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Identifying plant species and their usage for landscape on the historical mural paintings of Nan, Thailand

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ABSTRACT

Nowadays, marketing influences landscape design plant selection in Thailand, with less concern for ecology, culture, or local identity. Archaic murals showing historical contexts offer extraordinary evidence related to the effort to understand the history of plants in the geographic area. It is highly informative to study whether plants on murals correlate with plants that were part of daily life at the time that the murals were created. The study of Thailand's famous murals at Phumin and Nongbua temples is the first complete identification of plant species in Tid Buaphan's murals in Nan province. It aims to (1) document the plants on the murals in a database, (2) categorize and analyze them in order to identify their species, and (3) validate the plant species and study how they were used for landscape design in various contexts.

The murals at both temples were examined, photographed, and coded for documentation in a database. The collected pictures were classified by physical characteristics and identified by investigating the Tai Lue scripts and Lord Buddha allegories, which are represented as stories on the murals. Moreover, some realistic paintings were analyzed and compared with botany literature and discussed in interviews with a botanist.

There are 259 paintings in 76 groups at Phumin temple, and 560 paintings in 138 groups at Nongbua temple. The results show 35 hypothetical species, including eight exotic species. Plants are represented in various contexts, including residences, towns, and agricultural and natural areas. The identified species were potentially used for consumption, daily use, ornamentation, or a representions of religious or cultural beliefs. This research suggests plant species that reveal their historical value and can be used for current landscape design that seeks to express the historical and cultural values of Nan province.

Keywords: plant species, landscape, mural painting, plant identification, Thai painting, Thai temple

INTRODUCTION

These days, landscape and garden design in Thailand is influenced more by commercial marketing and less by concern for ecology, maintenance, or place identity, especially in historical and cultural heritage areas. Finding an appropriate plant species for any given design is critical in order to encourage designers to use suitable plant materials in the right places. One useful method for achieving this is performing plant species identification from painted murals that show life and nature in a certain period (Francissen, 1987) as they offer excellent evidence to enhance understanding of the culture, environment, and plants used in various landscape situations in the past.

Nan was once one of the most remote provinces in Thailand. Because of its salt resources, this area was often targeted for potential or actual takeover by many kingdoms such as Burma, Lanchang, and Lanna. Ultimately, Nan became a colony of Siam (Thailand's former name) in 1801, and was fully incorporated into Siam in 1931 (Majesty, 2001).

Having been acquired and lost by several kingdoms over time, Nan developed a unique character of art and culture driven by many tribes. Tai Lue was the most prominent tribe that emigrated from South China to settle in the area (Chueasaart, 1995) and created much art and culture in Nan province. One of Nan's most famous art pieces is a mural painted at Phumin temple, Muang Nan district, constructed in 1596 (Kaewpenthong, 2013). The temple underwent a significant renovation from 1867 - 1874, during the reign of King Rama IV (Dejwongya, 2018), and the mural is most likely to have been painted in 1894 (Imsamraan & Boonyananta, 2020).

While Phumin temple's mural paintings are wildly praised, Nongbua temple, located in the Thawangpha district, which has the same style of mural paintings, has never been studied. The assumption is that "Tid Buaphan" and his team painted both (Prabripoo, 2009). Significantly, there are only two temples in Nan province with Tid Buaphan artistry. This research is a complete analysis of plant species in Tid Buaphan's mural paintings in Nan province.

The mural paintings of the Phumin temple and Nongbua temple were painted in a realistic style. Studies of the Phumin temple describe the fabrics, tribal characteristics, culture, and so on depicted in the murals (Wimolkasem, 2019), and they offer substantial potential for the study of plants related to various contexts at that time. This research aims to (1) Document the plant species shown in the painted murals and to create a database for future use, (2) Categorize and analyze to identify and infer the identity of the plant species, and (3) Study plants used for landscape design in various contexts and validate plant species, as shown on mural paintings at that time. The study will show plant characteristics and examples in specific places, and should provide a guideline for landscape design today, especially when the design is related to the historical or cultural context of Nan province during the 19th century.

Current literature in Thailand has previously made comparisons between the plants shown in mural paintings and reality; however, no known research has systematically organized and analyzed the information to create a database designed according to academic principles.

LITERATURE REVIEW

Usually, plants in mural paintings were painted from artists' imaginations and daily life experiences (Francissen, 1987). Typically, plants in murals are historical records, and past attempts have been made to investigate them as part of an effort to understand the contexts of nature, society, and culture that influenced the plant's selection. What has been studied has been the identification of plant species used for decoration, consumption, or as cash crops (Voyiatzi et al., 1999; Francissen, 1987). Pächt (1950) determined plant species associated with the use of their fine arts. Sabernig (2014) researched plants and herbs in connection with ancient medical practices. Yi (2012) and Bopearachchi (2020) studied plant species to understand their relationship to cultural beliefs and religion, respectively.

Although plants in the mural paintings of Phumin temple and Nongbua temple are painted in a realistic style and can be inferred to be specific plant species from the botanical point of view, the paintings do not describe them or make explicit

identification explicitly (Francissen, 1987); what is required is a study of the mythology, culture, and history of Nan. Previously, there have been only a few articles that have carried out plant identification methods in murals paintings. For example, the article, *A Century of Scientific Research on Plants in Roman Mural paintings* (1879-1979) (Francissen, 1987), identified plants shown on murals in the Roman period by physically analyzing the plant images, studying plants in mythology, and inspecting plant distribution in the region. Another article, *Sylvanic trees institutionalized in ancient Northeast Asia: Cultural and environmental significance of Dan-tree and Sa-tree* (Yi, 2012), studied and identified trees on murals in terms of belief and symbolic meaning by studying deeply into the narrative and history compared to the mural painting. *The History of the Murals in the Medical College at Labrang Monastery* (Sabernig, 2014) presented physical tree identification that supported the treatise on Tibetan medicine. The article, *Brahma at the Ajapala Banyan Tree: Re-Examining Paintings at the Sulamani temple, Bagan* (Bopearachchi, 2020), gives a study of tree identification compared with Lord Buddha literature. However, identified trees were not described from a botanical perspective. Each study in the reviewed literature utilized at least two methods comprising a documentary review, physical tree identification, and cross-validated identification of each plant.

RESEARCH METHODOLOGY

Each plant on the walls of Phumin and Nonbua temples was photographed, one plant type – one picture. At Phumin temple, 259 pictures were taken, and at Nongbua temple 560 pictures. All of the pictures were coded according to their locations and recorded in the database. They were then divided into groups with the same painting style, plant characteristics, height, form, and the character of leaf, trunk, root, branch, flower, and fruit.

