


Brief Report

# Spatial Distribution Patterns and Ethnobotanical Knowledge of Farmland Demarcation Tree Species: A Case Study in the Niyodo River Area, Japan

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**Abstract:** Isolated trees in farmlands serve various ecological functions, but their distribution patterns and planting history are often unknown. Here, we examined the spatial distribution, uses, and folk nomenclature of farmland demarcation trees planted in the Niyodo River area in Japan. Hierarchical clustering using the data from 33 locations distinguished four tree composition groups characterized by the combination of *Euonymus japonicus*, *Ligustrum obtusifolium*, *Deutzia crenata*, and *Celtis sinensis*. Near the upper to middle reaches of the river, the group characterized by *E. japonicus* dominated. Near the middle to lower reaches, the group characterized by *L. obtusifolium* occurred relatively frequently. The other two groups were found sporadically near the upper to lower reaches. The locally unique plant name *nezu*, used for *L. obtusifolium*, seems to have originated from a word meaning “the tree does not sleep and keeps the watch” in Japanese. In the study area, *D. crenata* was one of the plant species utilized for the sticks (*magozue*) used in traditional funeral ceremonies, which might help to explain why local people maintain *D. crenata* around homesteads as a demarcation tree. These findings highlight both the commonalities and uniqueness of demarcation tree culture in different regions of Japan and contribute to deepening our understanding of agricultural heritage.

**Keywords:** agricultural heritage; cultural landscape; folk nomenclature; floristic composition; traditional knowledge

## 1. Introduction

The expansion of intensive agriculture and farmland abandonment threatens traditional agricultural landscapes and the intangible knowledge assets supporting such landscapes [1,2]. The utilization of traditional landscapes and local knowledge in other forms, for instance, as a destination for tourists seeking traditional agricultural experiences, has been proposed as a means for their conservation. Identifying the indigenous cultural values in traditional agricultural landscapes is often difficult, however, because written historical documents are insufficient or lacking and no comparison among similar production landscapes has been performed.

Isolated trees in farmland serve multiple functions. For example, they support faunal biodiversity [3] and local food security [4], provide various collective goods [5], and maintain farmland demarcation. However, how the locally specific composition of isolated trees was historically shaped remains unknown in most regions, because of the lack of historical information. Under such limitations, ethnobiological approaches that analyze the ecological, botanical, and linguistic perceptions of local people can provide clues to the history of isolated trees in farmland landscapes.

In the Musashino region of eastern Japan, isolated *Deutzia crenata* shrubs were originally planted for farmland demarcation before the 17th century, and the species began to be used as a windbreak after settlement expansion [6]. Since then, *D. crenata* demarcation trees and windbreaks in the region were replaced with various beneficial plants used for hedgerow windbreaks, reflecting the changing needs of the local economy and the horticultural preferences of the local people. For example, the tea plant *Camellia sinensis* was planted from the mid-19th to early 20th century, and many gardening plants such as *Rhododendron* spp., *Euonymus japonicus*, and *Juniperus chinensis* were planted from the early to mid-20th century, accompanying the increasing number of florists in rural areas. In recent years, spatial distribution patterns and some planting background information on demarcation tree species were reported for upland fields in eastern Japan [7] and areas along the Hijikawa River in southwestern Japan [8]. However, because of the lack of comparison studies on farmland demarcation trees, how the findings from these localities are common or unique remains difficult to evaluate.

In this study, we investigated the spatial distribution patterns, folk nomenclature, and uses of farmland demarcation trees on the alluvial plains along the Niyodo River in the Kochi Prefecture of Shikoku Island, southwestern Japan. Based on the results, we discuss the commonality and uniqueness of demarcation tree culture at different localities and share ethnobotanical knowledge of specific tree species maintained around homesteads in Japan.

