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Traditional Ecological Knowledge of the Tengger Tribe and its Influencing Factors in Bromo Tengger Semeru National Park

Denni Susanto[1,2*], Shinya Numata[2]

[1]Bachelor of Applied Science in Forest Management, Vocational College of Universitas Gadjah Mada, Jl. Yacaranda Depok Sleman, Indonesia 55281
[2]Department of Tourism Science, Tokyo Metropolitan University, Building No. 9, Minami-Osawa Campus, Minami-Osawa, Hachioji-city, Tokyo, Japan 192-0397

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Abstract

An understanding of the local traditional ecological knowledge (*TEK*) *of a region is crucial to understand the interactions between indigenous societies and their ecosystems. To understanding the TEK of Indonesian indigenous people and its influencing factors, we evaluated the Tengger people's knowledge and conservation awareness regarding culturally important plants* (*javanese edelweiss*). *We interviewed 641 people from seven Tengger villages located adjacent to Bromo Tengger Semeru National Park* (*BTSNP*)*, Indonesia. We developed 31 models to examine factors affecting edelweiss knowledge and calculated the Akaike information criterion values to select the best model. Sex, education, and residency duration were significant predictors of edelweiss knowledge. Our results show that the Tengger people have a high level of knowledge and conservation awareness of javanese edelweiss. Men, individuals with higher levels of education, and those who had lived in the area for a longer period of time had higher levels of edelweiss knowledge. Our findings confirm that communication within the community and external information sources, such as media and formal education, are involved in knowledge transmission related to edelweiss. Educational activities for local people can be used to disseminate TEK through formal education in schools and informal education programs conducted by the national park managers.*

Keywords: *knowledge, tribe, national park, conservation, protected*

**Correspondence author, email*: *denni.s@ugm.ac.id*

Introduction

Traditional ecological knowledge (TEK) refers to a collection of knowledge, practices, and beliefs that are transmitted across generations through cultural means. It encompasses the understanding of relationships among living beings, including humans, and their environment (Berkes, 1993; Berkes et al., 2000; Hernández-Morcillo et al., 2014; Sinthumule & Mashau, 2020). TEK is categorized into four domains based on a knowledge-practice-belief framework proposed by Berkes (1993), namely, local knowledge of animals, plants, soils, and landscape; land and resource management systems; social institutions; and worldview (Joa et al., 2018). Various terms are used to denote TEK, including local ecological knowledge, traditional knowledge, traditional forest knowledge, indigenous knowledge, and indigenous forestry knowledge (Joa et al., 2018). TEK provides information on the use of a conservation aid to determine species distribution (Joa et al., 2018), the status of endangered species (Phuthego & Chanda, 2004; Drew, 2005; Ceríaco et al., 2011; Turvey et al., 2015; Wilkinson & van Duc, 2017; Truong, 2022), predicted abundance (Berkes et al., 2000; Furusawa et al., 2014; Benner et al., 2021), and local threats (Nash et al., 2016; Tamou et al., 2018; Caballero-Serrano et al., 2019).

TEK can be influenced by various factors. Sociodemographic characteristics are one of the key generators of social roles and identities. These characteristics tend to generate highly salient identities (Stryker & Burke, 2000; Huddy, 2001; Smith, 2007). Therefore, the knowledge of the community may be influenced by their sociodemographic characteristics (Papworth et al., 2009; Beaudreau & Levin, 2014; Iniesta-Arandia et al., 2014). For instance, the level of education of an individual can affect his/her knowledge and attitudes toward environmental issues (Ugulu, 2021). At an individual level, TEK varies by sex, age, ethnicity, profession, and religious and cultural beliefs (Chazdon & Coe, 1999; Ayantunde et al., 2008). Anthropological studies have shown that TEK level and the perception of plant species differ by sex (Camou-Guerrero et al., 2008). As a result, preferences for useful plant species also differ between men and women (Fortmann & Rocheleau, 1984).