The study of plants at Phumin temple and Nongbua temple made use of three methods for identification: (1) Translation of plant names printed in Thai Lue script, (2) Identification of plants from Lord Buddha allegories, and (3) Interviews with specialists to infer plants species from their physical characteristics. The results were later verified by comparison with *The Forest Herbarium*, 2014 (Thailand's plant community's database) to classify plant species into exotic and native (Figure 1).

A primary study and database collection have been underway since 2017 (Chatakul, 2017); however, there has never been a study of the Nongbua temple before. This research refers to the initial result of the Phumin temple study (Chatakul, 2017) and revisits it by interviewing additional specialists. With respect to the Nongbua temple, this research started from scratch with the same methodology that was utilized at Phumin temple, and then compared plant species on a mural paintings from both temples.

Collecting data and creating a plant database

Phumin temple's chapel has mural paintings on twelve walls, while Nongbua temple's chapel has mural paintings on four walls. Plants were captured photographically and encoded as, for example, on P02 and B02 walls, as shown in Table 1.

Identifying plants

After coding all pictures, plants found in the Phumin temple murals were classified into 76 groups and those at the Nonbua temple were divided into 138. Three methods were employed to identify all classified plants:

- Translation of plant names painted in Tai Lue script by interviewing a Tai Lue language specialist – The Tai Lue had their own language; this method is the most reliable.
- Review the Lord Buddha allegories related to the painted stories in the mural paintings and compare them with the plants found. This method can suggest plant species; however, it cannot ensure those plants belong to the Nan area.

- Infer the plant species by physical plant characteristics - Since the murals are painted in a realistic style, plant species can be inferred by reviewing and forming a consensus with a botanist who is a member of the Royal Institute of Thailand, and an associate professor in Department of Botany, Chulalongkorn University; a local philosopher, the heir of Lord Ananta-woraritthi-det, 62nd ruler of the Nan; and a painting expert.

Selected plant species were cross-checked with those plant species' geographical distribution (The Forest Herbarium, 2014) for precision, and to differentiate between native and exotic plant species.

This study revises the earlier results of plant species identification in mural paintings at the Phumin temple (Chatakul, 2017). Further, more plant species were identified by interviewing additional specialists.

Analysis and conclusion

Plant species were cross-validated with co-evidence from deep interviews, archived photos, and related literature to prove that plants on the murals were related to daily use in various contexts in the past. The identified plants were analyzed, in combination with spatial contexts in terms of consumption and other usage shown on the murals, to understand the utilization of plants in the landscape of that time; this identification and analysis were integrated with interviews of local philosophers and painting experts, and reference to existing literature. The methodology and analysis can be extended to other plant species, find various evidence leading to the future suggestion of plant usage in landscape design, and contribute to the current literature.

Figure 1

Research Methodology Diagram

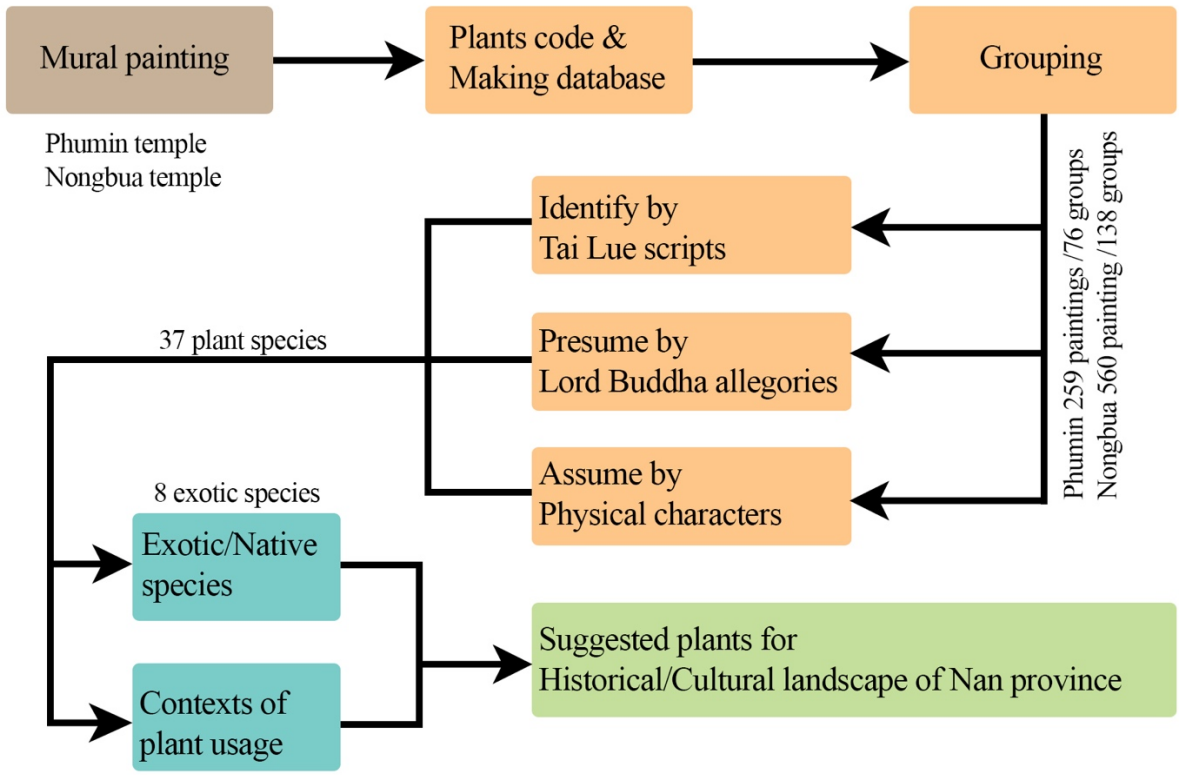
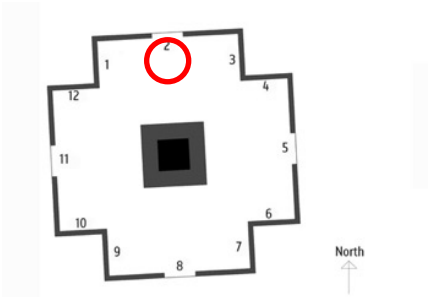
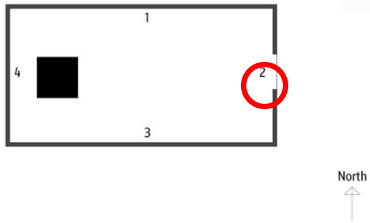


Table 1

Walls With Analyzed Mural Paintings and the Corresponding Plants Encoded (examples)

Wall with analyzed mural painting	Plants encoded
 Wall analyzed at Phumin temple.	 Phumin temple P02 wall.
 Wall analyzed at Nongbua temple.	 Nongbua temple B02 wall.

