmission of memory regarding the species. This is largely a result of the normalization of land use transformation as will be discussed in the following section.

Land use transformation and the absence of conservational efforts of *Cinchona*

The ethnobotanical memory narratives above are recollection of the past and no longer practiced today. This happened due to land-use transformation that have led to the decreasing population of *Cinchona.* Furthermore,

conservation efforts for this plant remain very limited, one of which is reflected in the existence of the '*Musium Kina*,' meaning the Museum of *Cinchona* (Figure 6). *Museum Kina* serves as a physical monument that deliberately records the once-thriving *Cinchona* plantation, also functions as a landmark that serves as a gateway to the village. This landmark features a stretch of vegetable gardens with raised lettering spelling out "TJIKEMBANG", situated to the left of the road from northern part, and serves as a welcome sign. Amidst the garden, several tall, leafless *Cinchona* trees stand prominently. This monument was originally established by plantation authorities in the 1980s as a public park and was intended to conserve *Cinchona* species despite the closure of the plantation. Nevertheless, this conservation effort can be considered a failure, as the tree population has continued to decline due to the interests of land authorities. In May 2024, there were 10-15 trees, which then decreased to only 2 individuals by August 2024.

The absence of *Cinchona* conservation efforts is related to local land-use preferences. *Cinchona* is considered less profitable to cultivate individually. The reason is that this plant requires a long time before it can be harvested, up to 10 years. This botanical characteristic makes it less profitable compared to vegetables, which can be harvested twice a year. In addition, the absence of middlemen outside the plantation system also made it difficult for local residents to market the cultivation of *Cinchona* grown individually. This situation is somewhat different from other plantation commodities, such as tea, which can be planted on privately owned land due to the availability of alternative middlemen outside plantation institutions.

Therefore, the failure of conservation efforts can be attributed to several factors. *Cinchona* is a Neotropical species that was introduced as a commodity for imperialism. When global demand declines, a plant can lose its commercial value, as happened with *Cinchona* after World War II. In addition, population pressure on land has also been an influential factor. This allowed local communities to shift land use from *Cinchona* plantations to subtropical vegetable farming (Mulyanto 2022). The transformation was shaped by broader political climate of the time, which encouraged widespread land occupations across Java and Sumatra as a reaction to the unfulfilled agrarian reform during the New Order regime (Bachriadi and Lucas 2001; McCarthy and Robinson 2016). This land use transformation was also driven by the 1970s Green Revolution which provided synthetic fertilizer and pesticide supplies to highland farmers, enabling the practice of upland agriculture (Mulyanto 2022). The provision of Agricultural Business Credit (*Kredit Usaha Tani*) in the early 2000s also provided start-up capital for new farmers. This lack of conservation effort contrasts with other regions, such as China and Kenya, where bio-cultural heritage landscapes have successfully integrated tourism, local customs, and livelihood systems (Su et al. 2016a, b, 2018; Ekblom et al. 2019).

On decreasing *Cinchona* population and the loss of ethnobotanical memory

The absence of conservation efforts for *Cinchona* species in study area has led to the loss of ethnobotanical memory. In this context, knowledge and memory of *Cinchona* are generally retained only by those who directly lived alongside the *Cinchona* plantation during its active period. Such memory is not transmitted to their younger generations, such as children and grandchildren. The distribution of this ethnobotanical memory can be seen in the diagram (Figure 7).

Residents under the age of 30, who have never lived in direct proximity to *Cinchona* plantations, tend to know only the general terms of '*kina,*' '*sulibra*,' or '*subsirubra*.' Beyond that, they possess no knowledge related to *Cinchona* due to the absence of intergenerational transmission. This tendency is evident in their inability to recognize the plant itself. Some even stated that all of it had completely disappeared from the village, without recognizing the remaining *Cinchona* trees in the area of *Museum Kina*. This inability to recognize the species is also accompanied by a lack of knowledge about the cultural practices surrounding it, such as plantation production stages and local consumption for medicinal purposes.

This loss of memory occurred due to the decreasing population of *Cinchona* as a result of land use transformation. The landscape that was once filled with *Cinchona* has undergone significant clearing. The decreasing population of this species has led to the disappearance of related activities, from production to local medicinal use of the plant. Eventually, along with growing insecurity related to land tenure, the memory of those cultural practices continues to fade. At present, although the land is occupied by farmers, its legal rights still fall under plantation leasehold. In other words, preserving memory of the *Cinchona* among the village residents is tantamount to recalling the vulnerability of the land that underpins their livelihoods.