## 2. Material and Methods

### 2.1. Study Area

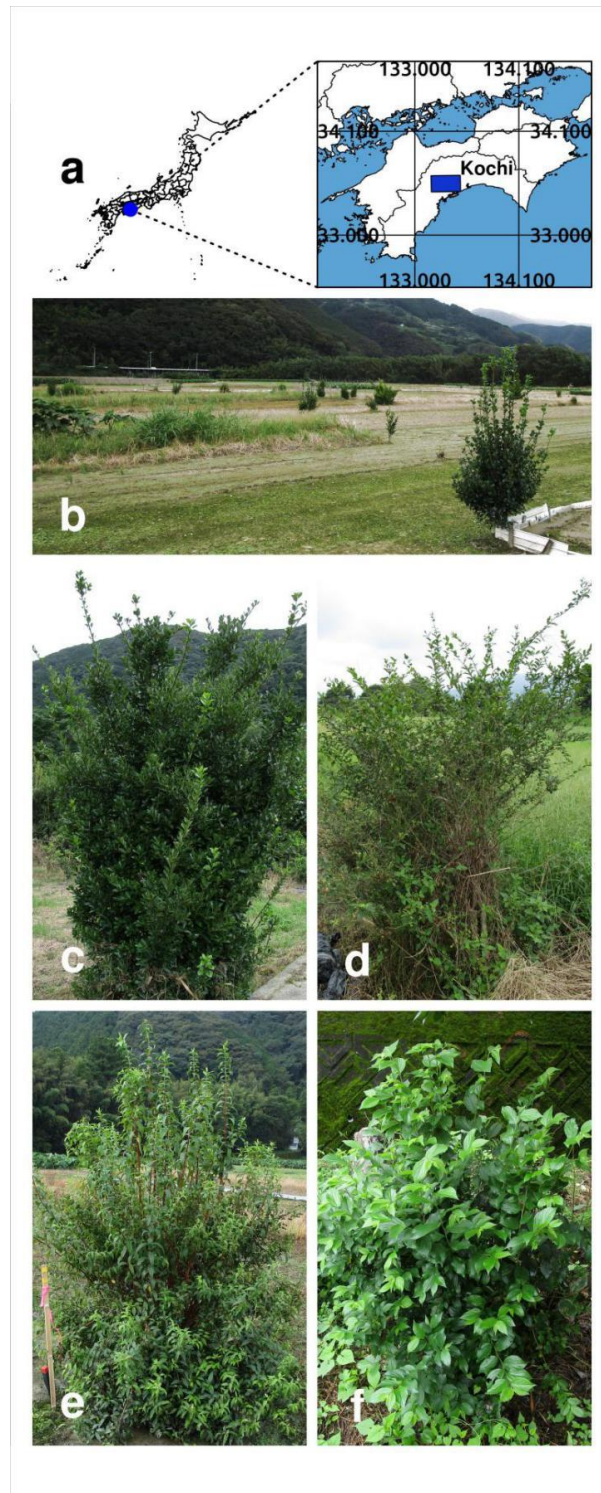
Farmland demarcation trees were investigated in areas along the Niyodo River in Kochi Prefecture (Figure 1). In the present and our past studies [7,8], “demarcation” was visually assessed at each study site depending on the kind of crops and the differences in soil and weed management conditions of adjacent farm parcels with isolated trees along their boundaries. Therefore, demarcation may not be directly relevant to the land ownership.

According to the climate data obtained at the Susaki weather station (1981–2010), the mean annual temperature was 16.7 °C and mean annual rainfall was 2604.3 mm. Upland fields and paddy fields predominate the alluvial plains, and steep mountains surround the river basin. Therefore, flooding has repeatedly damaged the farmland and residential areas for centuries [9].