RESULTS

Plants database

Phumin temple has 259 paintings, classified into 76 groups (Chatakul, 2017), while Nongbua temple has 560 paintings of plants, organized into 138 groups.

Plant species

Identified plant species painted with Tai Lue description

According to Chatakul (2017), five plant species at the Phumin temple have Tai Lue descriptions, including *Ananas comosus* (Pineapple), *Dioscorea* sp. (Yam), *Ficus religiosa* (Sacred fig tree), *Musa* sp. (Banana), and *Oryza sativa* (Rice). Moreover, the present study found another tree with Tai Lue script identified as "Parukchat," the mythical tree of wishes that grew only in heaven.

Unfortunately, the Nongbua temple does not have any Tai Lue script for plant names. The writings on the murals at this temple only describe the story of Lord Buddha's allegory.

Presumed plant species from Lord Buddha's allegories

The stories in the murals of Phumin temple and Nong Bua temple comprise the story of the Buddha, who was born as a Bodhisattva of previous lives, going through various hardships

and obstacles with a firm determination to perform his virtues. The story of the Lord Buddha allegories does not appear in Tripitaka, but, instead, is a narrative that has been passed on from word of mouth, known as Paññāyāsa Jātaka (Northern Thai Sangha, 2009).

- **Phumin Temple**

The upper part of the murals at Phumin temple shows Lord Buddha and the apostles. This part contains plants in several scenes; however, no story or direct evidence describes the plant species exactly.

The lower part of the murals tells the stories of Katthanakumara and Nemiraja (Lord Buddha reincarnation, according to Lanna beliefs). The tale of *Katthanakumara* shows the adventure of Katthanakumara attached to the moral of living. Katthanakumara was the son of Indra, the ruler of deities, and an ordinary woman. During his life, he traveled through many kingdoms to help people suffering from calamities. At the same time, the story of *Nemiraja* illustrates heaven and hell. Because Nemiraja was a good king, Indra (Katthanakumara's father) was permitted to guide him (Nemiraja) through heaven and hell. After the journey, Nemiraja came back and taught his people to live a good way of life.

The murals show various scenes that contain many plants. There are five plant species related to Lord Buddha's allegories at Phumin temple, including *Borassus flabellifer* (Toddy palm*), Dioscorea* sp. (Yam), *Oryza sativa* (Rice), and the mythical tree of wishes (The imaginary tree which grew in heaven) (Chatakul, 2017). It is evident that the plant species mentioned in the Lord Buddha allegories are not what the artist envisioned in the story. The story of *Katthanakumara* is, in fact, carved into a windowpane at Ong Theu temple, Vientiane, Laos. It consists of the same plants as those in the murals at Phumin temple. For example, Figure 2 shows *Oryza sativa* (Rice) and *Borassus flabellifer* (Toddy palm), which are clearly part of the story.

Figure 2

Carved Door and Window at Ong Theu Temple, Laos

- **Nongbua Temple**

The mural paintings at Nongbua temple illustrate the story of *Chandracath* (one of Lord Buddha's reincarnations, according to Lanna beliefs). Two brothers, Suriyacath (Suncatcher) and Chandracath (Mooncatcher), were born into a poor family, and the adventure begins when they accidentally find the mythical tree of resurrection. They travel through many reigns until finally, they become kings.

The story of *Chandracath* at Nongbua temple mentions 18 plant species. Still, only three plant species were found in the mural painting, which are presumed to be *Ficus* sp. (Fig tree), *Nelumbo nucifera* (Indian lotus), and the mythical tree of resurrection (The imaginary plant found in the Lord Buddha allegory).

Inferred identification based on physical plant characteristics

Additional information was obtained by interviewing the botanist, the local philosopher, and the painting expert after the preliminary study of Chatakul (2017), which improved the preparatory study hypothesis with respect to Phumin temple's plant species. What had previously been identified as *Dendrobium thyrsiflorum* (Dendrobium Orchid) was changed to *Dendrobium lindleyi* (Dendrobium Orchid). Moreover, eight more plant species were inferred by the botanist and the local philosopher: *Aegle marmelos* (Beal), *Artocarpus heterophyllus* (Jackfruit tree), *Burmannia disticha* (Double-Spike Bluethread), *Dipterocarpus alatus* (Yang), *Dipterocarpus costatus* (Yang-pai), *Duabanga grandiflora* (Beremban Bukit), *Erythrina subumbrans* (Indian coral tree), and *Leonotis nepetifolia* (Lion's ear).

From the murals at Phumin temple, twenty-five plant species identifications can be inferred from the realistic style of painting: *Aegle marmelos* (Beal), *Ananas comosus* (Pineapple), *Areca catechu* (Areca palm), *Artocarpus heterophyllus* (Jackfruit tree), Bambusoideae (Bamboo), *Benincasa hispida* (Wax gourd), *Bombax ceiba* (Cotton tree), *Burmannia disticha* (Double-Spike Bluethread), *Cocos nucifera* (Coconut), *Dendrobium lindleyi* (Dendrobium orchid), *Dipterocarpus alatus* (Yang), *Dipterocarpus costatus* (Yang-pai), *Duabanga grandiflora* (Beremban Bukit), *Entada rheedii* (St. Thomas's bean), *Erythrina subumbrans* (Indian coral tree), *Ficus religiosa* (Sacred fig tree), *Gossypium nanking* (China cotton). *Lasia spinosa* (Unicorn plant), *Leonotis nepetifolia* (Lion's ear), *Musa* sp. (Banana), *Nelumbo nucifera* (Indian lotus), *Oryza sativa* (Rice), *Paeonia suffruticosa* (Shrubby peony), *Saccharum officinarum* (Sugar cane), and *Schefflera* sp. (Umbrella tree).

From the Nonguua temple murals, twenty plant species identifications can be inferred: *Ananas comosus* (Pineapple), *Areca catechu* (Areca palm), Bambusoideae (Bamboo), *Benincasa hispida* (Wax gourd), *Capsicum annuum* (Cayenne pepper), *Cocos nucifera* (Coconut), *Dendrobium lindleyi* (Dendrobium orchid), *Duabanga grandiflora* (Beremban Bukit), *Ficus religiosa* (Sacred fig tree), *Ficus* sp. (Common fig), *Lasia spinosa* (Unicorn plant), *Leonotis nepetifolia* (Lion's ear), *Mangifera indica* (Mango tree), *Nelumbo nucifera* (Indian lotus), *Nymphaea* sp. (Water lily), *Oryza sativa* (Rice), *Paeonia suffruticosa* (Shrubby peony), *Salix tetrasperma* (Indian willow), *Senegalia rugata*, and *Sterculia pexa*.

