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Research Article

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Ecogeological Description of Sanyang Gotjawal, Jeju Island, Korea

Yun-Jae Yi[1†], Dae-Shin Kim[2†], Suk-Hyung Ko[2], Keun Chul Lee[3], Jung-Sook Lee[3] and Jong-Shik Kim[1*]

[1]Marine Industry Research Institute for East sea rim, Uljin 36315, Korea,
[2]World Heritage Office, Jeju Special Self-Governing Provincial Government, Jeju 63341, Korea,
[3]Korean Collection for Type Cultures, Korea Research Institute of Bioscience and Biotechnology, Jeongup 56212, Korea

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ORCID
Yun-Jae Yi
https://orcid.org/0000-0001-6742-595x

Dae-Shin Kim
https://orcid.org/0000-0002-6943-7572

Suk-Hyung Ko
https://orcid.org/0000-0001-5667-2752

ORCID
Keun Chul Lee
https://orcid.org/0000-0002-4700-4127

Jung-Sook Lee
https://orcid.org/0000-0003-0300-8836

Jong-Shik Kim
https://orcid.org/0000-0002-8181-1707

Abstract

BACKGROUND: Gotjawal forest on Jeju Island is characterized by uneven topography that developed as a result of freezing-thawing weathering process and irregular substrates caused by numerous lava-flow collapses. Sanyang Gotjawal, located in southwest of Jeju Island, is a well-developed forest with a long history. In addition to photographs, there is a need for a good way to describe the unique features of Gotjawal, including its geology and vegetation.
METHODS AND RESULTS: We illustrated the area's natural features using Clip Studio Paint 1.12.0. To reveal its complexity, we separated the vegetation and geological features in the illustrations.
CONCLUSION(S): We drew a cross-section of Gotjawal's unique layers, including lava flows. In addition to an eco-geological approach, we described the dominant vegetation and geological characteristics of the three forest layers (trees, shrubs, and herbs) in Gotjawal.

Key words: Cross-section, Ecogeological sketch, Illustration, Sanyang Gotjawal

Introduction

Gotjawal is an area on Jeju Island formed by past volcanic activity. It is characterized by an uneven topography that developed as a result of freezing, weathering, and the collapse of surface lava flows over a long period [1, 2, 8]. Sanyang Gotjawal, located in the western part of Jeju Island, is a well-developed forest, with an irregular substrate caused by numerous lava-flow collapses. The base topography of Sanyang Gotjawal consists of large and small rock masses, with very poor soil development [4, 5, 9]; however, it has

†These authors contributed equally.
*Corresponding author: Jong-Shik Kim
Phone: +82-54-780-3451; Fax: +82-54-780-3469;
E-mail: soilmicrobiome@gmail.com

constant high humidity and biodiversity. The microbial community of the Gotjawal network is less complex and coherent than the networks of other lava-formed forests in Hawaii, Florida, and Alaska due to its distinct soil properties [7]; the dominant species are *Bacillus valentina*, *Rhodoplanes cryptolatis*, *Methylocеanacter caenitepid*, and *Gaiella occulta* (unpublished data). In the Gotjawal area, large and small areas of subsidence have occurred; the collapse of the upper part of a cave or the subsidence of an underground cavity affects a large area and results in the growth of vegetation in the area of subsidence that differs from that of the surrounding area. The resulting distribution of plants changes with the depth of the subsidence. Despite its ecogeological importance, Gotjawal is being affected by human disturbance [4, 5, 6] and the climate crisis [9]. To assess its value, digital images are helpful. Photographs are commonly used as visual images for conservation. However, filming is difficult in Gotjawal because vegetation covers the terrain. In addition, it is difficult to understand the distribution of plants as a stratified structure from a photograph. In comparison, a digital description allows division of the forest into plant layers; the various parts of the description can be isolated and viewed. In this study, we produced a description of Sanyang Gotjawal that conveys its geological and ecological characteristics simultaneously. Photographs are useful to record natural characteristics and convey an appreciation of nature. However, in photographs, geological features are hidden by the forest. Therefore, we provide a digital description of Sanyang Gotjawal's ecogeological and vegetation features.

Methods and Materials

Gotjawal Study Site

To create the description, we explored Sanyang Gotjawal, which is part of the Hankyeong-Andeok (HA) Gotjawal terrain, one of four main terrains and is located in southwest Jeju Island [1, 2, 8]. The study site was at Sanyang Gotjawal (Fig. 1; 33°17'24.8"N, 126°15'14.9"E). Instead of combining the features of multiple points, we selected and painted points with characteristics representative of Sanyang Gotjawal. Photographs were taken as references to show the characteristics of Gotjawal, such as a dominant plant species or a terrain feature (Fig. 1).

Ecogeological Sketches and Illustration

As reported previously [3, 12], the images were illustrated using Clip Studio Paint v1.12.0 (CELSYS, Tokyo,

