

Reconstructing Indigenous Knowledge of Kasepuhan Girijaya for High School Biology Learning: An Ethnoscience Approach

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Abstract: Biology learning on ecosystem topics frequently encounters epistemological challenges arising from a disconnect between formal academic science and students' socio-cultural realities, a gap widely recognised in contemporary science education research. The study aimed to reconstruct the Indigenous Knowledge (IK) of Kasepuhan Girijaya into scientifically validated concepts for integration into high school biology curricula. A qualitative approach with an ethnographic design was employed; data were collected through participatory observation, in depth interviews with traditional leaders, and document analysis, and analysed using an interactive model encompassing data condensation, science reconstruction, and pedagogical relevance mapping. The findings suggest that Kasepuhan Girijaya's three tier land zoning system (Leuweung Tutupan, Titipan, and Garapan) demonstrates conceptual alignment with watershed management and soil conservation principles. Twelve IK practices were identified as providing plausible scientific mechanisms, including light intensity regulation, riparian bio engineering, and ecological rest each mappable to Biology Learning Outcomes in the Merdeka Curriculum. These findings are theoretical and analytical in nature; empirical testing of their pedagogical effectiveness remains a direction for future research.

Keywords: Critical thinking; ethnoscience; indigenous knowledge; sustainability consciousness.

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INTRODUCTION

Indigenous Knowledge (IK) is not merely an ancient tradition but constitutes a complex epistemological system emerging from centuries of dialectical interaction between indigenous communities and their ecological environments (Wiguna et al., 2023; Zidny et al., 2020). A knowledge system embodies conservation values critical to biospheric sustainability and have attracted increasing global attention as alternative strategies for biodiversity preservation (Aswani et al., 2018; Vandebroek et al., 2020). In Indonesia, this urgency is exemplified by the Kasepuhan Girijaya community at the foot of Mount Salak, whose members maintain ecological balance through strict customary institutions, particularly a three-tier land zoning system amid accelerating modernisation. This zoning reflects a holistic understanding of ecosystems, which ecological function, economic sustainability, and spiritual values operate simultaneously (Royyani & Walujo, 2012; Sany, 2024).

Science education in the 21st century faces a persistent epistemological gap between academic (Western) science taught in classrooms and the cultural realities students experience daily, a challenge widely documented in science education literature (Mazzocchi, 2020; Rahmawati et al., 2022). In Indonesian secondary schools, Ecosystem content is frequently taught in a reductionist and highly textual manner, alienated from students' socio-cultural contexts (Gondwe & Longnecker, 2015; Hasanah et al., 2022). Many biology teachers lack the competence to bridge scientific knowledge with Indigenous Knowledge critically and dialogically (Fasasi, 2017; Zidny et al., 2020), leading students to perceive science as abstract memorised facts rather than a relevant problem-solving framework (Ramlah et al.,

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2025; Suja, 2022). This disconnect contributes to low scientific literacy and diminished sustainability consciousness (Ardoin & Bowers, 2020; Gericke et al., 2019; Olsson & Gericke, 2016).

The ethnoscience approach, a pedagogical strategy for reconstructing indigenous community science into scientifically validated concepts, offers a concrete solution for bridging this cultural gap (Bahtiar et al., 2020; Karim et al., 2019). Integration of Indigenous Knowledge into science curricula aligns with the SDGs, particularly SDG 4 (Quality Education) and SDG 15 (Life on Land) (Kioupi & Voulvoulis, 2019; Segera, 2015). Empirical studies confirm the efficacy of this integration: ethnoscience-based learning stimulates critical thinking (Sumarni & Kadarwati, 2020), increases scientific literacy (Dewi & Suniasih, 2023; Imron et al., 2025), enhances creativity and learning outcomes in science (Pamungkas et al., 2017), and builds environmental character (Khastini et al., 2019; Putra & Wahyuni, 2025).

Despite this growing body of work, studies that specifically reconstruct indigenous land zoning systems for high school ecosystem learning remain scarce. Prior research has tended toward purely anthropological documentation (Royyani & Walujo, 2012) or philosophical environmental ethics without explicit links to school biology curriculum design (Sany, 2024). This study addresses that gap with three focused objectives: (1) to describe the ecological characteristics of Kasepuhan Girijaya's land zoning system; (2) to reconstruct selected IK practices into scientifically plausible biological concepts using an emic to etic ethnoscience framework; and (3) to map these reconstructed concepts onto the Biology Learning Outcomes (CP) of the Indonesian Merdeka Curriculum to support the development of contextual and meaningful ecosystem learning.