Final plants species result (combined results)

The research resultd in identification of 37 plant species painted on the walls of Phumin and Nongbua temples (Table 2).

Table 2

Final Plant Species Identification From Phumin Temple and Nongbua Temple

No.	Scientific Name	Common Name	Place		Methodology			Exotic plants
			Phumin temple	Nongbua temple	Tai Lue language	Buddha allegories	Realistic paint	
1	*Aegle marmelos*	Beal	x				x	T
2	*Ananas comosus*	Pineapple	x		x		x	ExH
				x			x	
3	*Areca catechu*	Areca palm	x				x	ExP
				x			x	
4	*Artocarpus heterophyllus*	Jackfruit tree	x				x	ExT
5	Bambusoideae	Bamboo	x				x	-
				x			x	
6	*Benincasa hispida*	Wax gourd	x				x	ExHC
				x			x	
7	*Bombax ceiba*	Cotton tree	x				x	T
8	*Burmannia disticha*	-	x				x	SapH
9	*Borassus flabellifer*	Toddy palm	x			x		P
10	*Capsicum annuum*	Cayenne pepper		x			x	ExUS
11	*Cocos nucifera*	Coconut	x				x	ExP
				x			x	
12	*Dendrobium lindleyi*	Dendrobium orchid	x				x	EO
				x			x	
13	*Dioscorea* sp.	Yam	x		x	x		HC
14	*Dipterocarpus alatus*	Yang	x				x	T
15	*Dipterocarpus costatus*	Yang-pai	x				x	T
16	*Duabanga grandiflora*	-	x				x	T
				x			x	

Table 2 (Continued)

No.	Scientific Name	Common Name	Place		Methodology			Exotic plants
			Phumin temple	Nongbua temple	Tai Lue language	Buddha allegories	Realistic paint	
17	*Entada rheedii*	St. Thomas's bean	x				x	C
18	*Erythrina subumbrans*	Indian coral tree	x				x	T
19	*Ficus religiosa*	Sacred fig tree	x		x		x	ExT
				x			x	
20	*Ficus* sp.	Common fig		x			x	-
21	*Ficus* sp.	Fig tree		x		x		-
22	*Gossypium nanking*	China cotton	x				x	ExS
23	*Lasia spinosa*	Unicorn plant	x				x	H
				x			x	
24	*Leonotis nepetifolia*	Lion's ear	x				x	H
				x			x	
25	*Mangifera indica*	Mango tree		x			x	T
26	*Musa* sp.	Banana	x		x		x	H
27	*Nelumbo nucifera*	Indian lotus	x				x	AqH
				x		x	x	
28	*Nymphaea* sp.	Water lily		x			x	-
29	*Oryza sativa*	Rice	x		x	x	x	G
				x			x	
30	*Paeonia x suffruticosa*	Shrubby peony	x				x	ExS
				x			x	
31	*Saccharum officinarum*	Sugar cane	x				x	G
32	*Salix tetrasperma*	Indian willow		x			x	T
33	*Schefflera* sp.	Umbrella tree	x				x	-
34	*Senegalia rugata*	-		x			x	ScanS

Table 2 (Continued)

No.	Scientific Name	Common Name	Place		Methodology			Exotic plants
			Phumin temple	Nongbua temple	Tai Lue language	Buddha allegories	Realistic paint	
35	*Sterculia pexa*	-		x			x	ST/T
36*	-	Mythical tree of the wish	x		x	x		-
37*	-	Mythical tree of resurrection		x		x		-

Note. AqH = Aquatic Herb, C = Climber, EO = Epiphytic Orchid, ExH = Exotic Herb, ExHC = Exotic Herbaceous Climber, ExP = Exotic Palm, ExS = Exotic Shrub, ExT = Exotic Tree, ExUS = Exotic Undershrub, G = Grass, H = Herb, HC = Herbaceous Climber, P = Palm, SapH = Saprophytic Herb, ScanS = Scandent Shrub , ST = Shrubby Tree, T = Tree

Table 3

Plant Species Found at the Phumin Temple

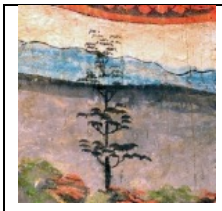
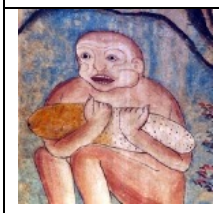
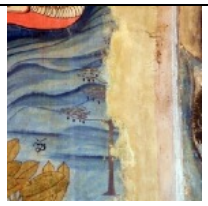
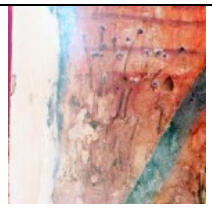
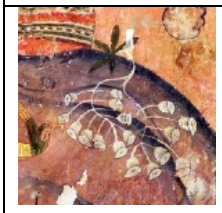
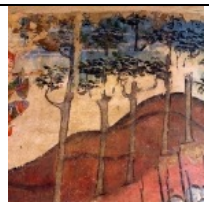
 Beal	 Pineapple	 Areca palm	 Jackfruit tree	 Bamboo
 Wax gourd	 Cotton tree	 *Burmannia disticha*	 Toddy palm	 Coconut
 Dendrobium orchid	 Yam	 Yang	 Yang-pai	 *Duabanga grandiflora*

Table 3 (Continued)

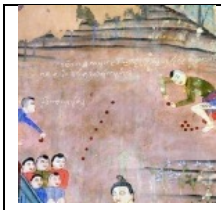
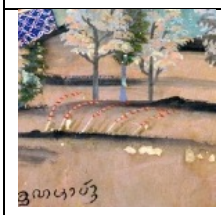
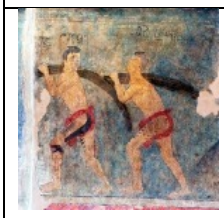
 St. Thomas's bean	 Indian coral tree	 Sacred fig tree	 China cotton	 Unicorn plant
 Lion's ear	 Banana	 Indian lotus	 Rice	 Shrubby peony
 Sugar cane	 Umbrella tree	 Mythical tree of the wish		