Southeast Asia, particularly Indonesia, has a high endemic biodiversity (Hughes, 2017; Rintelen et al., 2017). Indonesia is a multicultural country with diverse ethnic groups (Rachmadyanti et al., 2021; Putri et al., 2022). TEK

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plays a significant role in biodiversity conservation in Indonesia (Susanti & Zuhud, 2019; Suminar, 2023). The indigenous Tengger people live in villages on the slopes of the Bromo mountains in Indonesia (Haliim, 2018). These people are involved in the utilization of the plants in Bromo Tengger Semeru National Park (BTSNP) (Rohman et al., 2019). Javanese edelweiss (*Anaphalis javanica*), an endemic plant found in the mountains of Java, Indonesia (Roziaty & Wijaya, 2019; Oo et al., 2022), plays an essential role in the traditional system of the Tengger people (Ifa et al., 2019; Ade et al., 2021). It is used as an offering to the ancestors during traditional ceremonies, taking on significant cultural and symbolic significance (Pramita et al., 2013; Utomo & Heddy, 2018). Consequently, javanese edelweiss possesses characteristics that encompass traditional subsistence and commercial uses and values. Therefore, the knowledge of edelweiss held by the Tengger people is considered an important component of TEK in their society (Oteng-Yeboah et al., 2012).

In the present study, we examine the level of TEK regarding javanese edelweiss and analyze the correlation with conservation awareness. We also assess the influence of sociodemographic factors toward TEK by the Tengger people. Knowledge, attitudes, and experiences can affect the awareness of individuals regarding biodiversity conservation (Ibrahim et al., 2022). Therefore, awareness and knowledge can contribute to support, trust, and compliance with biological conservation efforts in national parks (Tuohy et al., 2022). Sociodemographic characteristics, such as age and sex, are significant predictors of knowledge, experience, and beliefs regarding nature (Chen et al., 2020; Zhang et al., 2020; van Der Goot et al., 2021). The level of education can also affect people's perception of nature and species (Hicks & Cinner, 2014). In the present study, we hypothesized that indigenous people with a high level of knowledge about javanese edelweiss have awareness regarding the importance of conserving this plant and that such knowledge varies by sociodemographic factors such as age, sex, and education.

Methods

Study area We conducted as survey in the East Java Province of Indonesia, particularly in Pasuruan, Probolinggo, Malang, and Lumajang districts, which make up the territory of the Tengger people (Figure 1). The study was conducted in seven villages: Tosary, Wonokitri, Podokoyo, Ngadisari, Ngadas, Ranupane, and Argosari. Some of the included areas are located within the BTS area. BTS was established in 1992 to protect biodiversity and the Tengger culture (BTSNP, 2022). The four districts have a total area of 50,276 ha.

Ethnic group Tengger tribe is the dominant ethnic group in the vicinity of the BTS (Figure 1). They live mainly around Mount Bromo and engage in agricultural activities (Kuspraningrum et al., 2020; Fatjerin & Budirahayu, 2021). These people descended from the largest Hindu kingdom in Indonesia, the Majapahit Kingdom, and most practice Tengger Hinduism (Huda & Khasanah, 2019).

The customs and culture of the Tengger people include annual traditional ceremonies on Mount Bromo to express gratitude to their ancestors. Ceremonies include Yadnya Kasada, Unan-unan, Entas-entas, and Karo, which involve the use of javanese edelweiss (*A. javanica*) as an offering to their ancestors, although this practice poses a threat to the plant (Pramita et al., 2013; Utomo & Heddy, 2018).

The Tengger people also engage in activities within the national park (Nurcahyono & Astutik, 2018). The traditional name of javanese edelweiss in the Javanese language is "*tanalayu*," where "*tana*" means land and "*layu*" means death, symbolizing that all humans will die and return to the land. During traditional ceremonies, all communities must bring javanese edelweiss flowers to Mount Bromo as an offering. The Tengger people possess an understanding of the traditional use of javanese edelweiss for ceremonies, engage in practices based on their knowledge, and believe that this plant has an important relationship with nature.