### 2.2. Marker Sampling

We mostly followed the protocol of our previous study [8] for marker sampling and interviews. We recorded the demarcation trees on the alluvial plains between the Yokobatake area at the upper reach and the Harunochou Saibata area at the lower reach of the Niyodo River. The names of all of the districts investigated here were recorded in farm production statistics collected in the 16th century [10]. Depending on the size of the farmland area and the abundance of demarcation trees remaining at each village, we randomly selected one to three sampling points in each small village area. As an exception, however, the sampling point including densely resprouted and possibly older *D. crenata* individuals at the Imanari district was arbitrarily added, because we considered it important to discuss the diversity and traditional state of tree composition. At each selected sampling point, up to five farmland boundaries marked with isolated woody plants were explored and the species of each marker plant was identified. At a location in the Oochi area, only one individual of *Ligustrum obtusifolium* on a farmland boundary was recorded. This datum was omitted from the following analysis on

tree composition. For the other sampling points, at least two farmland boundaries marked with demarcation trees were included in the analysis. Consequently, a total of 33 locations were surveyed from 22 August to 12 September 2019. In this paper, the plant nomenclature follows the YList [11] and the plant species origin and leaf types follow Miyawaki et al. [12].



**Figure 1.** Study site location, scenery, and examples of four demarcation trees. (a) Maps of the study site. (b) Demarcation trees in upland fields in the Imanari area, Ochi town. (c) *Euonymus japonicus*, (d) *Ligustrum obtusifolium*, (e) *Deutzia crenata*, and (f) *Celtis sinensis*.

The longitude and latitude of the boundary markers were recorded by comparing their positions in the farmland with that on photographs available on the internet (cyberjapandata.gsi.go.jp) taken by the Geospatial Information Authority of Japan [13]. For the map created using Quantum GIS software version 2.18.16 [14], the mean longitude and latitude of surveyed markers around each chosen point were used as the representative point. The village section data were obtained from [15].

### 2.3. Interviews

Semi-structured interviews were conducted at 32 locations close to the marker sampling points. The informants were composed of 22 males, 8 females, and two couples in the following age groups: 50 s ( $n = 1$ ), 60 s ( $n = 6$ ), 70 s ( $n = 17$ ), 80 s ( $n = 6$ ), 90 s ( $n = 1$ ), unknown ( $n = 1$ ). Because the collection of information on the demarcation tree history was our priority, when we met several family members at a focal field, we chose the oldest informant (s) for interviewing. In each interview, we asked about the following items: the local name of the marker species that was present at the informant's or neighboring fields, the reason that species was chosen, multiple uses of plants, introducer and introduction period, means of planting, and management method. We also recorded the additional information provided during the interviews. Hereafter, the local plant names and folk habit are written in italic type.

## 3. Statistical Analysis

The compositional similarities of demarcation tree species among the 33 locations were compared by hierarchical clustering [16]. The matrix used in this analysis consists of 33 rows (locations) and 11 columns (marker species), and each cell is filled with the presence/absence of each species at each study location. Using this matrix, dissimilarity indices based on the Jaccard index were calculated and hierarchical clustering was performed with complete linkage. In this study area, the number of *E. japonicus* individuals was especially high from the upper to middle reaches, which made it difficult to examine the compositional variation characterized by some minor accompanying species when the abundance-based distance measures were used. Therefore, the Jaccard index was adopted. This analysis was conducted with the *vegan* and *gplots* packages using R software version 3.3.3 [17].