Table 4

Plant Species Found at the Nongbua Temple

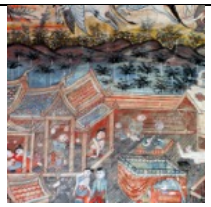
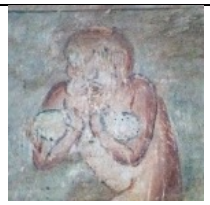
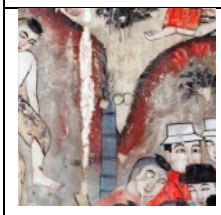
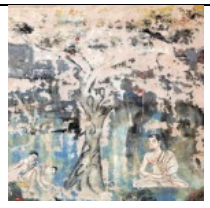
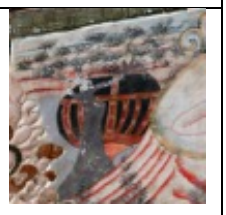
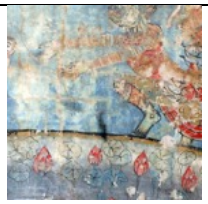
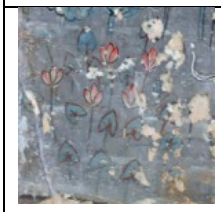
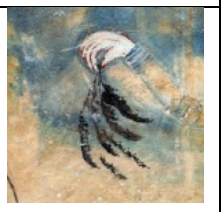
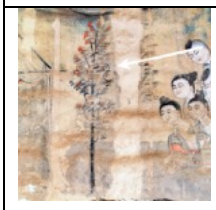
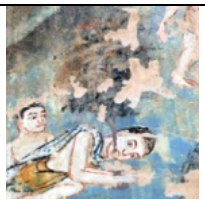
 Pineapple	 Areca palm	 Bamboo	 Wax gourd	 Cayenne pepper
 Coconut	 Dendrobium orchid	 *Duabanga grandiflora*	 Sacred fig tree	 Fig tree

Table 4 (Continued)

 Common fig tree	 Unicorn plant	 Lion's ear	 Mango tree	 Indian lotus
 Water lily	 Rice	 Shrubby peony	 Indian willow	 *Senegalia rugata*
 *Sterculia pexa*	 Mythical tree of resurrection			

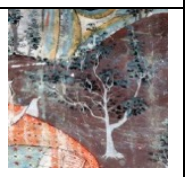
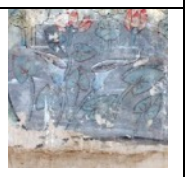
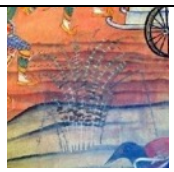
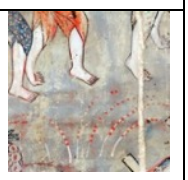
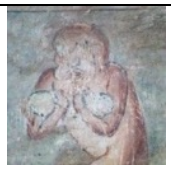
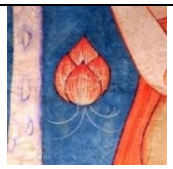
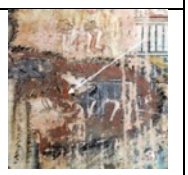
Two mythical trees were found in the mural painting, which cannot be added to the result: the Tree of Wishes and the Tree of Resurrection.

The identies of seven plant species could not be precisely inferred because the mural paintings do not have enough information. These species comprise Bambusoideae (Bamboo), *Dioscorea* sp. (Yam), *Ficus* sp. (Common fig), *Ficus* sp. (Fig tree), *Musa* sp. (Banana), *Nymphaea* sp. (Water lily), and *Schefflera* sp. (Umbrella tree) (note that sp. is an abbreviation for species used when the actual name cannot be specified). Each Genus has many species and hybrids that have similar characteristicsthat are not shown or cannot be distinguished on the mural paintings.

There are 13 species that were found in both temples: *Ananas comosus* (Pineapple), *Areca catechu* (Areca palm), Bambusoideae (Bamboo), *Benincasa hispida* (Wax gourd), *Cocos nucifera* (Coconut), *Dendrobium lindleyi* (Dendrobium orchid), *Duabanga grandiflora* (Beremban Bukit), *Ficus religiosa* (Sacred fig tree), *Lasia spinosa* (Unicorn plant), *Leonotis nepetifolia* (Lion's ear), *Nelumbo nucifera* (Indian lotus), *Oryza sativa* (Rice), and *Paeonia suffruticosa* (Shrubby peony) as shown in Table 5 (Prabripoo, 2009). The plants in both mural paintings were painted in the same style, as expected since Tid Buaphan and his team painted both temples.

Table 5

Plant Species Found at Both Temples

Plant name	Phumin temple	Nongbua temple	Plant name	Phumin temple	Nongbua temple
Pineapple			Sacred fig tree		
Areca palm			Unicorn plant		
Bamboo			Lion's ear		
Wax gourd			Indian lotus		
Coconut			Rice		
Dendrobium orchid			Shrubby peony		
Duabanga grandiflora					

DISCUSSION

The study found 35 hypothetical plant species in Phumin and Nongbua temple mural paintings. Some plant species are described in the Tai Lue language, the most reliable source for identification. Other plant species were presumed by relating the images to Lord Buddha's allegories. This is considered the second most reliable method. Relying on plant characteristics for identification in consultation with experts is the most challenging method. Still, some identifications were inferred using this final method.

Tid Buaphan, credited as the head mural painter of both Phumin temple and Nongbua temple,

created many scenes that were presumed to be inspired by the daily lives of Nan's people, as shown through costumes, architecture, and the activities of the people (Wimolkasem, 2019). Plant species offer further evidence to support this hypothesis. Of the 35 species found in the murals, 30 species are found distributed throughout the northern part of Thailand, including exotic ones, while five are not found in the region (The Forest Herbarium, 2014).

Plant species found in this study were painted in various contexts and places. They can be categorized into four locations, as shown in Table 6.

The identified plants painted in each context including (1) Residential areas that picture local houses with surrounding gardens, (2) Town areas that show palaces and many houses surrounded by town walls, (3) Agricultural areas that show rice fields or plantations and, (4) Natural areas, such as pastures, lakes, forest, etc., where there is no architecture were cross-validated with in-depth interviews, archived photos, and related pieces of literature to prove that plants found in the murals were inspired by the Nan environment, and reflected the usage of plants at that time.