Focal plant *A. javanica* is often found at altitudes of 2,000–3,000 m above sea level in the mountains of Java (Oo et al., 2022). This plant grows in specific habitats characterized by a volcanic substrate and suitable air temperature (Amalia et al., 2019; Lathifah et al., 2019). It serves as a pioneer plant in young volcanic soils within mountain forests and can survive on barren land (Hernawan et al., 2020). However, its presence in the BTS has decreased over time (Ade et al., 2021), especially along the official Mount Semeru Hiking Trail, points at which it is now completely extirpated (Amalia et al., 2019), even though it is a protected plant in Indonesia (Regulation of Minister of Environment and Forestry Number P.20/MENLHK/SETJEN/KUM.1/6/2018). The main threats in BTS are illegal collecting by the community for use as souvenirs (Rahma et al., 2022), use for traditional activities by the local people (Ifa et al. 2019; Ade et al. 2021), and climate change (Maghiar et al., 2021).

Data collection Non-probability sampling was used to select the targeted villages and respondents. This sampling technique involves selecting samples based on the research purpose, availability of participants, subjective judgment, or other nonstatistical criteria, rather than a predetermined probability (Guo & Hussey, 2004). Interviews were conducted with one person per household, and the interviewees were selected opportunistically using purposive sampling. The interviews were conducted with the household representative in the absence of other household members or villagers. Only individuals aged ≥18 years were interviewed. We selected seven Tengger villages located around the BTS: Tosari, Wonokitri, Podokoyo, Ngadisari, Ngadas, Ranupani, and Argosari (BTSNP, 2022). In total, 641 respondents were selected. We conducted semi-structured interviews in the seven Tengger villages between September and November 2022. In addition, people's activities in the fields were observed to facilitate intimate conversations.

To assess the knowledge of Tengger people regarding javanese edelweiss, we asked the following four questions with binary responses (Yes = 1, No = 0) (Archer et al., 2020; Zhang et al., 2020). The participants were asked whether they could identify a picture of javanese edelweiss, whether they

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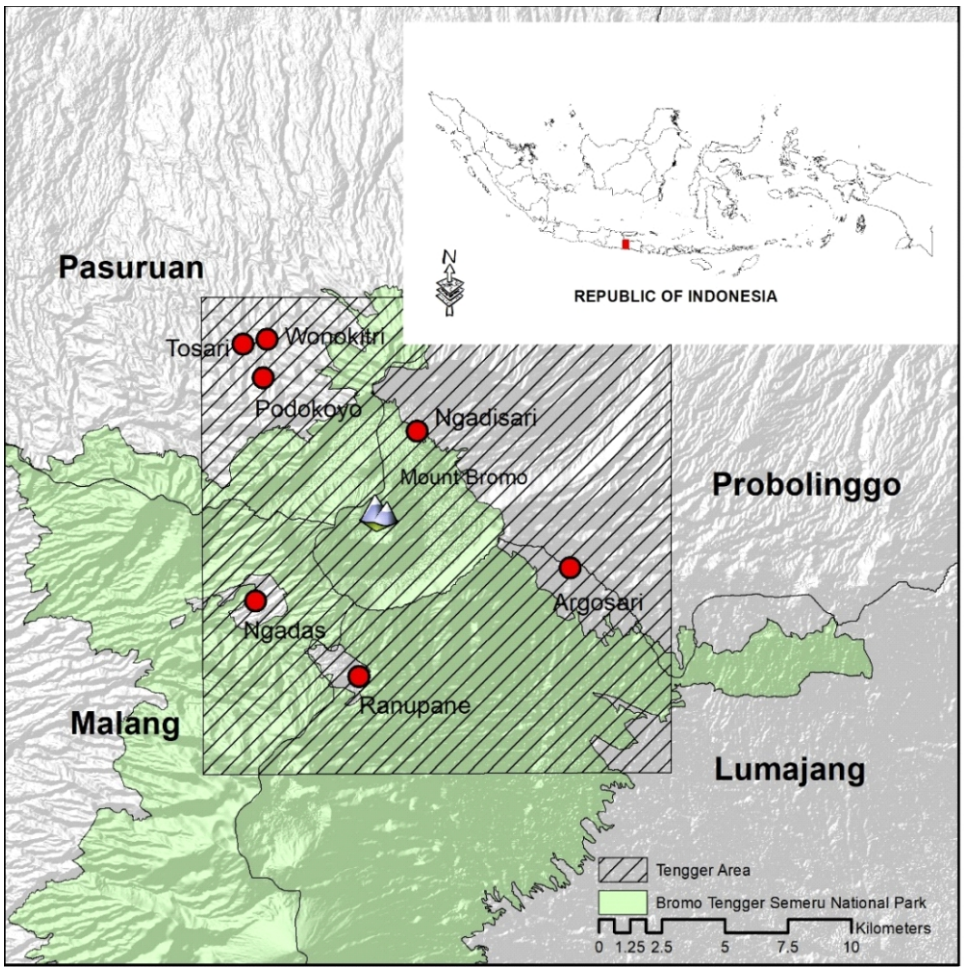