## 4. Results

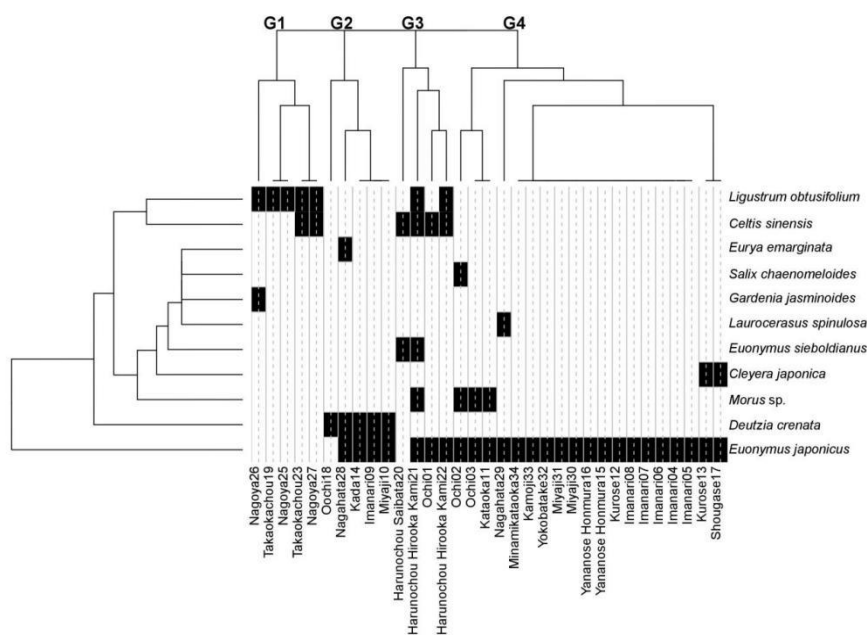
### 4.1. Spatial Distribution of the Marker Plants

As shown in Table 1, we recorded a total of 250 individuals of 11 woody species (including formerly cultivated crop tree varieties of *Morus* sp.). The cluster analysis distinguished four marker composition groups at the minimum level of pruning of the dendrogram (Figure 2). Group 1 ( $n = 5$ ) was characterized by the presence of *L. obtusifolium* and partly *Ce. sinensis* and the absence of *E. japonicus*. Group 2 ( $n = 5$ ) was characterized by the presence of *D. crenata*. Group 3 ( $n = 4$ ) was characterized by the co-presence of *L. obtusifolium*, *Ce. sinensis*, and *E. japonicus*. Group 4 ( $n = 19$ ) was characterized by the presence of *E. japonicus* and the absence of most other species. Group 1 was located in areas along the right bank of the middle to lower reaches (Figure 3). Groups 2 and 3 occurred sporadically between the upper and lower reaches. Group 4 was located at the upper reaches and in areas along the left bank of the middle reaches.

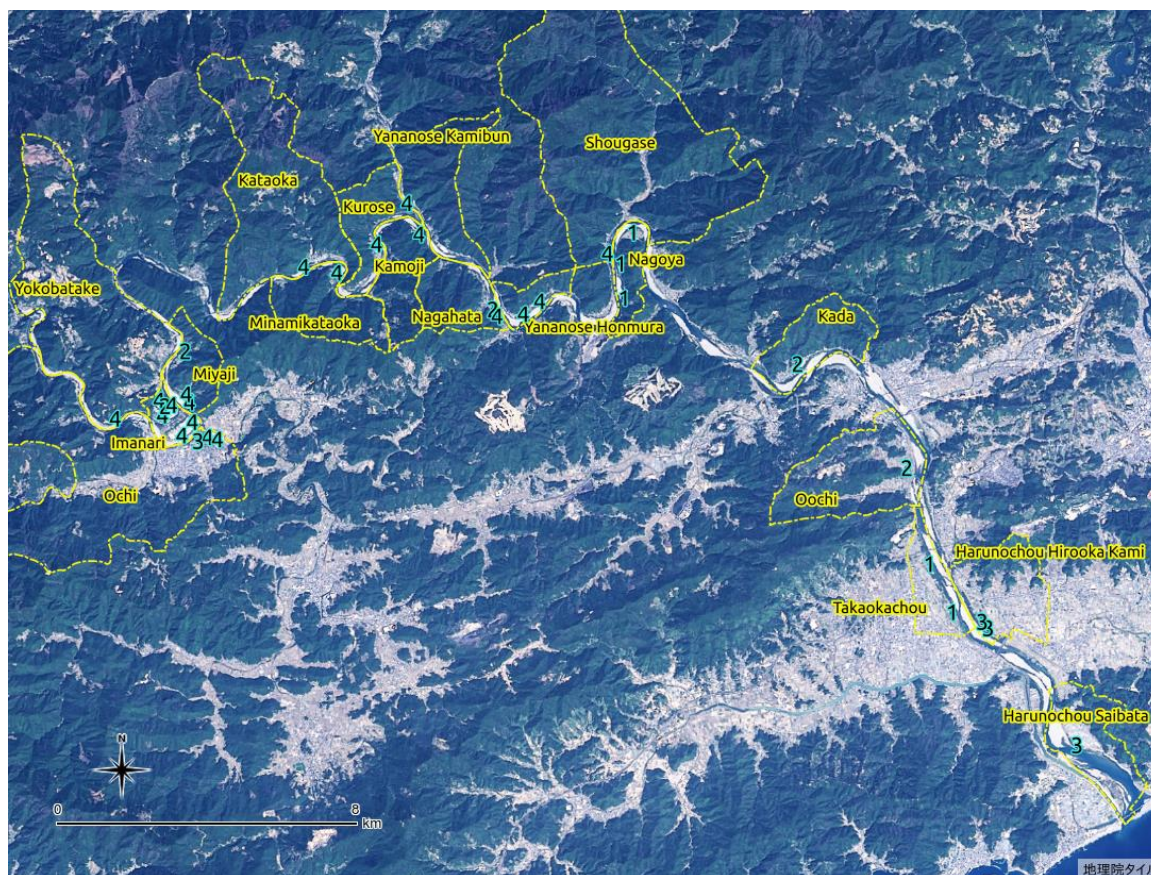
**Table 1.** Observed number of individuals, local name, species origin, and morphology of demarcation tree species in areas along the Niyodo River.