Table 6

Locations of Plant Species

No.	Scientific Name	Common name	Place		context
			Phumin	Nongbua	
1	*Aegle marmelos*	Beal	x		natural area
2	*Ananas comosus*	Pineapple	x		town area
				x	residential area
3	*Areca catechu*	Areca palm	x		residential area, town area
				x	residential area, town area
4	*Artocarpus heterophyllus*	Jackfruit tree	x		natural area
5	Bambusoideae	Bamboo	x		natural area
				x	natural area
6	*Benincasa hispida*	Wax gourd	x		miscellaneous
				x	miscellaneous
7	*Bombax ceiba*	Cotton tree	x		town area
8	*Burmannia disticha*	-	x		natural area
9	*Borassus flabellifer*	Toddy palm	x		town area
10	*Capsicum annuum*	Cayenne pepper		x	natural area
11	*Cocos nucifera*	Coconut	x		residential area, town area
				x	residential area

Table 6 (Continued)

No.	Scientific Name	Common name	Place		context
			Phumin	Nongbua	
12	*Dendrobium lindleyi*	Dendrobium orchid	x		agricultural area
				x	natural area
13	*Dioscorea* sp.	Yam	x		agricultural area
14	*Dipterocarpus alatus*	Yang	x		natural area
15	*Dipterocarpus costatus*	Yang-pai	x		town area
16	*Duabanga grandiflora*	-	x		natural area
				x	natural area
17	*Entada rheedii*	St. Thomas's bean	x		residential area
18	*Erythrina subumbrans*	Indian coral tree	x		natural area
19	*Ficus religiosa*	Sacred fig tree	x		town area
				x	natural area
20	*Ficus* sp.	Common fig		x	natural area
21	*Ficus* sp.	Fig tree		x	natural area
22	*Gossypium nanking*	China cotton	x		residential area
23	*Lasia spinosa*	Unicorn plant	x		agricultural area
				x	natural area
24	*Leonotis nepetifolia*	Lion's ear	x		natural area
				x	natural area
25	*Mangifera indica*	Mango tree		x	miscellaneous
26	*Musa* sp.	Banana	x		residential area, town area
27	*Nelumbo nucifera*	Indian lotus	x		miscellaneous
				x	the natural area, miscellaneous
28	*Nymphaea* sp.	Water lily		x	natural area
29	*Oryza sativa*	Rice	x		agricultural area
				x	agricultural area

Table 6 (Continued)

No.	Scientific Name	Common name	Place		context
			Phumin	Nongbua	
30	*Paeonia x suffruticosa*	Shrubby peony	x		the natural area, miscellaneous
				x	miscellaneous
31	*Saccharum officinarum*	Sugar cane	x		miscellaneous
32	*Salix tetrasperma*	Indian willow		x	natural area
33	*Schefflera* sp.	Umbrella tree	x		natural area
34	*Senegalia rugata*	-		x	miscellaneous
35	*Sterculia pexa*	-		x	residential area
36	-	Mythical tree of the wish	x		miscellaneous
37	-	Mythical tree of resurrection		x	natural area

Note. Miscellaneous means plants or parts of plants that are painted for decoration or are not set in any landscape context, such as a tree in heaven, flowers for hair decoration, or religious symbols.

Residential areas

Identified, presumed, and inferred plant species were reviewed with a local philosopher to understand how Nan's people use them, and to support the assumptions of plant species found in mural paintings (Figure 3-4). There were 7 plant species painted in the residential areas: *Ananas comosus* (Pineapple), *Areca catechu* (Areca palm), *Cocos nucifera* (Coconut), *Entada rheedii* (St. Thomas's bean), *Gossypium nanking* (China cotton), *Musa* sp. (Banana), and *Sterculia pexa.*

As depicted in the mural paintings, Nan province residents cultivated valuable plants, such as edible plants, around the house. The mural paintings show that fruits -- *Areca catechu* (Areca palm), *Cocos nucifera* (Coconut), and *Musa* sp. (Banana) -- were planted in an edible garden nearby the house, and they were placed in the agricultural area next to the edible house garden, too. In addition, some houses were decorated with ornamental trees, which cannot be identified, and flowering shrubs along the fence.

According to an interview with a local philosopher, the heir of Lord Ananta-woraritthi-det, 62nd ruler of the Nan, historically, the planting around dwellings in Nan province emphasized plants that were consumable or useful in daily life. Other useful plants found in natural areas were harvested instead of being grown in residential areas. Intensive gardening for landscape aesthetics was not a common practice. Only a small number of plants for ornamentation and belief were cultivated.

At the time period of the murals, houses in Nan province were wooden and raised on stilts. The basement was used for activities such as textile weaving and, sometimes, cooking during the summer months. Weaving in Nan province commonly relies on the use of fibers from *Gossypium nanking* (China cotton), a large and long-living herbaceous cotton plant with pink-white flowers. Other types of cotton, such as *Gossypium barbadens* and *Gossypium hirsutum*, were later imported, as seen from the murals depicting weavers in the basement under the house, with cotton-like flowering shrubs nearby. Cooking was another activity that influenced the

selection of plants, with a focus on ones that could be freshly consumed and processed in the house.

In craftsmanship, various species of beautiful seasonal and fragrant flowers were used to create ceremonial bouquets. *Acalypha hispida* (Chenille plant), *Gardenia jasminoides* (Cape jasmine), *Jasminum sambac* (Arabian jasmine), and *Rosa x damascena* (Damask rose) were grown for essential oil extraction. Moreover, other beautiful flowers such as *Senna suratensis* and *Crerodendrum viscosum* were used in various ceremonies. *Paeonia x suffruticosa* (Shrubby peony) was planted with the belief that it would bring luck to the house.

This research categorized the past household plants of Nan province into four groups: (1) Edible plants and herbs, (2) Consumable plants in daily life, (3) Decorating plants, and (4) Plants for other purposes.

Edible plants and herbs

Native species include *Alpinia galanga* (Galangal), *Bombax ceiba* (Cotton tree), *Bouea macrophylla* (Gandaria), *Cephalostachyum pergracile* (Asian bamboo), *Colocasia esculenta* (Taro), *Dimocarpus longan* (Longan), *Diospyros decandra* (Gold apple), *Lasia spinosa* (Unicorn plant), *Mangifera indica* (Mango tree), *Musa* sp. (Banana), *Oryza sativa* (Rice), *Sandoricum koetjape* (Santol), *Senegalia rugata* (Shikakai), *Zanthoxylum rhetsa* (Indian prickly ash). Exotic species, including *Allium ascalonicum* (Shallot), *Allium sativum* (Garlic), *Areca catechu* (Areca palm), *Artocarpus heterophyllus* (Jackfruit tree), *Benincasa hispida* (Wax gourd), *Capsicum annuum* (Cayenne pepper), *Citrus x aurantifolia* (Lime), *Cocos nucifera* (Coconut), *Nicotiana tabacum* (Tobacco), and *Perilla frutescens* (Deulkkae).

