BIODIVERSITAS
Volume 26, Number 10, October 2025
Pages: 5089-5108

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d261024

Public perception and behavior toward butterfly diversity and benefits in Bandung, West Java, Indonesia

NURULLIA FITRIANI[1,♥], BUDIAWATI SUPANGKAT[2], WAWAN HERMAWAN[3], JOHAN ISKANDAR[1], MUHAMAD AZAHAR ABAS[4]

[1]Doctor of Enviromental Science, Graduate School, Universitas Padjadjaran. Jl. Dipati Ukur No. 35, Coblong, Bandung 40132, West Java, Indonesia. Tel./fax.: +62-22-2504970, ♥email: fitrianinurullia@gmail.com
[2]Department of Anthropology, Faculty of Social and Political Science, Universitas Padjadjaran. Jl. Ir. Soekarno KM. 21 Jatinangor, Sumedang 45363, West Java, Indonesia
[3]Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran. Jl. Ir. Soekarno KM. 21 Jatinangor, Sumedang 45363, West Java, Indonesia
[4]Faculty of Earth Science, Universiti Malaysia Kelantan. Kampus Jeli, 17600 Jeli, Kelantan, Malaysia

Manuscript received: 5 June 2025. Revision accepted: 12 October 2025.

Abstract. *Fitriani N, Supangkat B, Hermawan W, Iskandar J, Abas MA. 2025. Public perception and behavior toward butterfly diversity and benefits in Bandung, West Java, Indonesia. Biodiversitas 26: 5089-5108.* Butterflies, with their ecological, cultural, and economic benefits, yet public understanding of their roles in Indonesia remains limited. This study assessed community Knowledge, Attitudes, and Behaviors (KAB) toward butterflies in Bandung, West Java, Indonesia. A mixed-method approach was applied through structured and semi-structured interviews with 100 respondents, complemented by butterfly diversity surveys across 31 urban-to-rural transects. The quantitative data were analyzed using Spearman's rho and Chi-square tests (N: 100, $p<0.05$), while qualitative interview data were examined through the SAMMSA framework. Butterfly diversity observations were analyzed descriptively. The result showed that knowledge levels were low (32%), moderate (41%), and high (27%). Attitudes were very positive (64%), moderately positive (33%), and negative (3%). Behaviors were largely pro-conservation (89%), with 8% moderately supportive and 3% low. Age (ρ: 0.285, p: 0.004) and education (ρ: 0.292, p: 0.003) were found to correlate positively with knowledge, while occupation significantly influenced attitudes (χ^2: 41.07, p: 0.008, V: 0.453) and behaviors (χ^2: 37.82, p: 0.019, V: 0.435). Knowledge did not predict behavior, but attitudes strongly did (ρ: 0.520, $p<0.001$, β: 0.48, R^2: 0.395). Field sampling recorded 87 species in five families, dominated by Nymphalidae, with kukupu coklat (brown butterflies) representing the largest folk category. The findings indicate that positive attitudes, more than factual knowledge, drive butterfly conservation behavior. Strengthening conservation in urban areas, therefore, requires experiential learning, cultural integration, and curriculum-based education to foster lasting community engagement in biodiversity protection.

Keywords: Bandung, biodiversity, butterflies, folk taxonomy

INTRODUCTION

Butterflies, members of the order Lepidoptera, play vital roles in ecosystems as pollinators; a function that is crucial for the survival of many plant species, and as a food source for birds, bats, and other insectivorous animals (Ghazanfar et al. 2016; Parsaoran et al. 2024). They are also sensitive bioindicators of environmental health, responding quickly to habitat changes and disturbances (Ismail et al. 2020). Beyond ecology, butterflies hold cultural significance, symbolizing transformation, spirituality, and beauty in various traditions, as reflected in folklore, art, and symbolism (Antil and Knaujia 2024). Economically, butterflies contribute through pollination, environmental education, and ecotourism. Initiatives like the Economics of Ecosystems and Biodiversity (TEEB) emphasize the importance of valuing these ecological, cultural, and economic contributions to support informed policy-making and conservation efforts (Daniel et al. 2012; Tibesigwa et al. 2019; Aulia et al. 2020).

Despite these multiple values, butterfly populations are declining globally. In the United Kingdom, numbers have fallen by around 50% since 1976 (Kyerematen et al. 2018), with similar declines reported in South Korea between 1999 and 2015 (Choi et al. 2017). In Indonesia, limited studies also indicate a significant decrease, largely driven by land-use changes such as the conversion of forests, rice fields, and plantations into urban and industrial areas (Nurhayati et al. 2025). These trends highlight the urgent need for effective conservation strategies.

Within this context, urban biodiversity conservation has gained increasing attention, as cities act both as drivers of habitat degradation and as potential arenas for ecological restoration (Lin et al. 2023). Conservation in urban environments can be strengthened through the establishment of green open spaces, ecological corridors, and community-driven initiatives (Danneck et al. 2023; Tiago et al. 2024; Oropeza-Sánchez et al. 2025). Importantly, several studies underline that successful butterfly conservation is highly dependent on public participation, as restoration activities and population assessments are more effective when supported by local communities (Solis-Sosa et al. 2019). To foster such engagement, the populace must possess adequate knowledge, cultivate positive attitudes, and adopt behaviors that support conservation (Penn et al. 2018).

To understand the mechanisms of public involvement, the Knowledge, Attitudes, and Behavior (KAB) framework provides a useful foundation, emphasizing that knowledge shapes attitude and ultimately influences behavior (Ulicsni et al. 2019; Recio-Roman 2024). Knowledge serves as the cognitive basis that enhances an individual's awareness and understanding of an issue. Adequate knowledge often fosters positive attitudes, which reflect one's evaluations and feelings toward the subject. These attitudes, in turn, become a driving factor that influences actual behavior. In this view, knowledge does not directly translate into behavior but operates through attitudes that mediate the transformation of awareness into action (Alzghoul and Abdullah 2015; Zhang et al. 2023). Complementary environmental behavior theories emphasize that pro-environmental practices rely not only on knowledge, but also on values, normative influences, and perceived behavioral control (Rahmawati et al. 2024). These perspectives show that while knowledge provides a foundation, encouraging conservation behaviors requires engaging with psychological, social, and normative factors that motivate individuals to take environmentally responsible actions (Perry et al. 2021; Dursun et al. 2024).

Moreover, the relationship between knowledge and environmental behavior is influenced by additional factors. The accuracy of information, for instance, significantly affects how people interpret ecological issues and connect knowledge with behavior (Tamar et al. 2020). In this context, language becomes a crucial medium, not only for communicating ecological information but also as a repository of traditional and experiential knowledge. Local languages and terminologies often encode ecological classifications, species names, and landscape observations, thereby preserving biodiversity knowledge within communities (Fish et al. 2024). Culture reinforces these linguistic expressions by embedding them into value systems, rituals, and collective identities, which together shape how nature is perceived and conserved. These relationships between language, culture, and ecology support a holistic understanding of biodiversity literacy. The Biodiversity Literacy Framework highlights that biodiversity knowledge is not solely scientific but also encompasses traditional, cultural, and lived experiences (Fajri et al. 2023). This framework underscores the importance of education, cultural continuity, and emotional connection to nature in promoting conservation values and behaviors.

In Indonesia, particularly in Bandung, West Java, research on butterflies has largely focused on ecological and taxonomic dimensions (Subahar and Yuliana 2010; Septianella et al. 2015). However, sociocultural and linguistic aspects have remained understudied, even though these perspectives are critical for shaping community engagement. Addressing this research gap, the present study examines public knowledge, attitudes, and perceptions of butterfly diversity in Bandung by combining ecological, cultural, and linguistic factors with the goal of developing more inclusive conservation strategies.

MATERIALS AND METHODS

Study area

This study was carried out in various parts of Bandung, covering urban, suburban, and rural areas. The classification of these areas follows the typology developed by Supriyatin et al. (2020), which mapped Greater Bandung based on urban development patterns. Sampling locations were purposively selected across different land-use categories, including parks and cemeteries, residential zones, commercial areas, agricultural and plantation zones, and industrial sectors. In total, 27 sampling points were established in urban Bandung, West Java, Indonesia, spread across 8 suburban regions, known locally as *Sub Wilayah Kota* (SWK): Bojonegara, Cibeunying, Tegalega, Karees, Arcamanik, Ujung Berung, Kordon, and Gedebage. For suburban and rural settings, 4 sampling points were chosen: one in Cimenyan (near the Ir. H. Djuanda Forest Park), one in Cilengkrang, and 2 in Parongpong, making a total of 31 sites (Figure 1). These sites were selected not only to represent the urban-suburban-rural typology, but also to capture ecological gradients in butterfly diversity and differences in human-nature interactions. Urban sites were expected to reflect highly modified landscapes with less habitat diversity, suburban areas offered transitional environments with mixed land uses, and rural sites represented relatively undisturbed habitats. This stratification allowed the study to evaluate how varying land-use intensities influence butterfly diversity and community perceptions.

Procedures

The study involved several procedures. Interviews were conducted to assess public knowledge, attitudes, and behaviors, as well as to document butterfly species recognized by the community and their associated uses. A mixed-method approach was applied, combining structured interviews for the quantitative component with semi-structured interviews for the qualitative component. In addition, direct observation and sampling played a crucial role in evaluating butterfly diversity at the study sites, providing a more accurate assessment.

Structured interview

The structured interviews were conducted to assess the levels of public knowledge, attitudes, and behaviors toward butterflies. This method was selected to ensure standardized data collection, minimize interviewer bias, and allow responses to be quantified for statistical analysis. Structured interviews were conducted using a closed-ended questionnaire (multiple-choice and Likert-type questions in Bahasa Indonesia). For items adapted from Malik et al. (2021), a translation and back-translation procedure were applied to maintain conceptual equivalence.

The knowledge questionnaire consists of statements with "Agree" or "Disagree" response categories. Each response is scored 1 if the respondent agrees and 0 if they disagree. There was a total of 10 questions, and the knowledge score categories can be found in Table 1.

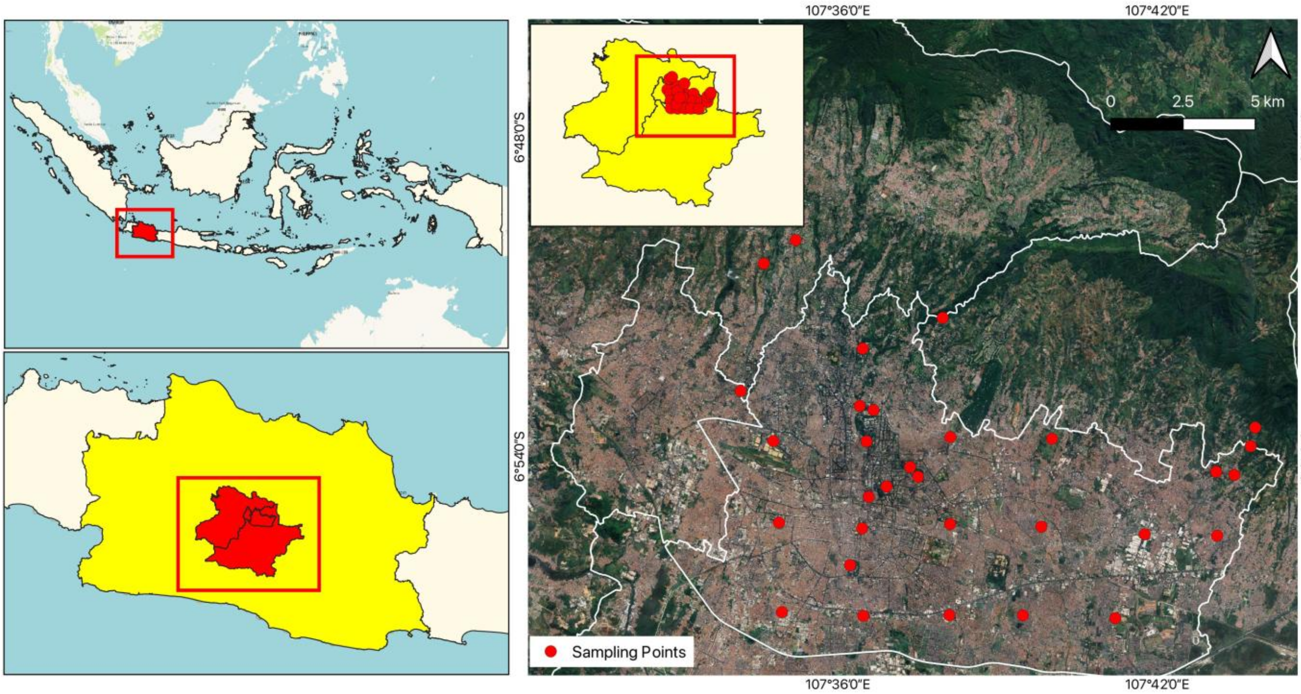

Figure 1. Location of research sampling points in the urban Bandung, West Java, Indonesia

Table 1. Knowledge score category

Score range	Category	Explanation
0-3	Low knowledge	A lack of understanding about the benefits and roles of butterflies
4-6	Moderate knowledge	Partial understanding, but further improvement is needed
7-10	High knowledge	Good understanding and likely awareness of the importance of butterflies

The questionnaire assessing attitude and behavior comprises five inquiries pertaining to attitude and four inquiries concerning behavior. The response categories are stratified into five distinct levels: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5). The scoring categories for attitude are delineated in Table 2, while the scoring categories for behavior are presented in Table 3. The cut-off points for these categories were determined by adapting the scoring framework of Malik et al. (2021) and adjusting to the context of this study.