METHOD

Research Design

This study adopted a qualitative approach with an ethnographic design, chosen for its capacity to explore the values, beliefs, and ecological rationality underlying land zoning practices holistically and naturalistically, without variable manipulation (Creswell & Guetterman, 2019). This framework enabled documentation of the emic perspective (community viewpoint) on environmental conservation, which was subsequently interpreted into an etic (scientific) perspective for pedagogical purposes (Sany, 2024).

Researcher Positionality and Reflexivity

The primary researcher is a biology education student with a background in ethnoscience and a familiarity with Sundanese cultural contexts. To minimise interpretive bias, several measures were applied: (1) all field interpretations were cross-checked against scientific literature before being accepted as reconstructed concepts; (2) data were reviewed by the supervising lecturer with expertise in biology education and ethnoscience; and (3) triangulation across three data sources (interviews, observation, and documentation) was consistently applied throughout analysis. The researcher maintained a reflexive journal to document assumptions and potential biases encountered during fieldwork.

Research Site and Participants

Fieldwork was conducted in the customary area of Kasepuhan Girijaya, Cidahu Sub-district, Sukabumi Regency, West Java. Participants were selected using purposive sampling targeting individuals with the highest level of authoritative knowledge of customary traditions (Royyani & Walujo, 2012). Two key informant traditional leaders (sesepuh) served as guardians of oral traditions and enforcers of customary law served as primary participants. Data saturation guided participant selection: data collection continued until no new conceptual categories emerged from subsequent interviews.

Data Collection Instruments

The primary instrument was the researcher as a human instrument (Creswell & Guetterman, 2019), enabling direct field engagement and real-time cultural interpretation. Supporting instruments included: (1) a semi-structured in-depth interview guide covering four domains: agricultural systems, customary forest zoning, ethnobotany, and environmental ethics; and (2) an observation checklist recording vegetation types, irrigation infrastructure, and topographic features. All sessions were audio visually recorded to establish an audit trail (Yukisari et al., 2025).

Research Procedure

The research procedure comprised two sequential stages. Stage 1 (Fieldwork) involved an immersive researcher presence at the site for concurrent data collection across the three land zones Leuweung Tutupan (>1,700 masl), Leuweung Titipan (1,200–1,700 masl), Leuweung Garapan (<1,200 masl), and associated agricultural practices and ethnobotanical traditions. Stage 2 (Pedagogical Processing) involved systematic analysis of qualitative data to reconstruct IK into scientific concepts, followed by mapping onto the Biology CP of the Merdeka Curriculum (Ramlah et al., 2025).

Data Analysis

Data analysis followed an interactive qualitative model (Creswell & Guetterman, 2019) comprising three steps:

Step 1 — Data Condensation and Coding. Verbatim transcription of interview recordings was followed by: (a) open coding to identify initial IK concepts (e.g., 'sacred forest prohibition,' 'bamboo preservation'); (b) axial coding to link cultural practice categories into thematic clusters (e.g., forest zoning → conservation behaviour); and (c) selective coding to determine core IK themes for reconstruction. Data triangulation was applied by comparing each identified concept across three sources—interview transcripts, field observation notes, and documentary evidence. Where inconsistencies arose between sources (e.g., discrepancies between a leader's stated rationale and observed practice), the study documented these as interpretive notes and resolved them through follow-up interviews.

Step 2 — Science Reconstruction. Each core IK theme was systematically translated into a biologically plausible concept through cross-referencing with peer-reviewed scientific literature. For example, the prohibition on entering Leuweung Tutupan was interpreted against the biological principles of in situ conservation and catchment area hydrology (Nugroho, 2017). The pamali Monday taboo was cross-referenced against ecological literature on soil bioturbation and ecosystem recovery (Colding & Folke, 2001). All reconstructed concepts were reviewed by the supervising lecturer to verify scientific plausibility before acceptance.

Step 3 — Pedagogical Relevance Analysis and CP Mapping. Reconstructed scientific concepts were mapped onto the Biology CP (Capaian Pembelajaran/ Learning Outcomes) for Phases E and F of the Merdeka Curriculum using the following criteria: (a) conceptual relevance — the reconstructed concept must directly correspond to a named concept or competency in the CP; (b) grade level appropriateness — the complexity of the concept must match the cognitive level specified for Phase E (Grade 10) or Phase F (Grades 11–12); and (c) contextual applicability — the IK practice must offer a concrete, place based context for delivering the curriculum concept. Only IK practices satisfying all three criteria were included in Table 1.