Consumable plants in daily life

Native species include *Clerodendrum infortunatum* (Bhat), *Gossypium nanking* (China cotton), *Millingtonia hortensis* (Indian cork tree), and *Murraya paniculata* (Orange jasmine). The one exotic species identified is *Rosa x damascena* (Damask rose).

Decorating plants

Native species include *Chassalia curviflora* (Chassalia), *Dendrobium densiflorum* (Dendrobium orchid), *Dendrobium lindleyi* (Dendrobium orchid), *Dendrobium sulcatum* (Dendrobium orchid), *Gloriosa superba* (Flame lily), *Hedychium villosum*, *Mimusops elengi* (Bullet wood), *Nymphaea* spp. (Water lily), *Rhynchostylis gigantea* (Foxtail orchid), *Spathoglottis* spp. (Ground orchid), *Vanda* sp. (Vanda orchid). Exotic species include *Acalypha hispida* (Chenille plant), *Cananga odorata* (Cananga tree), *Gardenia jasminoides* (Cape jasmine), *Hibiscus* sp., *Jasminum sambac* (Arabian jasmine), *Paeonia x suffruticosa* (Shrubby peony), *Plumeria rubra* (Frangipani), *Senna surattensis* (Scrambled egg bush), and *Zephyranthes* spp. (Fairy lily).

Plants for other purposes

Native species include *Azadirachta indica* (Neem tree) and *Ficus* sp. (Fig tree). Exotic species include *Ficus religiosa* (Sacred fig tree).

Therefore, four of the seven plants found on murals -- *Areca catechu* (Areca palm), *Cocos nucifera* (Coconut), *Gossypium nanking* (China cotton), and *Musa* sp. (Banana) -- were used around the house. In addition, based on results of the interviews, Nan people also used other twelve species that were depicted in different contexts rather than residential areas, namely *Artocarpus heterophyllus* (Jackfruit tree), *Benincasa hispida* (Wax gourd), *Bombax ceiba* (Cotton tree), *Capsicum annuum* (Cayenne pepper), *Dendrobium lindleyi* (Dendrobium orchid), *Ficus religiosa* (Sacred fig tree), *Ficus* sp. (Fig tree), *Lasia spinosa* (Unicorn plant), *Mangifera indica* (Mango tree), *Nymphaea* spp. (Water lily), *Oryza sativa* (Rice), and *Paeonia x suffruticosa* (Shrubby peony).

However, results from the interviews further indicate that many merely beneficial species, but naturally grown in large numbers, such as *Cochlospermum regium* (Yellow cotton tree), *Shorea roxburghii* (White maranti), would be cleared out from the house area as they were considered undesirable.

Figure 3

The Landscape Around the House at Phumin Temple

Figure 4

The Landscape Around the House at Nongbua Temple

Town areas

The painter did not place any plants inside the town wall in the mural paintings, in contrast to the actual situations. It is assumed that the painter wanted to show unobstructed architecture related to the stories; according to the painting expert, the mural painter removed all plants in town to avoid concealing necessary buildings. However, two categories show the relationship between plants and towns.

- The painter mainly used trees for the town backgrounds. The big trees planted along the road were assumed to be *Dipterocarpus costatus* (Yang-pai), which was a new landscape design style at the time (Figure 5). Moreover, *Dipterocarpus alatus* (Yang) were planted along nearby roadside towns (Figure 6). The most renowned shaded road in Chiangmai is one where *Dipterocarpus alatus* (Yang) was planted along the roadside in 1902 (Boonart, 2011), just a few decades after these mural paintings (1867 – 1874).
- Some towns planted *Cocos nucifera* (Coconut) and *Areca catechu* (Areca palm) along the town walls. These species were famous edible palms widespread in past kingdoms in northern Thailand, as shown in Figure 7.

Figure 5

Big Trees are Planted Along the Road in the Phumin Temple Murals

Figure 6

The Big Trees are Planted Beside the Entrance Road in the Phumin Temple Murals

Figure 7

Areca Palms are Planted Along the Town Wall in the Nongbua Temple Murals

A comparison of the plants displayed in the murals with those found in photographs taken from the National Archives in 1958 reveal that, within the city wall context, plants on the murals differed from the photographs. However, plants in the photographs, such as coconut, areca palm, papaya, and jackfruit (Figure 8), were still young, and probably planted after the murals were painted.

On the other hand, in the area of Phra That Chae Haeng temple, outside the city walls, fully grown mango and palm tree are clearly shown in both the photographs (Figure 9) and murals. They are likely to have been in place for a long time, and are consistent with the murals at Phumin temple and Nong Bua temple.

Figure 8

Areca Palms Were Planted Along the Town Wall at Nongbua Temple

Note. A picture of an elephant dragging a log into the Nan river, Nan, 1958. From Photo No. Phǭ sǭ bǭ 4.2.90/4, 1958 by The National Archives of Thailand. Copyright 1958 by The National Archives of Thailand.

Figure 9

Landscape at Phra That Chae Haeng Area in 1958

Note. A picture of Wat Phra That Chae Heang, Nan, 1958 (left). From Photo No. Phǭ sǭ bǭ 4.2.89/13, 1958 by The National Archives of Thailand. Copyright 1958 by The National Archives of Thailand. A picture of Wat Phra That Chae Heang, Nan, 2022 (right)

Agricultural areas

From a site planning perspective, the agricultural area is on the outskirts of the town, with scattered residences. No monoculture was found in the murals except for the rice fields, which mainly comprise the agricultural areas in Nan province, and also mentioned in the Buddha allegories (Figure 10). However, there are organized planted tree areas shown in the Phumin temple murals (Figure 12), which implies that there was forestry in Nan province. According to the local philosopher, Nan used to supply *Tectona grandis* (Teak wood) for Bangkok. According to the painting expert, it can also be hypothesized that the painter was influenced by Krua Inkhong, the first painter to use the perspective technique in Thailand. There were four plant species found in the agricultural area: *Dendrobium lindleyi* (Dendrobium orchid), *Dioscorea* sp. (Yam), *Lasia spinosa* (Unicorn plant), and *Oryza sativa* (Rice). Edible plants, including Yam and Unicorn plants, were found around the agricultural area, representing the diversity of food in the geographic location.

Nan is an important rice-growing province, and it is the primary food in the region. The rice paddies appear in the plains between the mountains (Figure 11). The local philosopher said that, in the past, rice was cultivated in the Pua district to feed the soldiers and people in Nan province town as well.