The questionnaire was pretested with a sample of 30 randomly selected respondents to evaluate its validity and reliability before the main survey was conducted. Validity was assessed using the Pearson product-moment correlation test, in which an item was considered valid if the calculated correlation coefficient (r) exceeded the critical value in the r table ($r>0.361$) at a significance level of $p<0.05$. The results showed that all items met this criterion ($r>0.361$), indicating that the questionnaire was valid. Items that did not meet the threshold were excluded from subsequent analyses. For the knowledge section, the number of questions was reduced from 14 to 10 after the validity test, while no items were excluded from the attitude and behavior sections.

Reliability was evaluated using Cronbach's Alpha, with a coefficient value of $\alpha>0.8$ considered acceptable. The reliability test showed that the knowledge questionnaire (α: 0.804) and the attitude and behavior questionnaire (α: 0.972) both demonstrated high internal consistency, indicating excellent internal consistency. Accordingly, the questionnaire satisfied the reliability criteria and was deemed suitable for use in this study. All validity and reliability analyses were conducted using SPSS version 20. Prior to participation, all respondents were informed about the purpose of the study and their rights as participants. Written informed consent was obtained, and confidentiality of responses was assured. The questionnaire began with an informed consent form, followed by a section for respondent identification and then the main questions on knowledge, attitudes, and behaviors.

This questionnaire was administered randomly to the cohort of respondents employing the Lynch formula, specifically:

$$\mathbf{n} = \frac{\mathbf{N.Z^2.P.(1-P)}}{\mathbf{N.d^2 + Z^2.P(1-P)}}$$

Where, n: Sample size (respondents), N: Population size, Z: Normal variable value (1.96), P: Largest proportion of probability (0.50), d: Error (0.10).

According to data from the BPS (2024), the city's population reached 2,506,600 people. Using the Lynch formula, the required minimum sample size was calculated to be 100 respondents. Eligible participants were individuals who lived or worked around the research transects; in the case of park transects, respondents were park visitors. Respondents were recruited through consecutive sampling, whereby every eligible passerby in the transect area was invited to participate, an approach considered suitable for areas with limited pedestrian flow. The data collection was carried out through face-to-face interviews using structured questionnaires by trained enumerators in public parks and community areas, with each session lasting approximately 10 to 15 minutes. The respondent data were then categorized based on gender, occupation, education, and age, as shown in Table 4.

Semi-structured interview

Semi-structured interviews were conducted in in-depth dialogue with key informants using interview guidelines. Key informants were selected based on their knowledge of butterflies or their experience related to butterflies. A purposive sampling strategy was applied, and in some cases, snowball referrals were used to identify additional informants with relevant expertise. The number of key informants in this study was 48, selected on the basis of their perceived knowledge and experience about butterflies. Key informants consisted of public officials (4 participants), kuncen/public figures/elders (3 participants), farmers (10 participants), smallholders (7 participants), cultural experts (5 participants), park/cemetery and urban forest managers (10 participants), tourist area managers (2 participants), batik industry owners (1 participant), butterfly hunters (2 participants), butterfly-based artisans and sellers (1 participant), and pet food sellers (3 participants).

Interviews were conducted face-to-face in locations convenient for the participants (e.g., homes, workplaces, or public spaces) and lasted between 30 to 60 minutes. With participants' consent, interviews were audio-recorded and supplemented with field notes. The interview guidelines included questions on butterfly species recognized by local people, their perceived ecological or cultural significance, and associated uses. To ensure trustworthiness, triangulation was applied by comparing perspectives across different categories of informants, and member checking was performed, when possible, to validate interpretations. Ethical clearance was maintained by obtaining informed consent from all participants, ensuring confidentiality, and anonymizing responses.

Sampling and observation of butterfly diversity

Butterfly sampling was conducted using a modified Pollard walk along 1-kilometer route transects, divided into four sub-transects that followed existing roads or paths around each site. This method is referred to as a route transect. The sampling of butterflies occurred under sunny meteorological conditions, specifically between the hours of 08:00 a.m. and 03:00 p.m. Butterflies observed within a 5 meter radius on either side and above the transect were recorded. This particular methodology is extensively employed in scholarly research focused on the assessment of butterfly diversity within a specified locale (Van Swaay et al. 2012).

Table 2. Attitude score category

Score range	Category	Explanation
21-25	Very positive attitude	Strong support for butterflies and their conservation
13-20	Moderately positive attitude	Some support, though possibly inconsistent or limited
5-12	Low/Negative attitude	Limited or no appreciation for butterflies or their importance

Table 3. Behavior score category

Score range	Category	Explanation
16-20	Pro-conservation behavior	Actively engages in butterfly-friendly or conservation actions
11-15	Moderately supportive behavior	Some positive actions, but not consistent
4-10	Low conservation behavior	Rarely shows any conservation-related behavior toward butterflies

Table 4. The demographic characteristics of the respondents

Variable	Number of respondents
Gender	
Female	61
Male	39
Occupation	
Civil servant (PNS)	9
Entrepreneur	9
Employee	32
Casual laborer	3
Student	3
Housewife	28
Retired	4
Unemployed	3
Doctor	1
Lawyer	1
Teacher/Lecturer	2
Farmer/Gardener	5
Education	
Primary School	2
Junior High School	3
Senior High School	26
Diploma I (One-Year Diploma)	1
Diploma III (Three-Year Diploma)	4
Bachelor's Degree (Sarjana)	57
Postgraduate (Master's/Doctoral)	7
Age	
Age range of <20	2
Age range of 20-30	7
Age range of 30-40	55
Age range of 40-50	20
Age range of 50-60	12
Age range of 60-70	2
Age range of 70-80	2

Adult butterflies encountered in proximity to the transect pathway were subsequently collected. Thereafter, identification was performed through the consultation of various scholarly texts or by engaging with experts in the field. The butterfly sampling was carried out every month from January to December, thereby covering both the rainy season and the dry season. Identification of butterflies was carried out using standard field guides and taxonomic references, complemented by the Kupunesia application. Species identifications were subsequently confirmed through consultation with expert entomologists to ensure accuracy.

Data analysis

To examine the influence of sociodemographic factors (age, gender, occupation, and education) on knowledge, attitude, and behavior, different statistical tests were applied according to the type of data. The Spearman's rho correlation test was used to analyze relationships between continuous or ordinal variables (e.g., age and education with knowledge, attitude, and behavior scores). The Chi-square test of independence was applied to assess associations between categorical variables (e.g., gender and occupation with knowledge, attitude, and behavior). Effect sizes were further interpreted using Cramer's V for Chi-square tests and correlation coefficients (ρ) for Spearman's rho. All analyses were conducted with SPSS software (version 20) using a total sample of N: 100, and a significance level of $p<0.05$ was applied. Based on the interpretation guidelines, the correlation coefficients in this analysis are categorized as follows: very weak (0.00-0.199), weak (0.20-0.399), moderate (0.40-0.599), strong (0.60-0.799), and very strong (0.80-1.00). For butterfly diversity, qualitative data obtained from field observations were descriptively analyzed through narrative explanation, allowing patterns of species distribution and relative abundance to be identified.

For interview data, semi-structured interviews were transcribed verbatim and analyzed using the SAMMSA framework: Summarizing, Analyzing, Abstracting, Memorizing, Modeling, Synthesizing, and cross-case Analyzing (MacDonald et al. 2023). This approach enabled a systematic and holistic interpretation of community insights, ensuring that local ecological knowledge, cultural values, and conservation-related behaviors were captured in a context-sensitive manner. Unlike conventional thematic coding, SAMMSA provides a stepwise and iterative structure. Interview transcripts were first summarized to capture essential points, then analyzed to identify meaningful units of information. Abstracting and memorizing were undertaken to interpret underlying concepts, followed by modeling to construct relationships between categories. Finally, synthesizing and cross-case analysis facilitated the comparison of themes across different informant groups. Through this process, recurring patterns related to local ecological knowledge and butterfly utilization were systematically identified, thereby enhancing both the depth and rigor of qualitative interpretation. Potential sources of bias include self-reporting bias from respondents and the possibility of social desirability effects during face-to-face interviews. These limitations were considered in the interpretation of the results.

RESULTS AND DISCUSSION

Community knowledge of butterflies

The interview results showed that public knowledge in Bandung was categorized as moderate (41%), low (32%), and high (27%), as shown in Figure 2. Low knowledge indicates limited awareness of butterflies' ecological roles, moderate knowledge reflects partial understanding with room for improvement, and high knowledge demonstrates strong comprehension of their importance. This distribution reveals that although many community members possess at least moderate knowledge, a sizeable proportion remain poorly informed, which could weaken collective conservation efforts. The predominance of moderate rather than high knowledge suggests that current awareness programs are insufficient to deepen ecological literacy. Furthermore, the persistence of low knowledge points to barriers such as unequal access to education and the limited integration of biodiversity into everyday discourse, factors that must be addressed to strengthen public support for butterfly conservation.

Beyond overall knowledge levels, it is important to examine the sources from which this knowledge is acquired. The primary source of information was direct observation (47%), followed by family and elders (28%), school education (17%), and social media (8%). The predominance of direct observation emphasizes the strong role of experiential learning, where everyday encounters with butterflies in natural and urban environments contribute significantly to ecological understanding (Kuo et al. 2019; Mathers and Brymer 2022). The contribution of family and elders underscores the importance of intergenerational knowledge transfer, consistent with traditional ecological knowledge (TEK) frameworks, which recognize families and communities as key agents in preserving biodiversity literacy through oral traditions and practices (Akhmar et al. 2023; Sinthumule 2023).

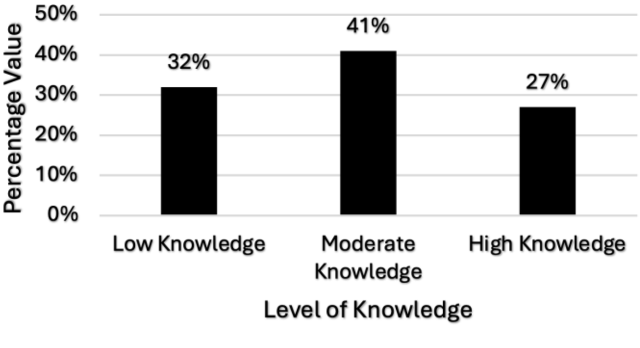

Figure 2. The percentage of local knowledge levels of butterflies in Bandung, West Java, Indonesia

The relatively small contributions from school education and social media suggest that formal curricula and digital outreach currently play a limited role in promoting butterfly conservation. While schools offer structured learning, their influence seems less impactful than direct experience, and social media remains underused despite its potential to raise awareness, especially among younger generations. Overall, these findings indicate that butterfly knowledge in Bandung is strongly rooted in lived experiences and cultural practices. However, formal education and modern communication strategies need to be improved to support these traditional sources and promote comprehensive biodiversity literacy.