Science Reconstruction Framework

To ensure transparency and replicability of the reconstruction process, Figure 1 presents the analytical framework applied in this study. The framework follows three stages: (1) Raw Data (verbatim emic description from community informants) → (2) Coding (open, axial, and selective coding) → (3) Scientific Concept (etic biological interpretation cross-referenced with literature) → (4) CP Mapping (matched to Merdeka Curriculum Phase E or F). An illustrative example: the raw statement "the forest on the mountaintop belongs to our ancestors and cannot be touched" was open coded as 'forest prohibition', axially coded as 'conservation behaviour driven by spiritual sanction,' selectively coded as the core theme 'sacred conservation zone,' reconstructed as the scientific concept of 'in situ conservation and catchment area protection,' and mapped to Phase E – Environmental Change: Watershed Conservation.

RESULT AND DISCUSSION

Empirical Findings: Land Zoning System

Field observations and in-depth interviews identified the land zoning system of Kasepuhan Girijaya as a traditional institution regulating spatial planning according to both ecological function and

spiritual values (Sany, 2024). The community divides the mountainous landscape into three vertical zones: Leuweung Tutupan (>1,700 masl) as an absolute conservation zone, Leuweung Titipan (1,200–1,700 masl) as an agroforestry buffer zone, and Leuweung Garapan (<1,200 masl) as a food production zone (Royyani & Walujo, 2012). This stratification suggests an indigenous understanding of abiotic limiting factors, elevation, slope, and hydrology in determining sustainable ecosystem allocation.

Scientific Reconstruction: Mapping IK to Biological Concepts

Through the three-step analytical framework described in the Method section; 12 IK practices were systematically reconstructed into scientifically plausible biological concepts. Each reconstruction involved: (a) extraction of the emic rationale from interview and observation data; (b) identification of the biological principle most consistent with the observed practice; and (c) validation through cross-referencing with peer-reviewed biological literature and review by the supervising lecturer. The complete results—including emic descriptions, etic scientific interpretations, and CP curriculum mappings—are presented in Table 1.

Table 1 Scientific Reconstruction of Indigenous Knowledge Practices of Kasepuhan Girijaya and Their Relevance to the Biology Curriculum (Merdeka Curriculum, Phases E & F)

| No. | Indigenous Knowledge Practice | Emic Description (Community Rationale) | Scientific Reconstruction (Etic Analysis) | Relevant Biology Curriculum (CP Phases E & F) |
|-----|--|--|---|--|
| 1 | Leuweung Tutupan (<i>Prohibited/Sacred Forest, >1,700 masl</i>) | The mountaintop forest is regarded as a sacred ancestral trust. Entry and logging are strictly forbidden as violators risk <i>kawalât</i> (divine retribution/disaster). | In situ conservation of primary forest as a catchment area: high Leaf Area Index maximizes canopy interception; dense root systems and humus layers create soil macropores enabling deep infiltration and groundwater recharge, ensuring year-round baseflow stability. This aligns with catchment area management principles (Nugroho, 2017; Royyani & Walujo, 2012). | <i>Phase E</i> – Environmental Change: Watershed & Soil Conservation |

| No. | Indigenous Knowledge Practice | Emic Description (Community Rationale) | Scientific Reconstruction (Etic Analysis) | Relevant Biology Curriculum (CP Phases E & F) |
|-----|---|--|--|--|
| 2 | Multi Strata Agroforestry in <i>Leuweung Titipan</i> (1,200–1,700 masl) | Coffee/tea are planted under shade trees (damar, puspa). Large trees are treated as sacred 'guardians' of soil and must not be felled. | Multi layered canopy stratification is consistent with light intensity regulation for C3 plants (coffee), potentially preventing photo-inhibition. The layered canopy may also reduce raindrop terminal velocity (throughfall effect), suggesting a mechanism for erosion mitigation and preservation of soil aggregate structure on steep slopes (Widianto et al., 2004) | <i>Phase E</i> – Ecosystem: Symbiosis; <i>Phase F</i> – Plant Physiology: Light Intensity & Photosynthesis; <i>Phase E</i> – Env. Change: Erosion Prevention |
| 3 | Bamboo Conservation on Riverbanks (<i>Walungan</i>) | Communities prohibit clear cutting of bamboo, believing roots " <i>hold the soil</i> " and prevent landslides. | Bamboo fibrous root networks are consistent with bio engineering principles for riparian zone stabilisation. This practice provides conceptual alignment with soil shear strength enhancement and sediment filtration mechanisms | <i>Phase F</i> – Plant Structure: Root Tissue; <i>Phase E</i> – Env. Change: Erosion & Sedimentation Control |