According to interviews with the local philosopher, there are also paintings of consumable and naturally collected plants such as *Dioscorea* sp. (Yam), *Lasia spinosa* (Unicorn plant), and *Bombax ceiba* (Cotton tree) in agricultural areas. These plants demonstrate the past use of native plants of Nan Province. *Dioscorea* sp. (Yam) heads can be used for cooking. *Lasia spinosa* (Unicorn plant) leaves and petioles removed from the soil can be consumed. *Bombax ceiba* (Cotton tree) flowers are edible, especially ceiba species that produces red flowers, which is more popular because it tastes better than the white-flowered type of anceps. In addition, the botanist said in an interview that, during the old days, fibers in the sheaths of *Bombax ceiba* (Cotton tree) were used to stuff pillows. Recently, the imported *Ceiba pentandra* (white silk cotton) has become more popular since it provides more fiber.

The local philosopher also stated that in the past, Nan province had harvested and delivered products from *Zanthoxylum limonella* as a tribute to Bangkok. Its mature fruit and seeds were used as a spice for a fishy smell as a substitute for pepper. It is a unique spice of northern Thailand.

Figure 10

Rice Fields Shown in the Murals at Phumin Temple

Figure 11

Rice Field in 1958 at Phrathat Chae Haeng Temple Area

Note. A picture of Phra That Chae Heang temple, Nan, 1958. From Photo No. Phō̱ sō̱ bō̱ 4.2.89/12, 1958 by The National Archives of Thailand. Copyright 1958 by The National Archives of Thailand.

Figure 12

Planted Trees Shown in Murals at the Phumin Temple

Figure 13

Tobacco Plantation and Forestry in 1958 in Nan Province

Note. A picture of elephants dragging logs to the Nan river, Nan, 1958. From Photo No. Phō̱ sō̱ bō̱ 4.2.90/5, 1958 by The National Archives of Thailand. Copyright 1958 by The National Archives of Thailand.

A photograph from the National Archives (Figure 13) taken in 1958 shows a *Nicotiana tabacum* (Tobacco) plantation along the Nan River, which is not featured on the murals, but which appeared in the form of local cheroots and tobacco tucked behind the ear. According to the local philosopher, tobacco was an important cash crop commonly grown in Nan in the past.

Natural areas

Natural areas in mural paintings contain many scenes, such as forests, abandoned sites, and war. Most trees were painted as supplementary to the scenes, according to a painting expert. However, the identities of nine trees can be inferred by height, form, and leaf color: *Aegle mamelos* (Beal), *Artocarpus heterophyllus* (Jackfruit tree), Bambusoideae (Bamboo), *Dipterocarpus alatus* (Yang), *Duabanga grandiflora* (Beremban Bukit), *Erythrina subumbrans* (Indian coral tree), *Ficus religiosa* (Sacred fig tree), *Ficus* sp. (Fig tree), and *Salix tetrasperma* (Indian willow).

Other smaller plants were painted in detail, making it easier to infer plant species precisely. There were nine small plants species (Figure 14): *Bumannia disticha*, *Capsicum annuum* (Cayenne pepper), *Dendrobium lindleyi* (Dendrobium orchid), *Lasia spinosa* (Unicorn plant), *Leonotis nepetifolia* (Lion's ear), *Nelumbo nucifera* (Indian lotus), *Nymphaea* sp. (Water lily), *Paeonia x suffruticosa* (Shrubby peony), and *Schefflera* sp. (Umbrella tree). Although most trees show Nan's natural landscape, some shrubs were indicated as ornamental plants within the scenes, including Dendrobium orchid, Indian lotus, Water lily, and Shrubby peony. Moreover, imported Cayenne pepper was found at a soldier camp as a consumable plant.

Exotic species

The plants depicted on the murals were further researched in "Thai Plant Names" (The Forest Herbarium, 2014) to determine their floristic region and whether each is a Thai native species or not. Eight species from the murals of the two

temples were found to have been introduced from foreign locations. The exotic species cultivated at Nan can be classified into four groups.

- Exotic species were imported to initiate new agricultural products (Figure 15), including *Ananas comosus* (Pineapple), *Areca catechu* (Areca palm), *Artocarpus heterophyllus* (Jackfruit tree), *Capsicum annuum* (Cayenne pepper), *Cocos nucifera* (Coconut). The local philosopher said that cayenne pepper was imported to be cultivated as a replacement for Galangal for spicy flavor in Nan province during the same period as the murals were painted at Phumin temple and Nong Bua temple.
- The *Ficus religiosa* (Sacred fig tree), which is related to the Biography of Lord Buddha, was imported to represent specific beliefs.
- The *Paeonia x suffruticosa* (Shrubby peony) was imported as an ornamental plant. Nan's people believed that it could bring good luck when it bloomed (Figure 16).
- The *Benincasa hispida* (Wax gourd) was imported to substitute for existing plants and improve plant production.

Exotic plant species in the mural paintings show Nan as one of the crucial provinces. Even though Nan was the most remote province and difficult to access, it was given importance by introducing new ideas and development, as shown by imported plants introduced and adapted to daily life in Nan.

Figure 14

Small Plants in a Natural Area

Bumannia disticha | Cayenne pepper | Dendrobium orchid | Unicorn plant | Lion's ear

Indian lotus | Water lily | Shrubby peony | *Schefflera* sp.

Figure 15

Exotic Plants for Initiating New Agricultural Products

Pineapple | Areca palm | Jackfruit tree | Cayenne pepper | Coconut

Figure 16

Exotic Plants Imported in Connection to Beliefs, as Ornamental Plants, or to Substitute for Existing Plants

Sacred fig tree

Shrubby peony

Wax gourd

CONCLUSION

The study found 35 plant species in more than 150-year-old mural paintings at Phumin temple and Nongbua temple, which show the usage of both native and exotic species at that time. The plant species found in the mural paintings can be categorized into four locations: (1) residential areas, (2) town areas, (3) agricultural areas, and (4) natural areas. They were potentially used for consumption, daily use, ornamentation, and religious or cultural beliefs. The identified species comprise information that is essential to understanding the past way of life in Nan province. Moreover, these species can be confidently added to the plant list for Nan landscape architectural projects, especially those related to Nan's history and culture in the reign of King Rama IV and King Rama V.

LIMITATIONS

Since all the mural paintings are older than 150 years, their appearances and details in some areas have faded or dissolved due to weathering processes such as damage to construction material, dryness, moisture, climate, temperature, and other causes. In addition, the number of local philosophers, relatives, or heirs of the related families with knowledge of the mural paintings from these temples who survive these days is extremely limited, which affects the pool of potential experts available for interviews.

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