Figure 1 Study areas in East Java Province included Pasuruan, Probolinggo, Malang, and Lumajang districts. The Tengger people reside in seven villages: Tosari, Wonokitri, Podokoyo, Ngadisari, Ngadas, Ranupane, and Argosari. This Indonesian community lives around Mount Bromo (Kuspraningrum et al., 2020). Mount Bromo and a part of the Tengger area are included in the Bromo Tengger Semeru area.

knew its name in the local language, whether they knew that this was a protected plant, and whether they were aware of the myths associated with javanese edelweiss. During the interview questions, photographs were shown to the participants (Nash et al., 2016). Follow-up questions were asked regarding the depth of knowledge.

To evaluate the conservation awareness of javanese edelweiss, we used five indicators based on the binary responses (Yes = 1, No = 0) from the interviews: awareness of javanese edelweiss protection, hope for the existence of javanese edelweiss in the future, awareness about javanese edelweiss exploitation, javanese edelweiss harvesting restrictions, and supporting the edelweiss conservation program. Questions involving participants' knowledge regarding the challenges and conservation of javanese edelweiss were asked to determine their awareness (Sigala et al., 2021).

We also incorporated questions on the cultural values and local uses of wildlife (Archer et al., 2020). Open-ended questions about the use of javanese edelweiss were asked to determine the local knowledge about this in the community. We also recorded independent variables, including age, sex, religion, formal education, residency duration, and javanese edelweiss use in the future.

Data analysis We employed a step-by-step data analysis approach to identify the influence of sociodemographic factors on the knowledge of javanese edelweiss. The knowledge level was rated as 0–4, and the awareness level was rated as 0–5. Correct answers were scored "1," and incorrect answers or "don't know" were scored "0" (Acher et al., 2020; Zhang et al., 2020; Ibrahim et al., 2022). To identify a correlation between awareness regarding edelweiss conservation and knowledge level of javanese edelweiss, we used Spearman rank correlation analysis.

We used the best-fitting Akaike information criterion (AIC) to predict the effects of sociodemographic factors on the knowledge of this plant (Gao et al., 2023). We developed and combined 31 models to explain the pattern of TEK related to javanese edelweiss based on the AIC value. The model selection procedure was selected because it provides the best balance between the fit and complexity of the model (Johnson & Omland, 2004). Models were fitted using the generalized linear mixed model function to include random

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effects (Archer et al., 2020; Zhang et al. 2020). Random effects allow generalizability of the results to the population from which clusters have been sampled. Modelling heterogeneity over a cluster using only fixed effects is often inadequate (Anderson et al., 2012). The village was considered a random effect because villages may be exposed to different natural resource management strategies (Nash et al., 2016). We tested for collinearity among variables. Given that correlation coefficients were ≤0.57, no variables were excluded as the variance inflation factor was <10 (Arumbu & Srinivasalu, 2018; Zhang et al., 2020). Statistical analyses were performed using R software (version 4.2.2; R Foundation for Statistical Computing, Vienna, Austria).