Species	Observed Number of Individuals (% of Total)	Local Name (Response/Total Answers) <sup>a</sup>	Species Origin <sup>b</sup>	Morphology <sup>c</sup>
<i>Euonymus japonicus</i>	174 (69.6)	<i>masaki</i> * (12/18), DN (5/18), F (1/18)	N	E
<i>Ligustrum obtusifolium</i>	36 (14.4)	<i>nezu</i> (3/6), DN (2/6), <i>nezunoki</i> (1/6)	N	D
<i>Deutzia crenata</i>	13 (5.2)	DN (7/10), <i>tsuge</i> (1/10), <i>utsuge</i> (1/10), <i>utsugi</i> * (1/10)	N	D
<i>Celtis sinensis</i>	7 (2.8)	<i>enoki</i> * (2/2)	N	D
<i>Morus</i> sp.	6 (2.4)		A or N	D
<i>Salix chaenomeloides</i>	4 (1.6)		N	D
<i>Cleyera japonica</i>	4 (1.6)		N	E
<i>Eurya emarginata</i>	2 (0.8)	DN (1/1)	N	E
<i>Euonymus sieboldianus</i>	2 (0.8)	DN (1/1)	N	D
<i>Gardenia jasminoides</i>	1 (0.4)		N	E
<i>Laurocerasus spinulosa</i>	1 (0.4)		N	E

<sup>a</sup> Asterisk indicates the standard Japanese name of the plant species. DN indicates that the informant did not know the plant name. F indicates that the informant forgot the plant name; <sup>b</sup> A, alien species; N, native species; <sup>c</sup> D, deciduous; E, evergreen.



**Figure 2.** Dendrogram of woody plant species planted as demarcation trees at 33 survey locations along the Niyodo River, Kochi Prefecture. The four marker composition groups, which were determined by pruning this dendrogram at the minimum level of branching, correspond to the labeled numbers in Figure 3.



**Figure 3.** Distribution of the four marker composition groups along the Niyodo River, Kochi Prefecture. In the surveyed area, the Niyodo River follows a southeastern course. The numbers (1–4, highlighted in cyan) indicate the marker composition groups shown in Figure 2. Village names are highlighted in yellow. The dash-dotted yellow lines show the village boundaries. The recent aerial photograph was obtained from the Geospatial Information Authority of Japan (Chiriin-chizu; <https://maps.gsi.go.jp/>).