Understanding not only the sources but also the content of community knowledge provides insights into how theoretical knowledge translates into practical familiarity with butterflies. Examining the content of this knowledge, particularly regarding the butterfly life cycle, reveals that nearly all respondents (99%) correctly identified the four developmental stages: egg, larva/caterpillar, pupa, and adult. However, practical familiarity is largely skewed toward adult butterflies, which are commonly observed in daily life, while early stages remain less visible. While 97% of respondents had seen caterpillars, only 21% had observed pupae, and 8% had encountered eggs. This indicates that although theoretical understanding is high, direct experience with butterflies is limited, which may influence how the community perceives butterfly development and their awareness of the ecological requirements necessary for reproduction and survival. Such limited firsthand encounters, particularly with the less visible life stages, can weaken the community's sense of connection to the full butterfly life cycle and reduce appreciation of the habitats needed to support each stage. In practical terms, this gap risks narrowing conservation support to the protection of adult butterflies alone, while overlooking the ecological conditions, such as host plants for larvae and safe sites for pupae, that are essential for sustaining populations. Without efforts to expand experiential learning, conservation initiatives may struggle to generate comprehensive and lasting behavioral change. This risk should be a cause for concern, motivating us to take action and expand experiential learning in conservation initiatives.

These findings align with Lim et al. (2022), who reported that urban park visitors in East and Southeast Asia were largely accustomed to seeing butterflies, and those with direct encounters demonstrated stronger perceptions and more positive attitudes. This underscores that human-butterfly interactions are shaped not only by knowledge but also by practical experience and perceptions.

Indeed, patterns of familiarity are reflected in community perceptions. Most respondents (96%) reported no fear of adult butterflies, viewing them as harmless and commonly found in gardens and parks. In contrast, caterpillars were perceived negatively by about 79% of respondents, often due to their hairy or spiny appearance, which was believed to cause itching or skin irritation, as well as their distinctive movement, locally referred to as utek-utekan. Caterpillars were also widely regarded as pests because they tended to damage ornamental plants in home gardens. This negative perception, while grounded in everyday gardening experiences, presents a significant barrier to butterfly conservation. Stigmatizing caterpillars solely as plant destroyer risks overshadowing their ecological importance as a vital life stage of butterflies. Suppose community members continue to perceive caterpillars as nuisances. In that case, they may be more inclined to eliminate them from gardens, thereby disrupting the butterfly life cycle and reducing opportunities for successful reproduction. Addressing this stigma through targeted education, such as emphasizing the role of host plants and the temporary nature of larval feeding, is therefore crucial for aligning household gardening practices with broader conservation goals.

Overall, these results illustrate that while knowledge of butterflies is theoretically strong, practical experience and perceptions vary across life stages, highlighting the importance of integrating hands-on observation and educational outreach to enhance both familiarity and positive attitudes toward butterfly conservation.

Community attitudes toward butterflies

The interview data revealed that 64% of respondents expressed very positive attitudes toward butterflies, 33% moderately positive, and 3% negative (Figure 3). These findings indicate that the majority of people in Bandung strongly support butterflies and their conservation, while a small minority displays limited or no appreciation for their ecological importance.

Positive attitudes may be influenced by butterflies' aesthetic appeal, cultural symbolism, and ecological functions (Kellert 1993; Barua et al. 2012; Ghazanfar et al. 2016; Parsaoran et al. 2024). In the context of Bandung, such attitudes are also shaped by local cultural and urban dynamics. As a city known for its creative identity and strong gardening culture, butterflies are often appreciated as ornamental elements that enhance the beauty of home gardens and public parks. Moreover, Sundanese cultural traditions, which emphasize harmony with nature, may reinforce positive symbolic meanings associated with butterflies. At the same time, urban residents' frequent encounters with butterflies in neighborhood gardens and green spaces provide daily reminders of their aesthetic and ecological value, further strengthening supportive attitudes toward conservation.

According to the Knowledge-Attitude-Behavior (KAB) framework, familiarity and knowledge shape attitudes, which in turn influence behavioral intentions toward conservation (Lim et al. 202). In this study, the high proportion of respondents encountering adult butterflies likely reinforces positive attitudes. At the same time, limited exposure to eggs, larvae, or pupae may explain the small fraction of negative or indifferent views.

The minority with negative attitudes highlights potential challenges in promoting butterfly conservation. Negative perceptions may result from misconceptions, limited exposure to early life stages, or a lack of understanding of ecological roles. Addressing these gaps through environmental education, experiential learning, and outreach programs can enhance appreciation and reduce indifference. Direct interactions with nature and participation in citizen science or ecotourism programs have been shown to strengthen positive attitudes and environmental stewardship (Kuo et al. 2019; Lim et al. 2022; Mathers and Brymer 2022).

Community behavior toward butterfly conservation

The behavioral data indicate that the majority of the Bandung community actively engages in conservation-oriented behaviors. Only 3% of respondents exhibited low levels of conservation behavior, 8% demonstrated moderately supportive behavior, and the vast majority (89%) actively participated in activities that support butterfly conservation (Figure 4). These results suggest a strong community commitment to protecting butterflies and their habitats. However, because the data rely on self-reported practices, there is a risk of social desirability bias, whereby respondents may overstate their conservation behaviors to align with perceived positive norms**.** While this suggests encouraging attitudes, it remains important to question whether such behaviors are consistently practiced or primarily situational, for example, when conservation aligns with household gardening interests or community programs. Socioeconomic factors may also shape these patterns, as individuals with greater resources and access to green space are more likely to engage in butterfly-friendly practices. In comparison, lower-income households may prioritize immediate economic concerns over conservation. Without addressing these structural differences, reported conservation behaviors may not fully translate into long-term, collective impact.

Conversely, a minority expressed opposition to butterfly conservation, primarily due to perceptions of caterpillars as agricultural pests. This aligns with studies highlighting that negative perceptions of specific life stages or species can limit conservation engagement (Barua et al. 2012). Addressing these concerns through targeted education, community workshops, and participatory programs could further increase support for conservation and reduce conflicts related to perceived pest issues.

Influence of sociodemographic factors on knowledge, attitude, and behavior

The relationship between age-knowledge, attitude, and behavior

The Spearman's rho correlation analysis was conducted to examine the relationship between age and knowledge, attitude, and behavior scores (Table 5). The results indicated a significant correlation between age and knowledge score (p-value: 0.004, which is lower than the 0.05 threshold), suggesting that older respondents tend to have higher levels of knowledge. The correlation between age and knowledge was weak (ρ: 0.285, p: 0.004) However, no significant correlations were found between age and attitude score (ρ: -0.20, p: 0.845) or between age and behavior score (ρ: 0.077, p: 0.447), as both p-values were greater than 0.05, indicating that age is not associated with either attitude or behavior in this sample.

This pattern may reflect generational differences in exposure to ecological information. Older individuals may have accumulated more knowledge over time through life experiences, informal learning, or interactions with nature in less urbanized settings. Yet, this accumulated knowledge does not necessarily translate into stronger conservation attitudes or behaviors, which are often shaped by current lifestyle, values, and social contexts rather than age alone. Younger respondents, despite having less knowledge, may still display positive attitudes or conservation-oriented actions if influenced by urban environmental campaigns, peer groups, or social media. This suggests that while age can influence the depth of knowledge, attitudes, and behaviors toward conservation are more heavily influenced by cultural and situational factors.

Table 5. Relationship between age and knowledge, attitude, and behavior

Variable	Correlation coefficient**	Sig. (p)	N
Age-knowledge score	0.285	0.004	100
Age-attitude score	-0.20	0.845	100
Age-behavior score	0.77	0.447	100

Note: **: Correlation is significant at the 0.01 level (2-tailed)

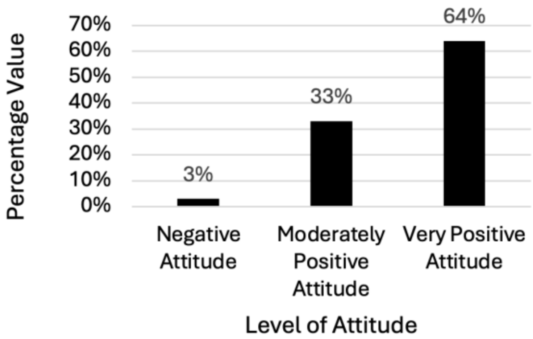

Figure 3. The percentage of local attitude levels of butterflies in Bandung, West Java, Indonesia

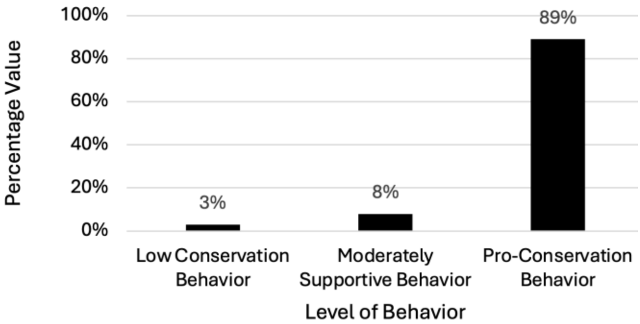

Figure 4. The percentage of local behavior levels of butterflies in Bandung, West Java, Indonesia

The relationship between gender and knowledge, attitude, and behavior

The Chi-square test was conducted to examine the association between gender and knowledge, attitude, and behavior (Table 6). The results indicated no significant associations for knowledge (χ^2: 3.542, p: 0.170, Cramer's V: 0.188), attitude (χ^2: 2.081, p: 0.353, Cramer's V: 0.144), or behavior (χ^2: 3.799, p: 0.150, Cramer's V: 0.195), as all p-values exceeded 0.05. These findings suggest that gender is not significantly related to knowledge, attitude, or behavior. Although the effect size based on Cramer's V suggested a weak association for knowledge and behavior, and a moderate association for attitude, none reached statistical significance.

Although this study found no statistically significant relationship between gender and conservation-related knowledge, attitudes, or behaviors, gender may still play a crucial role in butterfly conservation. International conservation frameworks increasingly recognize gender equity as a fundamental pillar of inclusive and effective biodiversity protection (Lau 2020). Empirical evidence suggests that women frequently serve as key contributors to conservation efforts, particularly through participatory planning and the transmission of local ecological knowledge (Gunwal and Mago 2019). Culturally, women have often been associated with a more nurturing and harmonious relationship with nature (Bandhani 2021). In the context of Bandung, while statistical findings from this study did not reveal a significant association between gender and conservation engagement, the potential role of women remains substantial. Supported by local policies that promote women's empowerment through family welfare organizations, women in Bandung are well-positioned to take on leadership roles in community-based butterfly conservation initiatives.

The relationship between occupation and knowledge, attitude, and behavior

The Chi-square test was performed to examine the association between occupation and knowledge, attitude, and behavior (Table 7). The results showed no significant association between occupation and knowledge (χ^2: 31.462, p: 0.087). In contrast, occupation showed significant associations with both attitudes (χ^2: 41.071, df: 12, p: 0.008, Cramer's V: 0.453) and conservation behavior (χ^2: 37.818, df: 12, p: 0.019, Cramer's V: 0.435). These findings suggest that occupational background plays a meaningful role in shaping conservation-related attitudes and behaviors, with moderate to strong effect sizes. Taken together, the results highlight that while knowledge levels are not significantly differentiated by occupation, attitudes and behaviors toward butterfly conservation are more strongly influenced by professional context.

The relationship between education and knowledge, attitude, and behavior

The correlation analysis was conducted to examine the relationship between education and knowledge, attitude, and behavior scores (Table 8). The results showed a significant positive correlation between education and knowledge score (ρ: 0.292, p: 0.003), indicating that higher levels of education were associated with greater knowledge. In contrast, no significant correlations were found between education and attitude score (ρ: -0.008, p: 0.940) or between education and behavior score (ρ: 0.045, p: 0.657), as the p-values exceeded 0.05. These findings suggest that education is significantly associated with knowledge, but not with attitude or behavior.