Results and Discussion

General pattern of TEK and conservation awareness We interviewed 641 people from the seven Tengger villages located adjacent to BTSNP. Most interviewees were males (n = 411; 64.12%), and the mean age was 43.18 (range: 18–90) years, with 89.86% of participants in the productive age range (18–64 years) (BPS, 2022). Most interviewees had completed no formal education (n = 351), elementary school (n = 7), high school (n = 255), or university education (n = 28). The interviewees included 351 Muslims, 7 Christians, 255 Hindus, and 28 Buddhists. The mean residency duration was 41 (range: 1–90) years, and 92.2% had resided in the village for more than 20 years (n = 591).

In total, 63.03% of respondents (n = 404) had a high level of knowledge about edelweiss, and 96.3% of respondents (n = 617) recognized the plant, 96.3% (n = 618) knew the local name, and 78.8% (n = 505) knew that it was protected (Figure 2). Furthermore, 87.5% of respondents (n = 561) were aware of myths about the plant within the Tengger culture. The Kuder Richardson 20 formula (Nja et al., 2023) reliability coefficient was 0.86.

Most residents (94.7%; n = 607) were aware that javanese edelweiss is a plant used for traditional ceremonies. In total, 4.4% (n = 28) of residents were aware that javanese edelweiss is sold and 1% (n = 6) were aware that it is used for medicinal purposes. Javanese edelweiss has medicinal properties and is used to treat conditions such as stomachaches and skin diseases.

Figure 3 presents the level of conservation awareness about javanese edelweiss in the Tengger people. Most

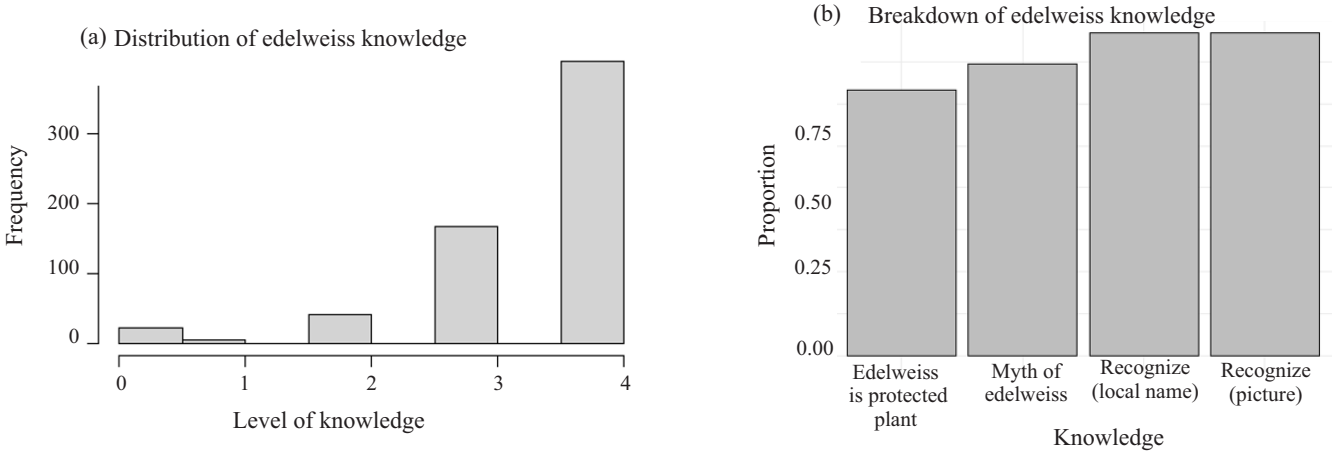

Figure 2 Distribution of the level of edelweiss knowledge within the Tengger people, ranging from 0 (low) to 4 (high). Distribution of edelweiss knowledge level (a). Proportion of correct answers to the four questions related to the javanese edelweiss knowledge (b).