| No. | Indigenous Knowledge Practice | Emic Description (Community Rationale) | Scientific Reconstruction (Etic Analysis) | Relevant Biology Curriculum (CP Phases E & F) |
|-----|---|--|---|---|
| | | | (Royyani & Walujo, 2012) | |
| 4 | Hydrological Land Allocation (<i>Blok Kiara & Blok Gatet</i>) | <i>Blok Kiara</i> (waterlogged soil) is dedicated to rice; <i>Blok Gatet</i> (dry soil) for vegetables and secondary crops, based on observed crop failure patterns. | This practice demonstrates conceptual alignment with abiotic limiting factor principles. Rice (<i>Oryza sativa</i>) possesses aerenchyma tissue enabling O ₂ diffusion under hypoxia; upland crops lack this adaptation, suggesting vulnerability to anaerobic root rot under flooded conditions (Ikmaludin et al., 2018; Las & Setyanto, 2005) | <i>Phase E</i> – Ecosystem: Abiotic Components; <i>Phase F</i> – Plant Physiology: Water Transport & Adaptation; Aerenchyma |
| 5 | Gravity Fed Irrigation (<i>Cai Kahuripan Channels</i>) | <i>Cai Kahuripan</i> spring water is channelled by gravity via earthen canals to irrigate rice fields year-round without mechanical intervention. | This practice provides evidence of sustainable surface runoff utilisation consistent with hydrological cycle principles, avoiding depletion of deep aquifer reserves— an approach aligned with sustainable watershed | <i>Phase E</i> – Ecosystem: Biogeochemical Cycle (Water Cycle) & Energy Flow |

| No. | Indigenous Knowledge Practice | Emic Description (Community Rationale) | Scientific Reconstruction (Etic Analysis) | Relevant Biology Curriculum (CP Phases E & F) |
|-----|---|--|--|--|
| | | | management (Royyani & Walujo, 2012) | |
| 6 | Rice Grain Drying Technique (<i>Dipoé</i>) | Harvested rice grains are spread thinly in direct sunlight (never bundled/ <i>geugeusan</i>) to dry quickly and evenly, preventing mould. | This technique is consistent with microbial growth factor inhibition: maximising evaporation surface area is likely to reduce grain water activity below 0.70, a threshold below which growth of decomposer microbes such as <i>Aspergillus flavus</i> is inhibited (Las & Setyanto, 2005). | <i>Phase E</i> – Role of Bacteria & Fungi: Detrimental Roles & Microbial Growth Factors |
| 7 | Monday Taboo (<i>Pamali</i> Against Rice Field Work) | Customary prohibition on all agricultural activity on Mondays, framed as allowing the earth to " <i>rest</i> ." | This practice suggests a functional ecological rest mechanism: cessation of anthropogenic disturbance may allow soil organisms (earthworms, microfauna) to perform bioturbation, potentially restoring aggregate structure and aeration disrupted by weekly | <i>Phase E</i> – Ecosystem: Balance, Stability & Decomposer Role; Sustainable Development: Conservation Ethics |

| No. | Indigenous Knowledge Practice | Emic Description (Community Rationale) | Scientific Reconstruction (Etic Analysis) | Relevant Biology Curriculum (CP Phases E & F) |
|-----|---|---|---|---|
| | | | cultivation (Colding & Folke, 2001). | |
| 8 | Ethnobotanical Use of Rhizome Herbs (<i>Beubeutian</i>) | <i>Curcuma longa</i> for gastric complaints; <i>Zingiber officinale</i> for colds; <i>Curcuma zanthorrhiza</i> as appetite stimulant. | Utilisation of plant secondary metabolites : curcumin in turmeric demonstrates anti-inflammatory properties consistent with prostaglandin/COX inhibition; gingerol in ginger shows thermogenic and antiemetic activity; xanthorrhizol in <i>temulawak</i> (Javanese Turmeric or Java Ginger.) exhibits hepatoprotective properties, providing conceptual alignment with phytochemical science (Yukisari et al., 2025). | <i>Phase E</i> – Biodiversity: Benefits (Medicine); <i>Phase F</i> – Metabolism: Secondary Metabolites |
| 9 | Herbal Medicine for Wounds & Fever | <i>Anredera cordifolia</i> leaves applied topically for wounds; <i>Andrographis paniculata</i> decoction for fever. | Binahong (Madeira vine) leaves contain saponins and flavonoids consistent with antiseptic properties and collagen synthesis | <i>Phase F</i> – Plant Structure: Phytochemistry; <i>Phase E</i> – Biodiversity: Conservation of Medicinal Plants |