The relationship between knowledge, attitudes, and conservation behavior

The results of the Spearman's rho analysis indicated that there was no significant correlation between knowledge and attitudes (p: 0.212) or between knowledge and conservation behavior (p: 0.155). These findings suggest that knowledge alone does not necessarily influence respondents' attitudes or behaviors toward conservation. However, a significant positive correlation was observed between attitudes and conservation behavior ($p<0.001$), with a moderate strength of association (ρ: 0.520). This implies that more favorable attitudes are associated with a greater likelihood of engaging in conservation-related behaviors (Table 9).

The regression models further support this finding. A multiple regression analysis showed that attitude was a significant predictor of conservation behavior (β: 0.48, $p<0.001$), while knowledge had no significant contribution to the model (β: -0.02, p: 0.62). The model explained approximately 40% of the variance in behavior (R^2: 0.395). Furthermore, a simple regression confirmed that knowledge did not significantly predict attitudes (R^2: 0.014, p: 0.24). The findings reveal a consistent pattern: the pathway from knowledge to attitude is weak and statistically insignificant, whereas the pathway from attitude to behavior is strong and highly robust (Figure 5). This suggests that conservation behavior is predominantly shaped by attitudes, with knowledge exerting negligible direct or indirect influence, a conclusion further corroborated by the Structural Equation Modeling (SEM) path diagram (Figure 6).

Table 6. Relationship between gender and knowledge, attitude, and behavior

Variable	N	Df	χ^2	P	Cremer's V
Knowledge	100	2	3.542	0.170	0.188
Attitude	100	2	2.081	0.353	0.144
Behavior	100	2	3.799	0.150	0.195

Table 7. Relationship between occupation and knowledge, attitude, and behavior

Variable	N	df	χ^2	p	Cremer's V
Knowledge	100	22	31.462	0.087	0,397
Attitude	100	22	41.071	0.008	0.453
Behavior	100	22	37.818	0.019	0.435

Table 8. Relationship between education and knowledge, attitude, and behavior

Variable	Correlation coefficient**	Sig. (p)	N
Education-knowledge score	0.292	0.003	100
Education-attitude score	-0.008	0.94	100
Education-behavior score	0.045	0.657	100

Note: **: Correlation is significant at the 0.01 level (2-tailed)

Table 9. Relationship between knowledge, attitudes, and conservation behavior

Variable	Correlation coefficient**	Sig. (p)	N
Knowledge-attitude score	-0.13	0.212	100
Knowledge-behavior score	-0.15	0.155	100
Attitude-behavior score	0.520	<0.001	100

Note: **: Correlation is significant at the 0.01 level (2-tailed)

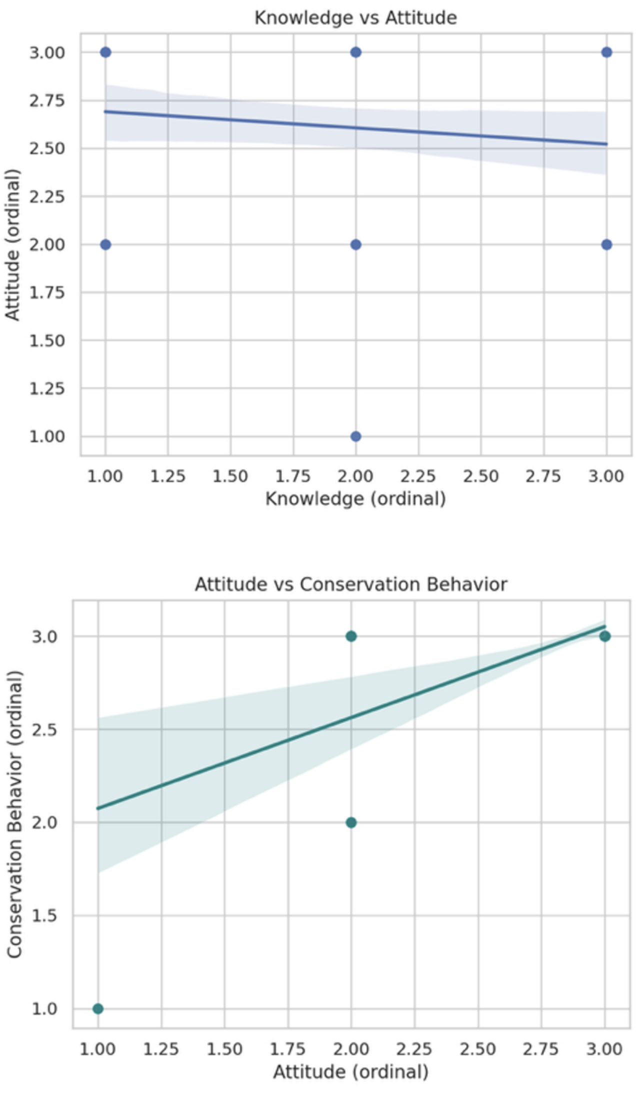

Figure 5. The relationship between knowledge, attitude, and conservation behavior toward butterflies

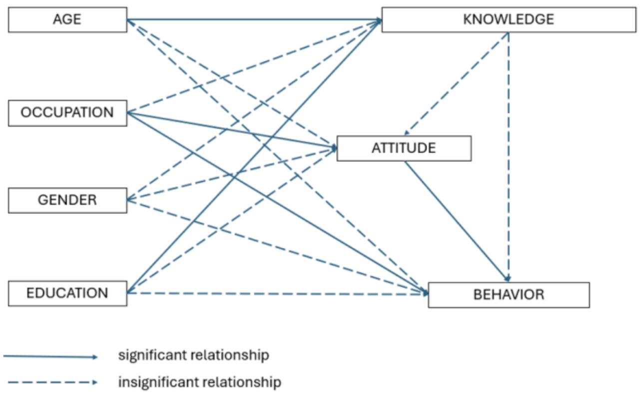

Figure 6. Path diagram in Structural Equation Modeling (SEM)

The structural model also incorporated sociodemographic variables such as age, education, occupation, and gender, which showed both significant and nonsignificant associations with knowledge, attitude, and behavior. However, the most consistent and statistically robust pathway was from attitude to behavior, consistent with the regression results. These findings indicate that, in this context, conservation behavior is driven more by positive attitudes than by the accumulation of knowledge. In the Knowledge-Attitude-Behavior (KAB) theory, knowledge serves as the cognitive base that shapes values, perceptions, and awareness, which are then internalized into attitudes. Nevertheless, the results of this study suggest that the classical KAB sequence does not completely apply, as the attitudinal component appears to be the main factor in behavioral change.

This result aligns with the perspective of Kollmuss and Agyeman (2002), who argue that environmental knowledge alone is insufficient to drive pro-environmental behavior. Their review of behavioral frameworks highlights the weak and often indirect links between knowledge, attitudes, and actions, underscoring the importance of emotional connection, individual values, and contextual factors. This phenomenon, widely referred to as the 'knowledge-attitude gap,' illustrates that factual understanding does not automatically lead to positive attitudes or behaviors, especially when competing motivations, social pressures, or structural barriers exist. To address this, they introduce the concept of 'pro-environmental consciousness,' in which behavioral change emerges from the interaction between internal drivers, such as motivation and values, and external enabling conditions.

Recent empirical research continues to support this view. For instance, a 2024 study on sustainable consumption found that environmental knowledge did not directly affect behavior but did so indirectly through attitude as a mediator, highlighting the complexity of this relationship (Rousta and Jafari 2024). Similarly, an investigation into pro-environmental behavior among tourists revealed that environmental affect and nature affiliation mediated the relationship between knowledge and behavior, suggesting that emotional engagement plays a crucial role in bridging knowledge to action (Kim et al.

2018). These findings underscore that knowledge alone may be cognitively necessary but is seldom sufficient without affective or contextual support.

To respond to these insights, this study introduces the Attitude-Based Conservation Education Initiative (ABCEI), a framework that prioritizes emotionally engaging and participatory learning experiences to promote conservation-oriented attitudes. Key strategies within ABCEI include hands-on activities such as visits to butterfly habitats, creating butterfly gardens in schools, and citizen science projects that involve local communities in butterfly monitoring and habitat restoration. These experiential methods aim to foster a sense of responsibility and emotional connection with nature (Gage and Graefe 2019).

In addition to experiential learning, ABCEI strongly advocates for the integration of conservation education into formal school curricula. Embedding conservation topics in classroom instruction, through reflective learning, values-based education, and dialogical activities, ensures that knowledge is systematically introduced and reinforced during formative years. While this study confirms that knowledge alone may not directly shape attitudes, the inclusion of conservation content in school curricula is nevertheless essential, as it provides the cognitive foundation upon which affective engagement and normative influences can operate. When paired with emotionally meaningful and socially relevant activities, curriculum-based knowledge can strengthen attitudes and ultimately foster pro-conservation behavior. This approach is further supported by Pessoa et al. (2024), who emphasize the role of schools in cultivating environmental awareness through participatory and critical pedagogy.

Furthermore, ABCEI recognizes the importance of involving families and the broader community. Activities such as intergenerational gardening projects, knowledge-sharing events, and community conservation days are designed to reinforce conservation values across age groups and build a more supportive environment for lasting behavior change (Clayborn et al. 2020).

Empirical support for this integrated approach comes from studies such as Baierl et al. (2021), who demonstrated that immersive, nature-based learning significantly enhanced both environmental attitudes and conservation behaviors among youth. Similarly, Clayborn et al. (2020) found that butterfly gardening served as an effective tool for ecological education by creating emotionally meaningful experiences that encouraged conservation-minded actions.

Therefore, ABCEI offers a comprehensive, attitude-focused educational model that moves beyond traditional knowledge-based approaches by embedding conservation into school curricula, fostering emotional engagement, and promoting community participation. While this initiative holds strong potential to inspire enduring commitment to butterfly conservation and biodiversity protection, its effective implementation in Bandung requires alignment with local realities, including the socioeconomic capacities of communities, the extent of governmental and institutional support, and the availability of public green spaces. Without such contextual support, the model risks remaining theoretical rather than operational; however, when integrated into city-level environmental education programs and reinforced by local policies, ABCEI can serve as a feasible and impactful framework for promoting pro-conservation attitudes and behaviors.

The folk classification of butterflies in Bandung

The people of Bandung refer to adult butterflies as kupu-kupu or kukupu. Their folk classification of butterflies includes seven categories in total: six based on wing color and one based on wing patterns. The color-based categories are kukupu hideung (black butterflies): butterflies with predominantly black wings; kukupu coklat (brown butterflies): butterflies with wings dominated by brown; kukupu koneng (yellow butterflies): butterflies characterized by a dominant yellow color; kukupu bodas (white butterflies): butterflies displaying predominantly white wings; kukupu biru (blue butterflies): butterflies that are mainly blue; and kukupu hejo (green butterflies): butterflies with wings dominated by green. In addition to these, the community also recognizes a pattern-based category, kukupu aya mataan (eye-like spot butterflies): butterflies with eye-like spots on their wings. Examples of butterflies classified by the community according to both color and wing patterns are presented in Figure 7. While folk taxonomy reflects community-based perspectives on butterfly diversity, scientific surveys provide a complementary account that allows for cross-regional comparison and ecological monitoring.

Observed butterfly diversity in Bandung

A total of 11,147 butterfly specimens were recorded during field sampling, representing 87 species distributed across five families: Nymphalidae, Papilionidae, Pieridae, Hesperiidae, and Lycaenidae. Among these, Nymphalidae dominated the assemblage with 42 species (Figure 8). The most common species found were *Papilio memnon*, *Hypolimnas bolina*, *Doleschallia bisaltide, Eurema blanda*, and *Appias olferna*. In comparison, the least found butterfly species were *Pareronia valeria*, *Anthene lycaenina*, *Faunis canens, Suada swerga, Symbrenthia hypselis, Miletus* sp., *Danaus chrysippus, Papilio polytes, Troides helena, Chilades pandava, Delias pasithoe, Ypthima pandocus*, and *Mycalesis sudra*. The diversity of butterflies found is presented in Figure 9.