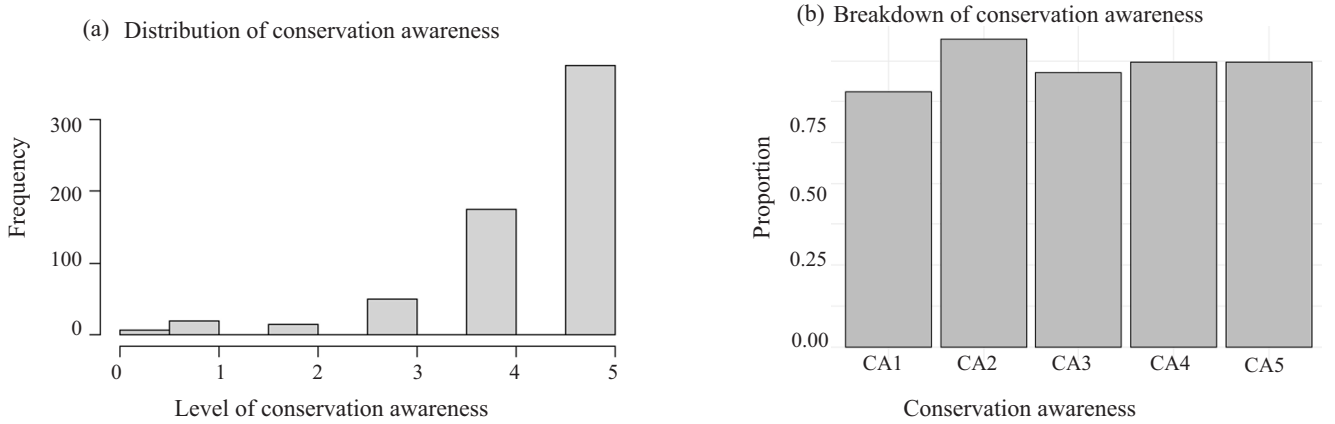

Figure 3 Conservation awareness among the Tengger people, ranging from 0 (low) to 5 (high) (a). Awareness level according to the responses to the five questions (b). Note: CA1 = awareness of its protection, CA2 = hope for its future existence, CA3 = awareness of its exploitation, CA4 = awareness of harvesting restrictions, and CA5 = support for its conservation program.

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respondents (58.5%; n = 375) had a high level of awareness; 78.7% were aware that it is protect, 93.9% hoped that it would exist in the future, 84.2% were aware of its exploitation, 87.9% were aware of harvesting restrictions, and 87.9% supported the conservation program. The Kuder Richardson 20 formula reliability coefficient was 0.63, indicating that the questions were acceptable and suitable for the analysis (Qumseya, 2021; Nja et al., 2023). A significant positive correlation was found between knowledge level and conservation awareness ($\rho = 0.52$; p-value < 0.001; Figure 4).

Our study suggests that the Tengger people possess knowledge of javanese edelweiss (Figure 2), consistent with the results of previous studies that have emphasized the importance of this plant in the Tengger culture (Ade et al., 2021; KLHK, 2022). The Tengger people frequently use javanese edelweiss in their traditional ceremonies. In general, the knowledge level and use pattern of plants differ among ethnic groups (Joshi et al., 2020). The Tengger people possess a high level of both knowledge and use of javanese edelweiss (Rahma et al., 2023; Fatjerin & Budirahayu, 2021). Their high knowledge level may be linked to their high level of use and also the spiritual significance of this plant (Rahma et al., 2023).

We found that participants with a high level of knowledge also had a high level of conservation awareness of the plant (Figure 4), consistent with the results of a previous study (Louv, 2005; Ibrahim et al., 2022). This may be due to the plant's significance in the traditional practices of the Tengger culture. Javanese edelweiss holds symbolic significance and is frequently used during traditional ceremonies. Those with high levels of knowledge were also willing to engage with conservation efforts (Archer et al., 2020).