Figure 6. Neglected *Musium Kina* in Cikembang Village, Kertasari Sub-district, Bandung District, West Java, Indonesia

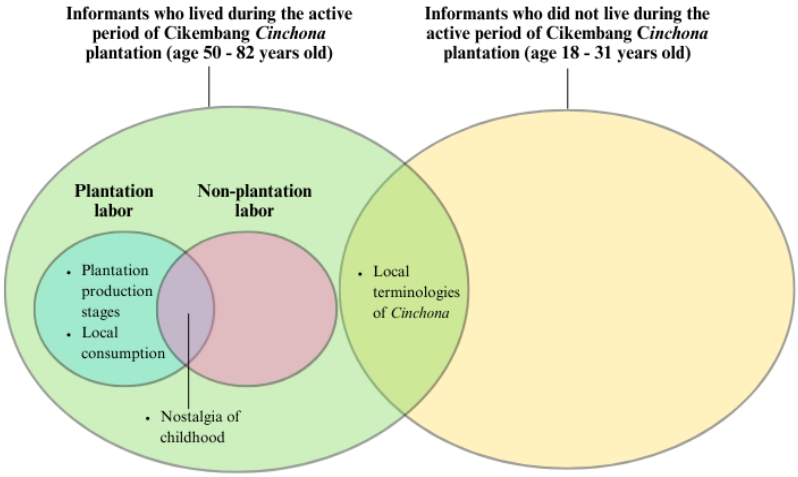

Figure 7. A diagram illustrating the relationship between informant categories and ethnobotanical memory narratives

This condition illustrates the co-evolution between biological and cultural aspects, forming a complex adaptive system as reflected in the concept of bio-cultural diversity. There exists interdependence linking plant and animal species together with their habitats and ecosystems (biological diversity), as well as various types of human cultures and languages (cultural and linguistic diversity) (Harmon 1996; Dressler 2005; Maffi 2007, 2018; Agnoletti and Rotherham 2015; Amici et al. 2015). The close connection between biological and cultural diversity is commonly observed in rural areas, based on the assumption that rural communities live in a more 'traditional' and 'nature-bound' manner (Agnoletti and Rotherham 2015). In relation to this, land use becomes a crucial factor in determining the existence of biological species, which then co-evolve with the cultural practices of surrounding human populations (Amici et al. 2015). This bio-cultural diversity perspective is clearly applicable to the phenomenon of the loss of ethnobotanical memory associated with *Cinchona* occurring in study area due to the decreasing species population. The interdependence is clearly evident when the plantation ceased operations, seen in the loss of ethnobotanical memory among the younger generation of local residents.

Another important point to note concerns the testimonies of individuals. oftentimes, they do not realize that the memory and knowledge of *Cinchona* are undergoing a process of forgetting within their own community. However, this impression can be obtained through the researchers' own analysis, a tendency commonly observed in studies related to memory and local knowledge. This implies that researchers need to be more attentive in uncovering and analyzing the underlying meanings.

In conclusion, ethnobotanical memory related to *Cinchona* can be gleaned from the testimonies of local residents in the study area as a post-plantation landscape. The memory narratives include local botanical terminology, sentiments of childhood nostalgia, plantation production stages, and local consumption for medicinal purposes. These memory narratives surrounding *Cinchona* illustrate how human cultural interactions and the presence of the species in the village were once closely intertwined, but have gradually faded over time. The fading of this ethnobotanical memory is primarily due to the absence of conservation efforts for the species, driven by several factors such as the collapse of the *Cinchona* bark market, population pressure, and land-use transformation. This led the interdependence of biological species, cultural practices, and linguistic expressions. Both memory and practice related to *Cinchona* have likewise been undergoing a process of erasure. This may represent a strategic adjustment in sustaining current livelihood strategies as vegetable farmers whose land remains part of the former plantation concession and who face the risk of eviction at any time. In other words, the presence of biological species and cultural activities (in this case, memory) are deeply interconnected and influenced by the broader national political-economic context. Thus, the story of a plant is not merely about sentiment or nostalgia, it also reflects the wider political-economic structures that shape it.

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