Butterfly research has been widely conducted in both urban and suburban areas. For instance, a study in Kunming, Yunnan Province, China, recorded only 50 species, with Nymphalidae being the most dominant family, similar to Bandung, although Riodinidae was also reported there (Fang et al. 2024). In contrast, butterfly diversity research in Bandung City remains limited and underpublished, with previous studies reporting relatively low species richness: 26 species at the Bosscha Observatory, Lembang (Subahar and Yuliana 2010), 45 species in Pasirluyu Village, Cisarua (Septianella et al. 2015), and 45 species in tea and quinine plantations in Pasir Jambu, Ciwidey (Parsaoran et al. 2024). This higher diversity is likely explained by Bandung's wide range of habitats spanning urban, suburban, and rural mosaics, which provide extensive floral resources and microhabitats.

Figure 7. Folk classification of butterflies according to color and wing patterns. A. Hideung, B. Coklat, C. Koneng, D. Bodas, E. Biru, F. Hejo, G. Aya mataan

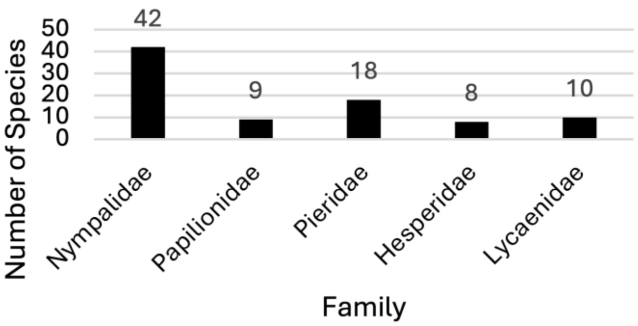

Figure 8. Family composition of adult butterflies found

Ombugadu et al. (2024) highlight that butterfly diversity in urban areas is shaped by landscape heterogeneity, with habitat patches such as savannah woodlands supporting higher richness than larger gallery forests. Similarly, in Loja City, southern Ecuador, heterogeneous semi-urban areas supported greater diversity. Canopy layering and vegetation density also play significant roles in structuring urban butterfly assemblages (Neal et al. 2024). In Bandung, butterfly presence is sustained by diverse habitats that support survival and reproduction. Land-use variation significantly affects diversity, as heterogeneous landscapes provide key microhabitats and food resources across the butterfly life cycle (Wang et al. 2025). Supporting this, Leksono et al. (2025) found that landscapes with dense vegetation in Lumajang, East Java, supported the highest butterfly diversity, whereas arable lands harbored the lowest. Additionally, the large number of sampling points (31) and extended sampling periods improved the detection of both common and rare species. Collectively, these ecological and methodological factors explain the higher butterfly richness observed in Bandung.

Given these findings, urban habitat restoration strategies are necessary to improve butterfly habitats in Bandung and make a substantial contribution to the worldwide conversation on environmental literacy and invertebrate conservation. Redesigning urban landscapes to include butterfly-friendly habitats in both natural areas and abandoned urban spaces reflects best practices in conservation efforts. In Puebla, Mexico, diversification of habitats has been shown to enhance butterfly diversity significantly (Barranco-León et al. 2016). Increasing the number of host and nectar plants, as well as improving vegetation structure in green urban spaces, also plays a critical role in supporting butterfly populations, as demonstrated by Azahra et al. (2022). Similarly, Baldock et al. (2019) emphasized that establishing butterfly gardens rich in host and nectar plants within schools, parks, and residential areas has been widely recognized as an effective strategy to sustain butterfly populations while simultaneously promoting environmental education. Encouraging reduced pesticide use alongside organic urban agriculture and biopesticides has been shown to benefit butterfly assemblages (Antil et al. 2024; Quandahor et al. 2024). In addition to their ecological advantages, these localized initiatives are useful experiential learning opportunities that raise urban dwellers' understanding of environmental issues.

Global frameworks such as the United Nations Environment Programme's (UNEP) Pollinator Initiative and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) have highlighted the significance of protecting pollinators, including butterflies, because of their critical role in food security and ecosystem functioning (IPBES 2017). UNEP's continuous policy support and the IPBES pollinator evaluation provide scientific and policy recommendations that help guide local initiatives in Bandung. Urban areas like Bandung can take the lead in putting nature-based solutions that preserve invertebrate biodiversity into practice while encouraging public participation and environmental literacy through inclusive, community-based stewardship by coordinating these urban conservation strategies with global science-policy initiatives. Overall, these actions demonstrate that effective butterfly conservation in urban landscapes relies on ecological restoration, sustainable practices, and active community involvement.

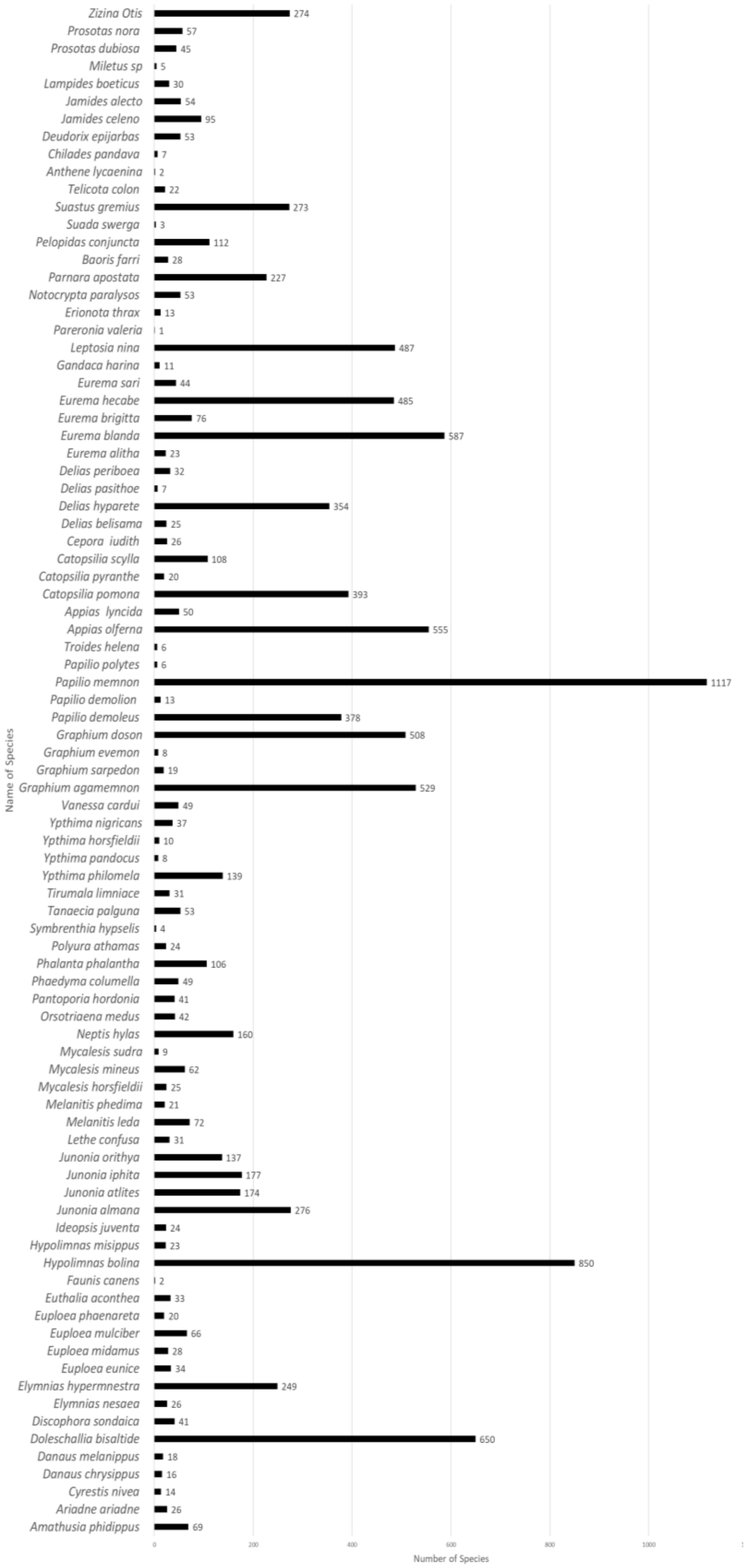

Figure 9. Butterfly species diversity

Table 10. Comparison of adult butterfly classification based on public knowledge with those found during sampling

Classification of butterflies based on society		Species name on sampling
Color	Kukupu Hideung (Black)	*Papilio demolion*
		Papilio memnon
		Papilio polytes
		Troides helena
	Kukupu Coklat (Brown)	*Amathusia phidippus*
		Ariadne ariadne
		Danaus chrysippus
		Danaus melanippus
		Doleschallia bisaltide
		Discophora sondaica
		Elymnias nesaea
		Elymnias hypermnestra
		Euploea eunice
		Euploea midamus
		Euploea mulciber
		Euploea phaenareta
		Euthalia aconthea
		Faunis canens
		Junonia almana
		Junonia atlites
		Junonia iphita
		Lethe confusa
		Melanitis leda
		Melanitis phedima
		Mycalesis horsfieldii
		Mycalesis sudra
		Neptis hylas
		Orsotriaena medus
		Pantoporia hordonia
		Phaedyma columella
		Phalanta phalantha
		Symbrenthia hypselis
		Tanaecia palguna
		Ypthima philomela
		Ypthima pandocus
		Ypthima horsfieldii
		Ypthima nigricans
		Vanessa cardui
		Baoris farri
		Erionota thrax
		Parnara apostate
		Pelopidas conjuncta
		Notocrypta paralysos
		Suada swerga
		Suastus gremius
		Telicota colon
		Anthene lycaenina
		Chilades pandava
		Deudorix epijarbas
		Jamides celeno
		Jamides Alecto
		Lampides boeticus
		Miletus sp.
		Prosotas dubiosa
		Prosotas nora
		Zizina otis
	Kukupu Koneng (Yellow)	*Catopsilia pomona*
		Catopsilia pyranthe
		Catopsilia scylla
		Delias belisama
		Delias pasithoe
		Eurema alitha
		Eurema blanda
		Eurema brigitta
		Eurema sari
		Gandaca harina
	Kukupu bodas (White)	*Appias olferna*
		Appias lyncida
		Leptosia nina
	Kukupu Biru (Blue)	*Graphium doson*
		Graphium sarpedon
		Junonia orithya
	Kukupu Hejo (Green)	*Polyura athamas*
		Graphium agamemnon
		Graphium evemon
Specific pattern	*Kukupu Aya Mataan* (There are 'eyes' on the butterfly wings)	*Junonia almana*
		Junonia atlites
		Junonia orithya
		Lethe confusa
		Melanitis leda
		Mycalesis horsfieldii
		Orsotriaena medus
		Ypthima philomela
		Ypthima pandocus
		Ypthima horsfieldii
		Ypthima nigricans

Comparison of observed butterfly diversity and community knowledge

Based on the sampling results in Bandung, 87 species of adult butterflies with a variety of colors were identified. These species were then categorized according to wing colors as described by the local community in Bandung. In some cases, the upper and underside of a butterfly's wings display different colors, making it necessary to cross-check or validate color classifications with the community to ensure a more accurate comparison between emic (insider/local) and etic (researcher/external) perspectives. A comparison between community-based butterfly classification and scientifically identified species found in Bandung is presented in Table 10.

Table 10 presents four species of black butterflies identified by the community: *Papilio demolion*, *P. memnon*, *P. polytes*, and *T. helena*, all of which belong to the family Papilionidae. Although these butterflies exhibit some variations in color, such as white or red spots and lines, they are generally perceived as black due to their dominant coloration when observed in flight. Table 10 also includes ten yellow butterfly species, three white species, three green species, three blue species, and eleven species locally referred to as aya mataan butterflies. The most commonly recognized category, however, is the brown butterfly (kukupu coklat), with 52 species identified, mostly from the Families Nymphalidae and Hesperiidae (Figure 10).

The term aya mataan, used by the local community, refers to butterflies with eyespot patterns on their wings. Sekimura et al. (2015) explained that these eyespots typically develop in species within the Nymphalidae family. Eyespot formation originates from signaling centers known as foci, which are evenly positioned between wing veins along the midline of wing cells. These clusters of cells emit morphogenetic signals that regulate the synthesis of circular pigment patterns around them.