#### 4.2. Folk Nomenclature

The folk nomenclature recorded for the four dominant species indicated simple naming systems, and for the most part scientific names of trees correspond well to a specific local name (e.g., *masaki* used for *E. japonicus*, *enoki* used for *Ce. sinensis*) or similar local names (e.g., *nezu* and *nezunoki* [-*noki* means tree in Japanese] used for *L. obtusifolium*). The origin and meaning of the name *tsuge* for *D. crenata* was unknown, but it may be a slight modification or misremembering of *utsuge*. According to a male informant at Takaokachou, the Japanese word *nezu* means “do not sleep and keep the watch” (*nezu-ni-ban-wo-suru*). Another male informant at Nagoya stated that there were at least two other species named *nezu*. These statements indicate that the planting practices for demarcation trees are linked strongly to the folk generic name *nezu* in some localities.

#### 4.3. Introduction, Management, and Multiple Usage

According to the interviews, nine informants planted their demarcation trees using cuttings of *E. japonicus*. One informant at Nagahata planted *Eurya emarginata*, the source of which was unknown. A male informant at Takaokachou stated that the *Morus* individuals remaining on his neighboring farmland boundaries were left after the cessation of silkworm raising in the area and may not be demarcation trees. In the study region, sericulture drastically declined during WWII [18]. Except for these answers, 31 informants stated that they did not know the origin of old demarcation trees, because most of them were planted before they were born.

Some informants proposed the reason of species choice as the durability of trees against repetitive cutting in the cropping environments for *E. japonicus* ( $n = 3$ ) and *L. obtusifolium* ( $n = 1$ ). Another reason given was the ease of management because of slow growth and the size at maturity for *D. crenata* ( $n = 1$ ) and *L. obtusifolium* ( $n = 1$ ) and the rigorous resprouting ability of *D. crenata* ( $n = 1$ ). The informants reported no strict season or way of cutting for the marker individuals of *E. japonicus* ( $n = 16$ ), *D. crenata* ( $n = 8$ ), *L. obtusifolium* ( $n = 5$ ), *Ce. sinensis* ( $n = 2$ ), *Euonymus sieboldianus* ( $n = 1$ ), or *E. emarginata* ( $n = 1$ ).

The shaded areas around *E. japonicus* ( $n = 2$ ), *Ce. sinensis*, and *E. sieboldianus* ( $n = 1$ ) trees were used for resting places. After WWII, local florists collected the branches of *E. japonicus* in the Imanari area ( $n = 1$ ). Although not always acquired from demarcation trees, long and straight stems of *D. crenata* were used for the sticks, called *magozue*, which were used in traditional funeral ceremonies in the Nagahata area ( $n = 1$ ). Bamboo species ( $n = 2$ , in the Nagahata and Minamikataoka areas) and the stems of a fern locally called *onishida* ( $n = 1$  in the Miyaji area) were also used as *magozue*.

#### 4.4. Marker Replacement and Removal

One informant in the Miyaji area stated that although, at present, many tree individuals used for demarcation are *E. japonicus*, there were more *D. crenata* individuals in the past. Some informants stated that some trees were removed because they became obstacles for machine plowing or agricultural production in the Imanari area ( $n = 2$ ). Others noted that there used to be more individual demarcation trees in the past in the Yananose Honmura and Takaokachou areas ( $n = 2$ ). Moreover, another informant in the Kada area stated that after public farmland surveys were conducted and artificial pillar markers were placed, there was no need to maintain the traditional tree markers.