Although knowledge of the use of javanese edelweiss in traditional ceremonies was common, participants were not sufficiently aware of its economic and medicinal uses. This suggests that the Tengger people do not use this plant in their daily activities for economic or medicinal purposes, in line with Ade et al. (2021). The local statistical bureau revealed that the livelihood of most residents depends on farming (BPS Kabupaten Malang, 2022; BPS Kabupaten Pasuruan, 2022; BPS Kabupaten Probolinggo, 2022; BPS Kabupaten Lumajang, 2022). Furthermore, the development of health facilities in Tengger villages has prompted people to use health facilities rather than traditional medicines. Therefore, the Tengger people may no longer use javanese edelweiss for medicinal purposes.

Effect of sociodemographic toward TEK We developed 31 priority models to explain the edelweiss knowledge of the Tengger people (Table 1). The model with the minimum AIC value was considered the best model (Burnham & Anderson, 2004). The model based on sex, education, and residency duration (GEN+EDU+ RES) had the highest AIC weight value ($\omega i = 0.83$). The model with the best fit was based on sex, education, and residency duration.

According to the best-fit model, people's knowledge of javanese edelweiss differed by sex, formal education, and residency duration (Tables 1 and Table 2). Conversely, knowledge did not differ by age or religion.

The model demonstrated that knowledge of javanese edelweiss significantly differed by sex, education, and residency duration (Table 2). Men, people with a higher educational level, and people who had lived in the village for longer periods of time had greater knowledge about the plant than other respondents.

Our findings suggest that men had higher knowledge about javanese edelweiss than women (Table 2). Previous studies have shown that men have higher knowledge and experience than women with regard to interaction with nature (Chen et al., 2020; Zhang et al., 2020; van Der Goot et al., 2021). The differences in the knowledge between male and female Tengger people may be due to several reasons. First, men tend to work outside the house, such as to manage livestock, which can lead to more frequent encounters with javanese edelweiss; females are often engaged in household chores (Nunes et al., 2015). Second, men are usually

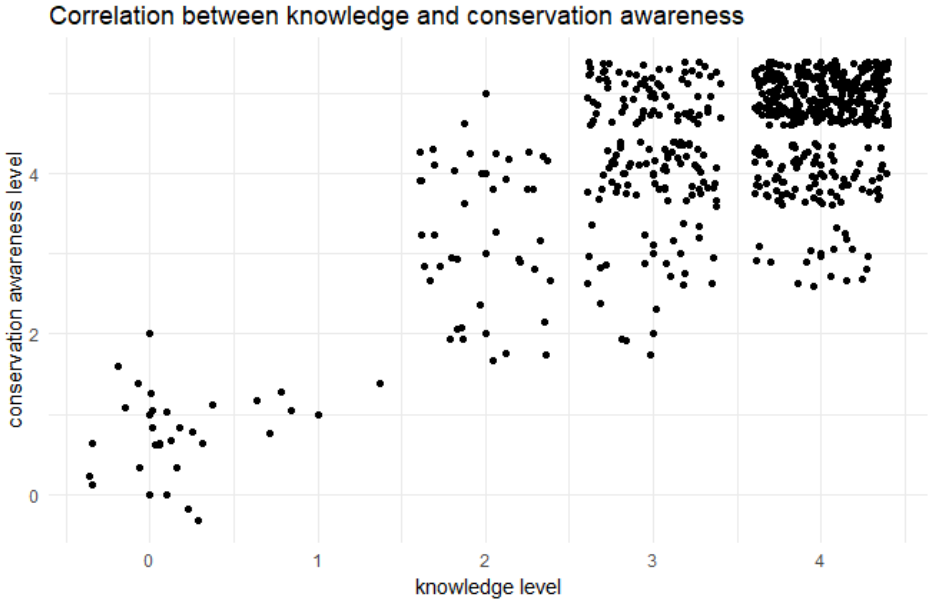

Figure 4 Relationship between respondents' knowledge of javanese edelweiss and conservation awareness.