Some butterfly species recorded during sampling were difficult to classify based on the community's colour-based folk taxonomy due to their complex or variable wing coloration. Species such as *H. bolina*, *H. misippus*, *Ideopsis juventa*, *Tirumala limniace*, *P. valeria*, *Papilio demoleus*, *Cepora iudith*, *Delias hyparete*, and *Delias periboea* posed challenges for categorization. For example, *H. bolina* exhibits different upper and underside wing colors, black on the dorsal side and brown on the ventral side, and also displays sexual dimorphism, with distinct wing patterns between males and females (Figure 11)

While the comparison between folk classifications (7 categories) and scientific identification (87 species) highlights substantial overlaps, it also reveals important epistemological differences. Folk taxonomy tends to rely on salient morphological traits, behavioral cues, or cultural relevance, which may lead to the grouping of multiple scientific species under a single local name or, conversely, the splitting of one species into several folk categories. Such differences should not be viewed as inaccuracies, but rather as reflections of distinct emic and etic perspectives: the emic (local knowledge) perspective emphasizes community-relevant criteria of recognition and use, whereas the etic (scientific) perspective relies on standardized morphological and taxonomic frameworks. Recognizing these dual systems of classification is crucial, as it underscores both the validity of local ecological knowledge and its potential limitations when translated into scientific biodiversity assessments, thereby fostering an open-minded and receptive attitude towards diverse perspectives.

The observed differences between folk classification and scientific identification have important implications for community-based conservation strategies. On one hand, folk taxonomy reflects emic perspectives grounded in daily interactions, cultural relevance, and utilitarian values of butterflies. These locally meaningful classifications can foster stronger community engagement in conservation because they resonate with local experiences and practices. On the other hand, scientific taxonomy provides a more standardized etic framework that ensures accuracy in biodiversity monitoring, species conservation status, and cross-regional comparability. Bridging these two systems is therefore essential: conservation programs can integrate scientific data for monitoring and policy purposes while simultaneously recognizing and validating local knowledge to strengthen legitimacy and participation. This dual approach not only enhances conservation effectiveness but also mitigates the knowledge-behavior gap, ensuring that strategies remain both ecologically robust and socially grounded.

The ability of the local community in Bandung to describe morphological traits of butterfly species observed in their surroundings suggests that the community holds fundamental knowledge required for species-level identification. This foundational understanding provides a crucial basis for the implementation of future butterfly monitoring programs through citizen science initiatives, which hold significant potential to support conservation efforts. Moreover, such initiatives have been recognized as effective tools for detecting local extinctions of butterfly populations, especially within urbanized and fragmented landscapes (van Tongeren et al. 2023).

Local perspectives on the functions and values of butterflies in Bandung

Beyond visual recognition and ecological categorization, butterflies also hold functional and cultural meanings for local communities. While folk classification emphasizes how species are perceived and grouped based on observable traits, the functions and values attributed to butterflies reveal how these perceptions are embedded in everyday practices, livelihoods, and symbolic systems.

According to the interview, butterflies are perceived to provide several benefits, including environmental benefits, benefits of seasonal forecasting, economic benefits, and cultural value. The cultural value includes aspects such as the myth of butterfly presence, butterflies in the Kukupu dance, butterflies in batik motifs, and butterflies as a source of product and design inspiration. The perceived benefits of butterflies according to the local community in Bandung are presented in Table 11.

Environmental benefits

Based on interviews with the community, butterflies are perceived to contribute ecologically as pollinating insects. Locals observed that butterflies are active during the day, often landing on flowers, where they assist in pollination by transferring pollen as they feed. They also noted that butterflies are particularly drawn to brightly colored flowers, such as red and yellow, and that they extract nectar from these flowers. While butterflies are indeed pollinators (Mertens et al. 2021), their role is considered less effective compared to bees and flies (Wardhaugh 2015; Ollerton et al. 2017). According to Cepero et al. (2015), butterflies use a combination of visual cues, such as color, shape, and texture, to select flowers, though preferences may differ among taxa or behavioral contexts. Morphological and behavioral adaptations for pollination vary across Lepidoptera. For instance, members of Papilionidae, Pieridae, and some Nymphalidae and Hesperiidae species possess long proboscises suited for feeding on nectar in deep flowers, whereas many Lycaenidae and Riodinidae have shorter proboscises that limit their access to nectar in specialized flowers (Corbet 2000; Tiple et al. 2009).

Benefits of seasonal forecasting

Local communities report that butterflies can act as natural indicators of seasonal change. At the onset of the rainy season, typically in early November, numerous yellow-colored butterflies (referred to as koneng in Sundanese) are observed flying from east to west (*ti wetan ka kulon*). Conversely, during the dry season, butterflies turn brown with distinctive white streaks (guratan bodas) and move in the opposite direction, from west to east (ti kulon ka wetan). Field observations in Bandung identify the yellow butterfly appearing during the rainy season as *Catopsilia pomona*, while the brown butterflies observed in the dry season belong to the genus *Euploea* (Figure 12).

Table 11. The benefits of butterflies, according to the local community in Bandung, West Java, Indonesia

No	The benefit of butterfly
1	Environmental benefits (Pollinator)
2	Seasonal forecasting
	a. Wet season
	b. Dry season
3	Economic benefits
	a. Butterfly ornament
	b. Pet food
	c. Fish bait
4	Cultural value
	a. The myth of butterfly presence
	b. Butterflies in the Kukupu dance
	c. Butterflies in batik motifs
	d. Butterflies as product and design inspiration

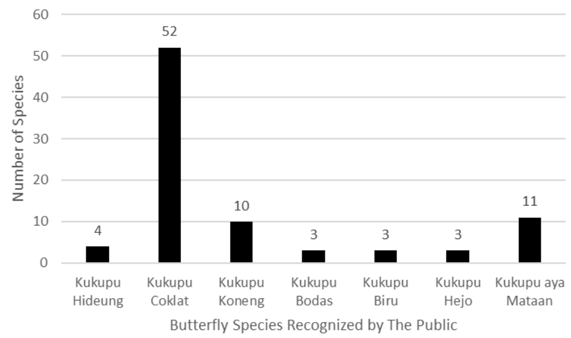

Figure 10. The number of butterfly species recognized by the public

Figure 11. *Hypolimnas bolina*. A: Underside, B: Upperside, C: Male, D: Female

Figure 12. Butterfly marker of the season. A. *Catopsilia pomona*, B. *Euploea mulciber*

Butterflies are known for their migratory behavior, particularly among the Pieridae, Danaidae, and Nymphalidae families, though it is less common in Lycaenidae and Hesperiidae. Gokul and Ramesh (2021) confirm that *C. pomona* exhibits migration patterns from northeastern regions toward southwestern Tamil Nadu, India, with peak migration in October and a decline by July. Similarly, Sekarappa (2016) documented biannual migrations of *Euploea* species, moving northeastward in April and southwestward during a three-period spanning September to November.

Economic benefits

Local community members report that butterflies offer economic value, particularly through their use in handicrafts and as bird feed. Preserved butterflies are crafted into individual pieces or decorative items such as wall hangings and clocks. In Bandung, butterfly hunters commonly collect specimens from areas like Cihanjuang and Cimenyan, where butterflies are reportedly abundant. These activities are conducted without permits, as the collected species are not classified as rare. Hunting occurs approximately every three months or on request, targeting species such as *Graphium sarpedon*, *P. memnon*, *D. chrysippus*, *Delias belisama*, and others. Collection typically takes place during sunny mornings (9-11 a.m.) using handmade butterfly nets.

Preservation involves injecting alcohol into the butterflies, stretching them after two days, and applying additional alcohol to the wings. The stretching process takes about a week, after which the butterflies are packed into envelopes and sent to artisans or traders. Unsold specimens are stored in mothball-treated containers, but if they remain unsold for over two months, they are discarded.

Based on interview results, butterfly selling prices range from Rp 3,000 to Rp 25,000 per specimen, depending on the species. *Eurema* is the cheapest, while *Papilio karna* is the most expensive due to its rarity, although this species was not found during field observations. *Graphium doson* is the most frequently traded species and is commonly used for decorative crafts. The average sales reach 3–5 specimens per month at around Rp 10,000 each. Some hunters sell directly through online platforms, but the profits are relatively modest, around Rp 100,000 to Rp 150,000 per month, and are considered supplementary income.

Butterfly artisans obtain specimens from both wild hunters and captive breeders. Though captive butterflies are pricier, they are of higher quality and used to create decorations such as wall clocks and snow globes. Rare and expensive butterflies are typically sourced from regions like East Java, Sulawesi, Maluku, and Papua. Finished crafts are sold online, generating monthly revenues of approximately Rp 500,000, with buyers from cities such as Bandung, Jakarta, and Bali, as well as international customers from the UAE and Thailand.

Butterflies also serve as a food source for insectivorous birds. According to locals, banana skippers (*Erionota thrax*) are particularly used to feed species like the whiterumped shama (*Copsychus malabaricus*), oriental magpie-robin (*Copsychus saularis*), and long-tailed shrike (*Lanius schach*). These caterpillars (Figure 13), which curl on banana leaves, are sold fresh for Rp 500 to Rp 1,500 each by traders in Sukahaji, with supply depending on customer demand. Monthly sales range from 50 to 150 caterpillars, typically sourced from areas such as Soreang, Lembang, Sumedang, Garut, and Tasikmalaya.

Feeding birds with banana skippers should be done in moderation, as excessive consumption may lead to obesity. These caterpillars are typically given to birds prior to singing competitions to enhance vocal performance, with feeding usually starting about a week before the event. During this period, birds are given 1-2 caterpillars daily. Banana skippers are also commonly used during the breeding season to support reproductive activity.

Mwansat et al. (2015) note that insects, including members of the Lepidoptera order, are vital dietary components for many bird species. Nutritionally, insects are rich in protein and fat, which are essential for bird growth and development. Birds consume insects at various life stages (eggs, larvae, pupae, or adults), with larvae often preferred for feeding chicks due to easier digestion.

In addition to their use as bird food, local communities also use banana skipper cocoons as fish bait. At Sukahaji Market, these cocoons are sold for approximately Rp 40,000 per 500 grams and are commonly used to catch fish such as pomfret and common carp.

Cultural value

The myth of butterfly presence. According to local beliefs, the presence of butterflies, particularly those that enter a home, is seen as a symbolic sign of visitors. A dark-colored butterfly entering the house is thought to signal the arrival of an unexpected guest. Conversely, a white or brightly colored butterfly is associated with a welcome visitor who is believed to bring good fortune. Additionally, if a butterfly appears at night, it is interpreted by the community as a sign of impending misfortune or sorrowful news.

Butterflies in the Kukupu dance. The Kukupu dance is a classical Sundanese performance choreographed by cultural figure Raden Tjetje Sumantri (also known as R. Rusdi Somantri) around 1952. Unlike most traditional classical dances that tend to be lengthy, Kukupu dance is relatively short, lasting approximately 8 minutes, and features more dynamic movements. Compared to other classical dance traditions from regions such as Yogyakarta, Solo, or Bali, Kukupu is considered livelier and more suitable for entertaining state guests. Performed exclusively by women, the dance emphasizes grace and elegance, accompanied by classical Sundanese gamelan music. Sundanese artist Tb. Oemay Martakusumah designed the costume for Kukupu dance to resemble the appearance of an adult butterfly. It includes wings, antennae, and various decorative elements, typically crafted in light and colorful tones to enhance visual appeal.

Inspired by the natural behavior and life cycle of butterflies, the dance interprets their transformation through movement (Figure 14). The performance begins with the “trisi” step, a light heel-run while holding a shawl, symbolizing a newly hatched caterpillar (Figure 14.A). The dancer then moves in four directions to depict a butterfly drying its wings after emerging from its cocoon (Figure 14.B). This is followed by the “ngumis” motion, representing a butterfly sipping nectar (Figure 14.C), as well as movements mimicking the insect climbing branches and learning to fly (Figure 14.D). The final section portrays the butterfly taking full flight (Figure 14.E), completing the transformation narrative.