## 5. Discussion

### 5.1. Commonality and Uniqueness of Tree Species Choice

A comparison of the present study with previous reports [6–8] shows that the dominance of *E. japonicus* and *D. crenata* in some districts and *Morus* individuals, perhaps left after their use for commercial sericulture, were common in those places. In contrast, the dominance or sub-dominance of *L. obtusifolium* was unique in the study region. Moreover, the dominance of *Chaenomeles speciosa* and the relatively frequent *Salix* usage (including a fiber crop variety *Salix koriyanagi* and wild species *Salix pierotii* and *Salix chaenomeloides*) along the Hijikawa River areas in Ozu city [8] and the dominance of *D. crenata* accompanying sub-dominant *Pourthiaea villosa* and the tea plant *Ca. sinensis* in some parts of the Ibaraki Prefecture, Eastern Japan [7] were also respectively unique. Although the reason why such distinct variation of dominant tree abundance was observed among those places remains unclear, the use of *Morus*, *S. koriyanagi*, and *Ca. sinensis* highlights that maintaining the former crops for demarcation is a common behavior of local farmers.

### 5.2. Implications from Folk Nomenclature

The local name *nezu* or *nezunoki* and its etymological meaning (“the trees do not sleep and keep the watch”) for *L. obtusifolium* seem indigenous. The statement of folk generic use of *nezu* for several different species also highlights that the wording reflects the importance of demarcation tree planting along the right bank of the middle to lower reaches of the Niyodo River. In this study region, many local people (12 out of 18 informants, Table 1) recognized the name of *E. japonicus* as *masaki*, which is also the scientific name in Japanese. In contrast, the local people living along the Hijikawa River hardly recognized the correct plant name and often called *E. japonicus* *boke*, which is the local and scientific name of another dominant demarcation tree species, *C. speciosa* [8]. These differing degrees of recognition of *E. japonicus* in the two relatively close localities indicate that, although the species used and landscapes are similar, their planting background seems independent of each other. As noted in previous ethnobiological research [19–22], the comparison of the folk nomenclature gathered in this

study with that from previous works, such as [8], can deepen the ethnobiological understanding of local plant use.

### 5.3. Folk Plant Usages

Although the demarcation trees were seldom used for multiple purposes, some statements provided important insights. These examples were the use of *D. crenata* sticks at home funerals and the historical commercial use of *E. japonicus* in the florist trade. A previous report from Hidaka village in Kochi Prefecture [23] and our results show that using small sticks made of various plant materials, known as *magozue*, at home funerals was part of the traditional ritual in at least several villages in the Niyodo River basin. Similarly, a single stick of *D. crenata* was laid beside the dead body at home funerals in central Japan [24] and eastern Japan [7]. As frequently mentioned in the old Waka poems [25] and represented in the naming of the month *uzuki* in the Japanese calendar, *D. crenata* is a symbolic plant in Japanese culture. In addition to these features, the use of *D. crenata* sticks at home funerals may be another motivation for local people to maintain this species around their homesteads in wide areas across Japan. The use of *E. japonicus* by florists was also recorded in the Hijikawa area after WWII [8] and in eastern Japan before the war [6]. These ornamental needs in the early to mid-20th century and the ease of planting by cuttings may be additional reasons for the increase of *E. japonicus* markers in recent decades in different rural areas.

## 6. Conclusions

This study elucidated the unique tree composition and some background of the trees' planting based on folk nomenclature and usage in areas along the Niyodo River. Our findings shed light on the commonalities and uniqueness of demarcation tree culture across various landscapes. Moreover, this study provides insight into the ritual importance of *D. crenata* at home funerals across Japan, perhaps since olden times. However, local people in the study region have been gradually removing the demarcation trees because they are becoming obstacles as agricultural practices are modernized and the trees are being replaced with artificial pillars after public land surveying. Although the trees may have few practical merits in present-day food production and land management systems, the different composition of demarcation tree species and local peoples' intangible ethnobotanical knowledge of these trees in each landscape represent an invaluable cultural heritage and should be conserved. In further research, the regional variation of demarcation tree landscapes and their ethnobotanical history should be examined using similar multidisciplinary approaches. In such projects, the collection of information from local elderly informants must be prioritized, because such information is irretrievable after generational change in rural communities.

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**Conflicts of Interest:** The authors declare that they have no competing interests.

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