| No. | Indigenous Knowledge Practice | Emic Description (Community Rationale) | Scientific Reconstruction (Etic Analysis) | Relevant Biology Curriculum (CP Phases E & F) |
|-----|--|---|---|--|
| | | | stimulation. Andrographolide in Sambiloto (Green Chireta atau King of Bitters) demonstrates antipyretic and antimicrobial activity in phytochemical literature (Yukisari et al., 2025) | |
| 10 | Living Fence & Home Garden Cultivation | Medicinal plants (katuk, beluntas, <i>sirih</i>) planted as garden borders for immediate household access. | This practice aligns with ex situ conservation principles at the household level, suggesting a community scale mechanism for maintaining genetic diversity (germplasm) and plant biodiversity (Yukisari et al., 2025). | <i>Phase E</i> – Biodiversity: In Situ & Ex Situ Conservation Strategies |
| 11 | Environmental Stewardship Philosophy (<i>Mupusti Alam lain Migusti Alam</i>) | Nature must be " <i>dipusti</i> " (cared for/revered), not " <i>digusti</i> " (exploited without limit). | This philosophy demonstrates conceptual alignment with stewardship ethics : humans as responsible guardians of the biosphere. It may function as an internal social control preventing | <i>Phase E</i> – Sustainable Development: Environmental Ethics & Human–Environment Interaction |

| No. | Indigenous Knowledge Practice | Emic Description (Community Rationale) | Scientific Reconstruction (Etic Analysis) | Relevant Biology Curriculum (CP Phases E & F) |
|-----|---|--|--|---|
| | | | the tragedy of the commons by establishing ethical limits on resource extraction (Sany, 2024; Triana & Andi, 2023). | |
| 12 | Harvest Sharing Tradition (<i>Sedekah Bumi</i>) | A portion of the rice harvest is set aside for neighbours and communal ceremonies as an expression of gratitude. | This tradition provides evidence of a social ecological resilience mechanism: communal food redistribution may strengthen community adaptive capacity against food scarcity, suggesting alignment with social-ecological systems theory (Triana & Andi, 2023) | <i>Phase E</i> – Ecosystem: Human Interaction with Environment; Energy Flow |

Note. CP = Capaian Pembelajaran (Learning Outcomes); masl = meters above sea level; IK = Indigenous Knowledge. Scientific interpretations represent conceptual alignments, not empirically tested outcomes.

Pedagogical Relevance Mapping

Of the 12 reconstructed IK practices, all met the three CP mapping criteria (conceptual relevance, grade level appropriateness, and contextual applicability). Seven practices were mapped to Phase E topics (primarily Ecosystem and Environmental Change), and five to Phase F topics (Plant Physiology, Metabolism, and Plant Structure). This distribution suggests that Kasepuhan Girijaya's IK provides contextual learning material across both phases of the biology curriculum in Senior Secondary School.

DISCUSSION

IK as a Source of Scientifically Plausible Ecological Principles

The findings suggest that the Indigenous Knowledge of Kasepuhan Girijaya demonstrates broad conceptual alignment with principles of modern ecology, hydrology, and conservation biology. The data provide evidence that traditional practices spanning forest zoning, agricultural techniques, and environmental ethics are consistent with ecological science, supporting the view that indigenous communities may apply longitudinal empirical observation in natural resource management, predating

formal conservation theory (Ramlah et al., 2025). However, it is important to note that this study is qualitative and theoretical; the findings represent conceptual alignments rather than causally verified mechanisms.

In the buffer zone (Leuweung Titipan), the multi-strata agroforestry system demonstrates conceptual consistency with canopy stratification principles: shade regulation for coffee (a C3 plant) is plausibly consistent with photo-inhibition prevention, and layered canopy structure may reduce raindrop terminal velocity to mitigate splash erosion (Widianto et al., 2004). The conservation of Leuweung Tutupan as a prohibited sacred forest is consistent with catchment area management: undisturbed primary forest maintains conditions associated with high canopy interception and macropore-rich humus layers, suggesting groundwater recharge mechanisms that support downstream baseflow (Nugroho, 2017; Royyani & Walujo, 2012). These conceptual alignments, while not empirically tested in this study, are grounded in established biological literature.