The Kukupu dance incorporates movements that mirror the natural behavior of butterflies. As described by James (2017), after hatching from their eggs, caterpillars begin feeding and actively seek safe areas to avoid predators. When a butterfly emerges from its chrysalis, its wings are still delicate and undeveloped. The insect typically rests briefly with its wings hanging, then gradually expands them by circulating blood through the wing veins. This process must be repeated until the wings become firm and functional. Simultaneously, the butterfly's proboscis initially appears as two separate coiled strands, which it moves in a repeated coiling and uncoiling motion. This action eventually fuses the strands into a single, tube-like organ used for nectar feeding. In local cultural understanding, this particular movement of the proboscis is referred to as ngumis.

Butterflies in batik motifs. Batik is a traditional textile known for its distinctive Indonesian motifs, such as kawung, lereng, megamendung, lasem, sekar jagad, and others. In Bandung, local batik artisans adapt these traditional patterns by incorporating elements that reflect the city's identity. These adaptations are evident in the choice of colors, fabric types, and motif designs. Characteristic Bandung batik motifs often feature architectural landmarks like the Pasupati Bridge and Gedung Sate. Additionally, motifs are drawn from the region’s native flora and fauna, such as the peacock flower (*Caesalpinia pulcherrima*), locally called patrakomala, and butterflies (Figure 15).

Figure 13. Banana skipper for songbird feed

Figure 14. Kukupu dance movements (Source: PT Unggul Cipta Piranti (Emperor Edutainment) (2019))

According to the artisans, butterfly motifs are often combined with traditional patterns like lasem. Philosophically, the butterfly in batik represents themes of peace, hope, self-sacrifice, and the wisdom inherent in human life. The butterfly's metamorphosis symbolizes transformation and authenticity, and these values are visually expressed through batik design. Butterfly-themed batik can be created in a variety of colors and through different techniques, including dyeing, hand-drawing (batik tulis), stamping (batik cap), and printing.

Butterflies as product and design inspiration. Butterflies serve as a creative inspiration for a wide range of products and design works. Crafts that incorporate butterfly elements can be found in various materials, such as wood, leather, glass, ceramics, textiles (e.g., t-shirts), metal, and more (Figure 16). The diverse forms and vibrant colors of butterflies have motivated designers to create items that carry both aesthetic appeal and significant economic value, a fact that the audience will surely appreciate.

Interviews with artists and designers revealed that the process of creating a product or design often begins with the observation and exploration of captivating subjects, one of which is butterflies. This active engagement in exploration, whether it's through direct observation in natural environments or referencing books and other sources, is a crucial part of the creative process. Following this phase of inspiration, the artist typically produces sketches that then guide the formation and development of the final product. These cultural and economic values provide leverage points for conservation: instead of positioning butterflies solely as ecological indicators, strategies in Bandung could align with cultural practices (dance, batik, crafts) to embed conservation messages in everyday life.

Figure 15. Batik with butterfly motif

Figure 16. Butterfly-based design (A) and product example (B)

This study demonstrates that although public knowledge of butterfly diversity in Bandung is generally moderate, attitudes and behaviors toward conservation are strongly positive. The results reveal that knowledge alone does not determine conservation behavior; rather, attitudes play the central role in influencing public actions. Age and education contribute modestly to knowledge, while occupation significantly affects both attitudes and behaviors. The presence of 87 recorded species, dominated by Nymphalidae, reflects the city's ecological richness, supported by varied landscapes and cultural connections to butterflies. Public recognition of butterflies as pollinators, seasonal markers, and cultural symbols underscores their ecological and sociocultural importance. Therefore, conservation programs in Bandung should emphasize emotionally engaging and participatory approaches, integrating folk ecological knowledge and cultural traditions (such as the kukupu dance and batik motifs) to strengthen long-term commitment to butterfly conservation and environmental literacy, and make future butterfly conservation a distinctive feature of Bandung's urban identity.

ACKNOWLEDGEMENTS

Gratitude is extended to the Research and Community Service Institute (LPPM) of Universitas Padjadjaran (UNPAD), Bandung, West Java, Indonesia, for providing research funding assistance through the UNPAD Dissertation Research for Lecturers program. Gratitude is also extended to the people of Bandung who assisted with the research process, as well as to Tahura Ir. H. Djuanda, Bandung and the officials in the Bandung City Government, Bandung District, and West Bandung District.

REFERENCES

Akhmar AM, Rahman F, Supratman, Hasyim H, Nawir M. 2023. The cultural transmission of traditional ecological knowledge in Cerekang, South Sulawesi, Indonesia. SAGE Open 13 (4): 1-17. DOI: 10.1177/21582440231194160.

Alzghoul BI, Abdullah NAC. 2015. Pain management practices by nurses: An application of the knowledge, attitude, and practices (KAP) model. Glob J Health Sci 8 (6): 154-160. DOI: 10.5539/gjhs.v8n6p154.

Antil J, Kanaujia A. 2024. Fluttering folklores: Butterflies and their significance in mythology. In: Nakella AK (eds). Folklore Connect, Wildlife and Biodiversity. Bharti Publications. New Delhi.

Antil J, Tripathi P, Kanaujia A. 2024. Impact of agrochemicals on butterflies, the consequences for pollination and conservation measurements: A review. AgriTech Today e-Magazine 2 (8): 150-154.

Aulia AF, Sandhu, Millington AC. 2020. Quantifying the economic value of ecosystem services in oil palm-dominated landscapes in Riau Province in Sumatra, Indonesia. Land 9 (6): 194. DOI: 10.3390/LAND9060194.

Azahra SD, Rushayati SB, Destiana D. 2022. Green open spaces as butterfly refuge habitat: Potential, issues, and management strategies for butterfly conservation in urban areas. Berkala Sainstek 10 (4): 227. DOI: 10.19184/bst.v10i4.33123.

Badan Pusat Statistik (BPS). 2024. Kota Bandung dalam Angka Bandung Municipality in Figures 2024 volume 44. BPS Kota Bandung. [Indonesian]

Baierl TM, Johnson B, Bogner FX. 2021. Assessing environmental attitudes and cognitive achievement within 9 years of informal earth education. Sustainability 13 (7): 3622. DOI: 10.3390/su13073622.

Baldock KCR, Goddard MA, Hicks DM, Kunin WE, Mitschunas N, Morse H, Osgathorpe LM, Potts SG, Robertson KM, Scott AV, Staniczenko PPA, Stone GN, Vaughan IP, Memmott J. 2019. A systems approach reveals urban pollinator hotspots and conservation opportunities. Nat Ecol Evol 3 (3): 363-373. DOI: 10.1038/s41559-018-0769-y.

Bandhani A. 2021. Role of women in environmental conservation. In: Sheidaei F, Akbari E, Akbari E, Choobchian S, Choobchian S, Abbasi E (eds). Climate Change, Water Availability and Food Security: Impacts Sustainable Management. Iran.

Barranco-León M, de las N, Luna-Castellanos F, Vergara CH, Badano EI. 2016. Butterfly conservation within cities: A landscape-scale approach integrating natural habitats and abandoned fields in central Mexico. Trop Conserv Sci 9 (2): 607-628. DOI: 10.1177/194008291600900204.

Barua M, Gurdak DJ, Ahmed RA, Tamuly J. 2012. Selecting flagships for invertebrate conservation. Biodivers Conserv 21 (6): 1457-1476. DOI: 10.1007/s10531-012-0257-7.

Cepero LC, Rosenwald LC, Weiss MR. 2015. The relative importance of flower color and shape for the foraging monarch butterfly (Lepidoptera: Nymphalidae). J Insect Behav 28 (4): 499-511. DOI: 10.1007/s10905-015-9519-z.

Choi SW, Kim SS, Kwon TS, Park H. 2017. Significant decrease in local butterfly community during the last 15 years in a calcareous hill of the middle Korea. Entomol Res 47 (5): 300-308. DOI: 10.1111/1748-5967.12225.

Clayborn K, Koptur S, O'Brien. 2020. Plugging students into nature through butterfly gardening: A reconciled ecological approach to insect conservation. Child Youth Environ 30 (2): 30. DOI: 10.7721/chilyoutenvi.30.2.0030.

Corbet SA. 2000. Butterfly nectaring flowers: Butterfly morphology and flower form. Entomol Exp Appl 96 (3): 289-298. DOI: 10.1046/j.1570-7458.2000.00708.x.

Daniel TC, Muhar A, Arnberger A, Aznar O, Boyd JW, Chan KMA, Costanza R, Elmqvist T, Flint CG, Gobster PH, Grêt-Regamey A, Lave R, Muhar S, Penker M, Ribe RG, Schauppenlehner T, Sikor T, Soloviy I, Spierenburg M, Von Der Dunk A. 2012. Contributions of cultural services to the ecosystem services agenda. Proc Natl Acad Sci USA 109 (23): 8812-8819. DOI: 10.1073/pnas.1114773109.

Danneck J, Tiang DCF, Ngo Duc K, Azhar B, Sanusi R, Campos-Arceiz A, Lechner AM. 2023. Conserving urban tropical biodiversity by connecting networks of green patches. Integr Conserv 2 (2): 80-94. DOI: 10.1002/inc3.21.

Dursun İ, Kılıç HY, Tümer Kabadayı E, Dönmez D. 2024. Roles of cognitive, affective, social, and situational factors in norm activation theory: Evidence for recycling behavior. Intl J Manag Econ Business 20: 44-60. DOI: 10.17130/ijmeb.1498346.

Fajri SR, Sudiatmika AR, Suma IK, Suardana IN. 2023. Studi meta analisis: Peningkatan kemampuan literasi biodiversitas berdasarkan model pembelajaran dan tingkat pendidikan. Bioscientist 11 (2): 1764. DOI: 10.33394/bioscientist.v11i2.9686. [Indonesian]

Fang SQ, Li YP, Pan Y, Wang CY, Peng MC, Hu SJ. 2024. Butterfly diversity in a rapidly developing urban area: A case study on a university campus. Diversity 16 (1): 4. DOI: 10.3390/d16010004.

Fish RD, Austen GE, Bentley JW, Dallimer M, Fisher JC, Irvine KN, Bentley PR, Nawrath M, Davies ZG. 2024. Language matters for biodiversity. BioScience 74 (5): 333-339. DOI: 10.1093/biosci/biae014.

Gage R, Graefe D. 2019. Campus conservation initiatives: Factors influencing student engagement, attitudes and behaviours. Intl J High Educ Sustain 2 (3): 197. DOI: 10.1504/ijhes.2019.101960.

Ghazanfar M, Mali MF, Hussain M, Iqbal R, Younas M. 2016. Butterflies and their contribution to the ecosystem: A review. J Entomol Zool Stud 4 (2): 115-118.

Gokul T, Ramesh T. 2021. A note on seasonal migratory movement of *Catopsilia pomona* in the plains of Madurai District, Tamil Nadu. J Entomol Res 45 (4): 749-758. DOI: 10.5958/0974-4576.2021.00120.1.

Gunwal I, Mago P. 2019. Role of women in environment conservation. SSRN Electron J 1-13. DOI: 10.2139/ssrn.3368066.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2017. The Assessment Report on Pollinators, Pollination and Food Production of The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), Germany.

Ismail N, Rahman AAA, Mohamed M, Bakar MFA, Tokiman L. 2020. Butterfly as a bioindicator for the development of conservation areas in Bukit Reban Kambing, Bukit Belading, and Bukit Tukau, Johor, Malaysia. Biodiversitas 21 (1): 334-344. DOI: 10.13057/biodiv/d210141.

James DG. 2017. The Book of Caterpillars: A Life-Size Guide Six Hundred Species from Around the World. The University of Chicago Press, Chicago. DOI: 10.7208/chicago/9780226287539.001.0001.

Kellert SR. 1993. Values and perceptions of invertebrate. Conserv Biol 7 (4): 743-970. DOI: 10.1046/j.1523-1739.1993.740845.x.

Kim MS, Kim J, Thapa B. 2018. Influence of environmental knowledge on affect, nature affiliation, and pro-environmental behaviors among tourists. Sustainability 10 (9): 3109. DOI: 10.3390/su10093109.