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Table 1 Top five models based on the Akaike information criterion (AIC) value. The five final models had delta AIC values > 2. The model with the minimum AIC value was considered the best model (Burnham & Anderson, 2004)

Model structure	df	AIC	ΔAIC	ωi
EK = GEN + EDU + RES	6	1,571.79	0	0.83
EK = EDU + RES	5	1,575.73	3.94	0.116
EK = GEN + EDU + AGE	6	1,577.58	5.79	0.046
EK = GEN + AGE	5	1,581.92	10.13	0
EK = GEN + AGE + RES	6	15,836.91	15.12	0

Note: EK = edelweiss knowledge, *GEN* = sex, EDU = education, *RES* = residency duration, *AGE* = age in years.

Table 2 Results of generalized linear mixed models showing that people's knowledge of javanese edelweiss differs by sex, formal education, and residency duration but not age or religion

	Coefficient	SE	t	*p*-value
(Intercept)	2.452	0.197	12.432	<0.001
Sex	0.216	0.067	3.192	<0.01
Age	0.004	0.005	0.866	0.386
Education	0.141	0.042	3.37	<0.001
Residency duration	0.116	0.004	2.612	<0.01
Religion	-0.03	0.023	-1.304	0.193

involved in agricultural activities, such as clearing lands, which exposes them to various plants (Naah & Guuroh, 2017; Herawati et al., 2019). Third, certain rituals only allow the involvement of men (Ratih & Juwariyah, 2020).

Our results suggest that Tengger people with a high level of formal education have a higher knowledge level of javanese edelweiss (Table 2). This suggests that the transfer of knowledge is influenced by local transmission in the communities as well as via formal education. Zhang et al. (2020) suggested that formal education enables the transfer of knowledge related to javanese edelweiss. Based on the rules of the Indonesian Ministry of Forestry (Regulation Number P.52/Menhut-II/2006), formal education is important for introducing protected plants in Indonesia. The Tengger people who have received formal education in junior high school can receive materials about local plants. The Indonesian Ministry of Education and Culture (Regulation of Minister of Education and Culture Number 58/2014) has also included information on the local plants and related traditions in the natural science materials taught in junior high school. If information related to javanese edelweiss is included in the educational material taught in the schools of the Tengger region, the Tengger people who receive formal education may have a higher level of javanese edelweiss knowledge than those who have not received formal education.

Our results suggest that Tengger people with prolonged residence in the Tengger region have a high knowledge of javanese edelweiss. Conversely, knowledge of the plant did not differ by age (Table 2). These results are not consistent with those of previous studies (Chen et al., 2020; van Der Goot et al., 2021). This may be because living in a particular region for an extended period can be more important than age in terms of acquiring knowledge related to javanese edelweiss. The Tengger people welcome newcomers through trade and preaching (Manggala, 2019), which may enable the exchange of information and experiences within the community. This may facilitate the acquisition of knowledge about javanese edelweiss. Therefore, individuals who have resided in the region for a longer period of time are more likely to have accumulated a greater understanding and direct experience with javanese edelweiss than those who have resided for only a short period of time. TEK is not only transmitted as verbal information but is also acquired through experience (Berkes et al., 2000). A prolonged residency duration can facilitate TEK transmission due to direct experience and environmental observation. In line with this, local people who have encountered animals have a higher knowledge about these species (Turvey et al., 2017; Okui et al., 2021). The younger people may also learn and increase their knowledge about these plants during cultural ceremonies, rituals, or traditional events that are more prevalent among all tengger people. The intensive transmission of knowledge within the Tengger community likely starts in childhood because they are involved in every traditional events.

Conclusion

The Tengger people have high levels of knowledge and conservation awareness of javanese edelweiss. Certain sociodemographic characteristics, including sex, educational level, and residency duration, are significant predictors of such knowledge. Notably, knowledge transfer for javanese edelweiss is influenced by local transmission and formal education. These findings highlight the potential role of formal education in TEK preservation and dissemination. Previous studies have reported both positive and negative impacts of formal education on TEK. Our results suggest a potential integration or interplay between

local transmission within the community and formal education in shaping the knowledge related to javanese edelweiss among the Tengger people.

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Disclosure Statement

I, Denni Susanto, declare that all authors have no conflict of interest. The funding sponsors had no role in the design of the study, in the collection, analysis, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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