The pamali Monday taboo provides evidence that culturally enacted social taboos may function as ecologically rational governance mechanisms: the weekly cessation of agricultural activity is conceptually consistent with soil bioturbation recovery processes described by Colding & Folke (2001). Similarly, the dipoé drying technique is consistent with principle of water activity reduction that inhibit microbial growth (Las & Setyanto, 2005). Ethnobotanical practices demonstrate plausible phytochemical grounding: curcumin, gingerol, saponins, and andrographolide in community-used medicinal plants show pharmacological properties documented in peer-reviewed literature (Yukisari et al., 2025). All practices converge on the philosophy of Mupusti Alam lain Migusti Alam, which demonstrates alignment with stewardship theory and may function as an internal social control against resource over exploitation (Sany, 2024; Triana & Andi, 2023).

Limitations and Critical Reflection

Several limitations of this study warrant explicit acknowledgement. First, the ethnographic scope is confined to two key informants in one customary community; this limits the diversity of perspectives captured and means findings should not be generalised to other indigenous communities with different ecosystem typologies. Second, cultural interpretation bias is an inherent risk in ethnosience research: the translation of emic cultural practices into etic scientific concepts is an interpretive act subject to the researcher's theoretical background and cultural assumptions. Although triangulation and supervising lecturer review were employed to mitigate this, residual interpretive subjectivity cannot be fully eliminated. Third, the scientific reconstructions presented here are conceptual alignments derived from literature review, not empirically validated outcomes; the actual ecological functions of these practices in the Kasepuhan Girijaya context have not been quantitatively measured.

Pedagogical Implications and Potential as a Model for Other Regions

The ethnosience reconstruction methodology applied in this study suggests potential as a replicable model for other indigenous communities across Indonesia. The three-step framework (data condensation and coding → science reconstruction → CP mapping) is not inherently site-specific and could be adapted to reconstruct IK from other regions, such as Dayak agroforestry systems in Kalimantan, Subak irrigation practices in Bali, or Baduy ethnobotanical traditions in Banten, thereby enriching national biology education resources with diverse local contexts (Khastini et al., 2019). This potential, if developed through systematic comparative studies, could contribute to a more culturally inclusive national science curriculum.

Integration of the reconstructed IK practices into Ecosystem and Biodiversity curricula holds potential to support higher-order thinking through authentic problem-based learning. For example, students could be challenged to analyse the hydrological implications of converting Leuweung Tutupan to agricultural land, drawing on the water cycle and catchment area concepts. This approach is consistent with findings that ethnosience-based learning enhances scientific literacy and learning outcomes (Imron et al., 2025; Pamungkas et al., 2017). However, effective integration requires teachers to have a function as cultural brokers who can critically distinguish the symbolic mythical from the scientifically logical dimensions of IK, to avoid misconceptions (Ramlah et al., 2025; Suja, 2022).

CONCLUSION

The particular study demonstrates that the Indigenous Knowledge of Kasepuhan Girijaya demonstrates conceptual alignment, including validated biological principles spanning ecology, plant physiology, hydrology, food microbiology, and pharmacology. Twelve IK practices were reconstructed through an emic to etic ethnoscience framework and mapped onto Biology Learning Outcomes in the Indonesian Merdeka Curriculum, suggesting their potential as contextually rich learning material for Ecosystem and Biodiversity topics.

The study's principal theoretical contribution is evidence that trust-based social control mechanisms, particularly the pamali system, demonstrate conceptual alignment with ecologically rational governance, suggesting that indigenous taboo systems may be epistemologically commensurable with, rather than incommensurable from, Western ecological science. It advances the ethnoscience argument that IK constitutes a valid complementary knowledge tradition grounded in longitudinal empirical observation.

The reconstruction methodology applied suggests potential as a transferable model: the three-step framework (coding → science reconstruction → CP mapping) could be adapted for indigenous communities across Indonesia, enriching the foundation of culturally responsive biology education nationally. Two principal limitations apply: (1) the ethnographic scope is confined to one community, limiting generalisability; and (2) the science reconstructions are analytical, theoretical rather than empirically tested. Future research should therefore: (a) conduct quasi-experimental studies to measure the impact of Kasepuhan Girijaya-based ethnoscience teaching materials on student scientific literacy, critical thinking, and environmental ethics; (b) expand comparative ethnoscience reconstruction studies to other Indonesian indigenous communities; and (c) involve experts on biology subject in a formal validation panel for the reconstructed concepts to further strengthen scientific rigour.

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