Kollmuss A, Agyeman J. 2002. Mind the gap: Why do people act environmentally, and what are the barriers to pro-environmental behavior? Environ Educ Res 8 (3): 239-260. DOI: 10.1080/13504620220145401.

Kuo M, Barnes M, Jordan C. 2019. Do experiences with nature promote learning? Converging evidence of a cause-and-effect relationship. Front Psychol 10: 305. DOI: 10.3389/fpsyg.2019.00305.

Kyerematen R, Kaiwa F, Acquah-Lamptey D, Adu-Acheampong S, Andersen RS. 2018. Butterfly assemblages of two wetlands: response of biodiversity to different environmental stressors in Sierra Leone. Open J Ecol 8 (7): 379-395. DOI: 10.4236/oje.2018.87023.

Lau JD. 2020. Three lessons for gender equity in biodiversity conservation. Conserv Biol 34 (6): 1589-1591. DOI: 10.1111/cobi.13487.

Leksono AS, Yanuwiadi B, Millah N, Abdullah SA. 2025. Butterfly diversity along an altitudinal gradient and land uses in East Java, Indonesia. Biodiversitas 26 (2): 551-563. DOI: 10.13057/biodiv/d260204.

Lim VC, Sing KW, Chong KY, Jaturas N, Dong H, Lee PS, Tao NT, Le DT, Bonebrake TC, Tsang TPN, Chu L, Brandon-Mong GJ, Kong WL, Soga M, Wilson JJ. 2022. Familiarity with, perceptions of, and attitudes toward butterflies of urban park users in megacities across East and Southeast Asia. R Soc Open Sci 9 (11): 220161. DOI: 10.1098/rsos.220161.

Lin Y, Huang S, Fang W, Zhao Y, Huang Z, Zheng R, Huang J, Dong J, Fu W. 2023. Butterfly communities vary under different urbanization types in city parks. Animals 13 (11): 1775. DOI: 10.3390/ani13111775.

Macdonald ME, Siedlikowski S, Liu K, Carnevale FA. 2023. Introducing SAMMSA, a five-step method for producing 'quality' qualitative analysis. Qual Health Res 33 (4): 334-344. DOI: 10.1177/10497323231154482.

Malik MAA, Mustapha MF, Sobri MN, Abd-Razak NF, Mohd-Zaidi MN, Shukri AA, Sham ZMAL. 2021. Optimal reliability and validity of measurement model in confirmatory factor analysis: Different likert point scale experiment. J Contem Issues Thought 11: 105-112. DOI: 10.37134/jcit.vol11.9.2021.

Mathers B, Brymer E. 2022. The power of a profound experience with nature: Living with meaning. Front Psychol 13: 764224. DOI: 10.3389/fpsyg.2022.764224.

Mertens JEJ, Brisson L, Janeček Š, Klomberg Y, Maicher V, Sáfián S, Delabye S, Potocký P, Kobe IN, Pyrcz T, Tropek R. 2021. Elevational and seasonal patterns of butterflies and hawkmoths in plant-pollinator networks in tropical rainforests of Mount Cameroon. Sci Rep 11 (1): 9710. DOI: 10.1038/s41598-021-89012-x.

Mwansat GS, Turshak LG, Okolie MO. 2015. Insects as important delicacy for birds: Expanding our knowledge of insect food ecology of birds in the tropics. Ecol Safety 9: 434-441.

Neal W, Araya Y, Wheeler PM. 2024. Influence of canopy structural complexity on urban woodland butterfly species richness. J Insect Conserv 28 (5): 1051-1062. DOI: 10.1007/s10841-024-00594-z.

Nurhayati, Syarifuddin, Ritonga YE, Pradwinata R, Pendong LM. 2025. Butterfly diversity in natural and modified habitats at Bahorok District, Langkat Regency, North Sumatra. Jurnal Entomologi Indonesia 22 (1): 17-28. DOI: 10.5994/jei.22.1.17.

Ollerton J, Dötterl S, Ghorpadé K, Heiduk A, Liede-Schumann S, Masinde S, Meve U, Peter CI, Prieto-Benítez S, Punekar S, Thulin M, Whittington A. 2017. Diversity of Diptera families that pollinate *Ceropegia* (Apocynaceae) trap flowers: An update in light of new data and phylogenetic analyses. Flora 234: 233-244. DOI: 10.1016/j.flora.2017.07.013.

Ombugadu A, Hassan ZA, Ibrahim JI, Atabo LO, Ayim JO, Attah SA, Maikenti JI, Parlato BP, Deme GG. 2024. Butterfly community composition within a tropical urban landscape is influenced by habitat type and temperature. Insect Conserv Divers 17 (2): 324-333. DOI: 10.1111/icad.12705.

Oropeza-Sánchez MT, Solano-Zavaleta I, Cuandón-Hernández WL, Martínez-Villegas JA, Palomera-Hernández V, Zúñiga-Vega JJ. 2025. Urban green spaces with high connectivity and complex vegetation promote occupancy and richness of birds in a tropical megacity. Urban Ecosyst 28 (1): 1-18. DOI: 10.1007/s11252-024-01612-3.

Parsaoran AW, Nabhan A, Putra K, Putri JN, Amirah KM, Naca SB, Ruslan H. 2024. Diversity of butterfly species of the superfamily Papilionoideae in two types of garden habitats in the tea and quinine research center area, Pasir Jambu District, Bandung Regency, West Java. J Trop Biodivers 5 (1): 19-33. DOI: 10.59689/bio.v5i1.246.

Penn J, Penn H, Hu W. 2018. Public knowledge of monarchs and support for butterfly conservation. Sustainability 10 (3): 807. DOI: 10.3390/su10030807.

Perry GLW, Richardson SJ, Harré N, Hodges D, Lyver POB, Maseyk FJF, Taylor R, Todd JH, Tylianakis JM, Yletyinen J, Brower A. 2021. Evaluating the role of social norms in fostering pro-environmental behaviors. Front Environ Sci 9: 620125. DOI: 10.3389/fenvs.2021.620125.

Pessoa P, Aboim S, Afonso L, Lopes JB, Sá-Pinto X. 2024. Tasting to preserve: An educational activity to promote children's positive attitudes towards intraspecific diversity conservation. Plos One 19 (1): e0285649. DOI: 10.1371/journal.pone.0285649.

PT Unggul Cipta Piranti (Emperor Edutainment). 2019. Menari Tari Kupu Kupu dan Tari Topeng Kelana-Kostum dan Pagelaran Tari Kupu Kupu. https://www.youtube.com/watch?v=NIS4kLe4MEA. [Indonesian]

Quandahor P, Kim L, Kim M, Lee K, Kusi F, Jeong IH. 2024. Effects of agricultural pesticides on decline in insect species and individual numbers. Environments 11 (8): 182. DOI: 10.3390/environments11080182.

Rahmawati H, Hutagalung FD, Harsono YT, Qoyyimah NRH. 2024. Pro-environmental behavior model among university students. Psympathic 11 (1): 9-16. DOI: 10.15575/psy.v11i1.32182.

Recio-Román A, Recio-Menéndez M, Román-González MV. 2024. Examining the Attitude–Behavior Gap in EU Ecolabel Adoption: A Mediation Path Analysis. Sustainability (Switzerland) 16 (16): 7214. DOI: 10.3390/su16167214.

Rousta A, Jafari EA. 2024. Impact of environmental knowledge, responsibility, and concern on sustainable consumption behavior: Does customer attitude matter? Manag Environ Qual: Intl J 35 (8): 1858-1877. DOI: 10.1108/MEQ-06-2023-0166.

Sekarappa B. 2016. Study on nectar plants of a few butterfly species in agriculture ecosystems of Chamarajanagar District, Karnataka, India. Intl J Entomol Res 1 (5): 2455-4758. DOI: 10.13140/RG.2.2.32392.62720.

Sekimura T, Venkataraman C, Madzvamuse A. 2015. A model for the selection of eyespots on butterfly wings. Plos One 10 (11): e0141434. DOI: 10.1371/journal.pone.0141434.

Septianella G, Peggie D, Sasaerila HY. 2015. Keanekaragaman kupu-kupu (Lepidoptera) di kawasan Desa Pasirlangu, Kecamatan Cisarua, Kabupaten Bandung Barat, Jawa Barat. Pros Sem Nas Masy Biodiv Indon 1: 1816-1820. DOI: 10.13057/psnmbi/m010811. [Indonesian]

Sinthumule NI. 2023. Traditional ecological knowledge and its role in biodiversity conservation: A systematic review. Front Environ Sci 11: 1164900. DOI: 10.3389/fenvs.2023.1164900.

Solis-Sosa R, Semeniuk CAD, Fernandez-Lozada S, Dabrowska K, Cox S, Haider W. 2019. Monarch butterfly conservation through the social lens: Eliciting public preferences for management strategies across transboundary nations. Front Ecol Evol 7 (8): 316. DOI: 10.3389/fevo.2019.00316

Subahar TS, Yuliana A. 2010. Butterfly diversity as a database for the development plan of Butterfly Garden at Bosscha Observatory, Lembang, West Java. Biodiversitas 11 (1): 24-28. DOI: 10.13057/biodiv/d110106.

Supriyatin R, Pravitasari AE, Pribadi DO. 2020. Pemetaan karakteristik wilayah urban dan rural di wilayah bandung raya dengan metode spatial clustering. J Geogr 12 (2): 125. DOI: 10.24114/jg.v12i02.17647. [Indonesian]

Tamar M, Wirawan H, Arfah T, Putri RPS. 2020. Predicting pro-environmental behaviours: The role of environmental values, attitudes and knowledge. Manag Environ Qual 32 (2): 328-343. DOI: 10.1108/MEQ-12-2019-0264.

Tiago P, Leal AI, Rosário IT, Chozas S. 2024. Discovering urban nature: Citizen science and biodiversity on a university campus. Urban Ecosyst 27 (5): 1609-1621. DOI: 10.1007/s11252-024-01526-0.

Tibesigwa B, Siikamäki J, Lokina R, Alvsilver J. 2019. Naturally available wild pollination services have economic value for nature-dependent smallholder crop farms in Tanzania. Sci Rep 9 (1): 3434. DOI: 10.1038/s41598-019-39745-7.

Tiple AD, Khurad AM, Dennis RLH. 2009. Adult butterfly feeding-nectar flower associations: Constraints of taxonomic affiliation, butterfly, and nectar flower morphology. J Nat Hist 43 (13-14): 855-884. DOI: 10.1080/00222930802610568.

Ulicsni V, Babai D, Vadász C, Vadász-Besnyői V, Báldi A, Molnár Z. 2019. Bridging conservation science and traditional knowledge of wild animals: The need for expert guidance and inclusion of local knowledge holders. Ambio 48 (7): 769-778. DOI: 10.1007/s13280-018-1106-z.

Van Swaay C, Brereton T, Kirkland PA, Warren M. 2012. Manual for Butterfly Monitoring. Butterfly Conservation Europe, Wageningen.

van Tongeren E, Sistri G, Bonifacino M, Menchetti M, Pasquali L, Salvati V, Balletto E, Bonelli S, Cini A, Portera M, Dapporto L. 2023. Unstructured citizen science reduces the perception of butterfly local extinctions: The interplay between species traits and user effort. Biodivers Conserv 32 (14): 4701-4718. DOI: 10.1007/s10531-023-02721-9.

Wang K, Qi Y, Hu Y, Han D. 2025. Distribution and influences on butterfly diversity in urban park green spaces: A case study of Harbin, China. Ecol Evol 15 (6): e71554. DOI: 10.1002/ece3.71554.

Wardhaugh CW. 2015. How many species of arthropods visit flowers? Arthropod-Plant Interactions 9 (6): 547-565. DOI 10.1007/s11829-015-9398-4.

Zhang Y, Zhang B, Chen C, Feng X, Song S, Wang H. 2023. The mediation effect of attitude on the association between knowledge and self-management behaviors in Chinese patients with diabetes. Intl J Public Health 13: 68. DOI: 10.3389/ijph.2023.1606022.