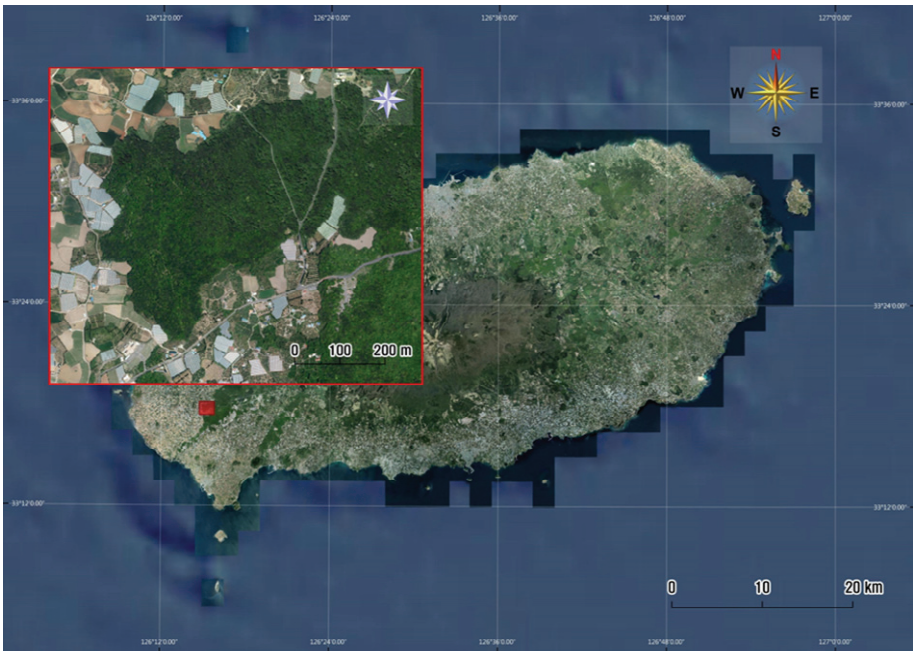

Fig. 1. The location of Sanyang Gotjawal on Jeju Island, South Korea. The map shows the Sanyang Gotjawal Forest (33°17'24.8"N, 126°15'14.9"E). The red box indicates that Sanyang Gotjawal is surrounded by agricultural fields and villages. The forest is divided into tree, shrub, and herb layers.

Japan) and a 680TF graphics pen tablet (Shenzhen Huion Animation Technology, Shenzhen, China). The layers were illustrated to show volcanic rock, the terrain, and vegetation covered by fallen leaves. Plants were colored differently after selecting the dominant species according to the slope (Fig. 2A–C).

Soil Chemical Analysis

Soil samples were collected from soil-limited environments. To reduce soil-sampling errors, six subsamples collected near each point were mixed to create one sample [7]. Soil chemistry was measured using standard methods of soil chemical analysis. The following values were calculated for Sanyang Gotjawal: pH 5.36, electrical conductivity (EC) 4.14 dS m^{-1}, organic matter (OM) 251.9 g kg^{-1}, total nitrogen (TN) 1.15%, cation exchange capacity (CEC) 42.8 $cmol_c$ kg^{-1}, available phosphate content 43 mg kg^{-1}, and exchangeable K 0.71 $cmol_c$ kg^{-1}, Ca 24.82 $cmol_c$ kg^{-1}, Mg 4.67 $cmol_c$ kg^{-1}, and Na 0.46 $cmol_c$ kg^{-1}. Previously, we defined Gotjawal soil as having limited amounts of soil with high OM, TN, and microbial biodiversity.

Results and Discussion

Sanyang Gotjawal is a V-shaped valley with slopes of 70–90 degrees; it is about 15 m deep, 4 m wide at the bottom, and 15 m wide at the top. The surface is rough, with a shallow soil layer and piles of fallen leaves on the rounded rocks (Fig. 2A). Inside the valley, temperature changes with the slope, resulting in a stratified plant distribution. Dark-colored trees that are larger and thicker than maple trees grow at the top of the valley, while brightly colored maples grow in the middle of the slope; the vegetation from the top to the middle of the valley is mainly dark green. Olive-colored ferns grow in gaps in the rock in the middle and at the bottom of the valley, where mainly cloudy blue-green *Pteris cretica* L. grows (Fig. 2B; Table 1).

Sanyang Gotjawal is a mix of 'a'a lava (75%) and pahoehoe lava (0.5%) [1]. 'A'a lava, which appears frequently on Jeju Island, is characterized by its high viscosity and constant breaking of already hardened lava during a flow. The resulting clinker is seen as small boulders at the bottom (Fig. 2C). Sumgol terrain comprises holes formed between the bottom and rocks. The temperature and humidity of Gotjawal remains constant due to the passage of wind through the Sumgol. Sumgol terrain has excellent permeability and absorbs rain water [10, 11]. Existing information on the geological properties of Gotjawal is limited because the rock is hidden by vegetation overgrowth. To overcome this, most Gotjawal studies have used aerial photography or photographic maps, but there have been few descriptions of the area. Our description is meaningful because it shows the geological and ecological properties of Sanyang Gotjawal simultaneously.

As shown in Table 1 and Fig. 2A, the dominant species in the tree layer are *Castanopsis sieboldii* (Makino) Hatus., *Quercus glauca* Thunb., and *Distylium racemosum* Siebold & Zucc. The dominant species in the shrub layer are *Acer palmatum* Thunb., *Machilus japonica* Siebold & Zucc., and *Camellia japonica* L.; this structure differs from that of the area surrounding

Table 1. Dominant plant species in the tree, shrub, and herb layers of the Sanyang Gotjawal subsidence area

Layers	Dominant species
Tree layer	*Castanopsis sieboldii* (Makino) Hatus. *Quercus glauca* Thunb. *Distylium racemosum* Siebold & Zucc.
Shrub layer	*Acer palmatum* Thunb. *Machilus japonica* Siebold & Zucc. *Camellia japonica* L.
Upper herb layers[1]	*Arachniodes exilis* (Hance) Ching
Middle herb layers[2]	*Arachniodes exilis* (Hance) Ching *Polystichum lepidocaulon* (Hook.) J.Sm.
Bottom herb layers[3]	*Neolepisorus ensatus* (Thunb.) Ching *Pteris cretica* L.

[1] Upper part of the subsidence slope or flat land
[2] Middle part of the subsidence slope
[3] Bottom part of the subsidence slope

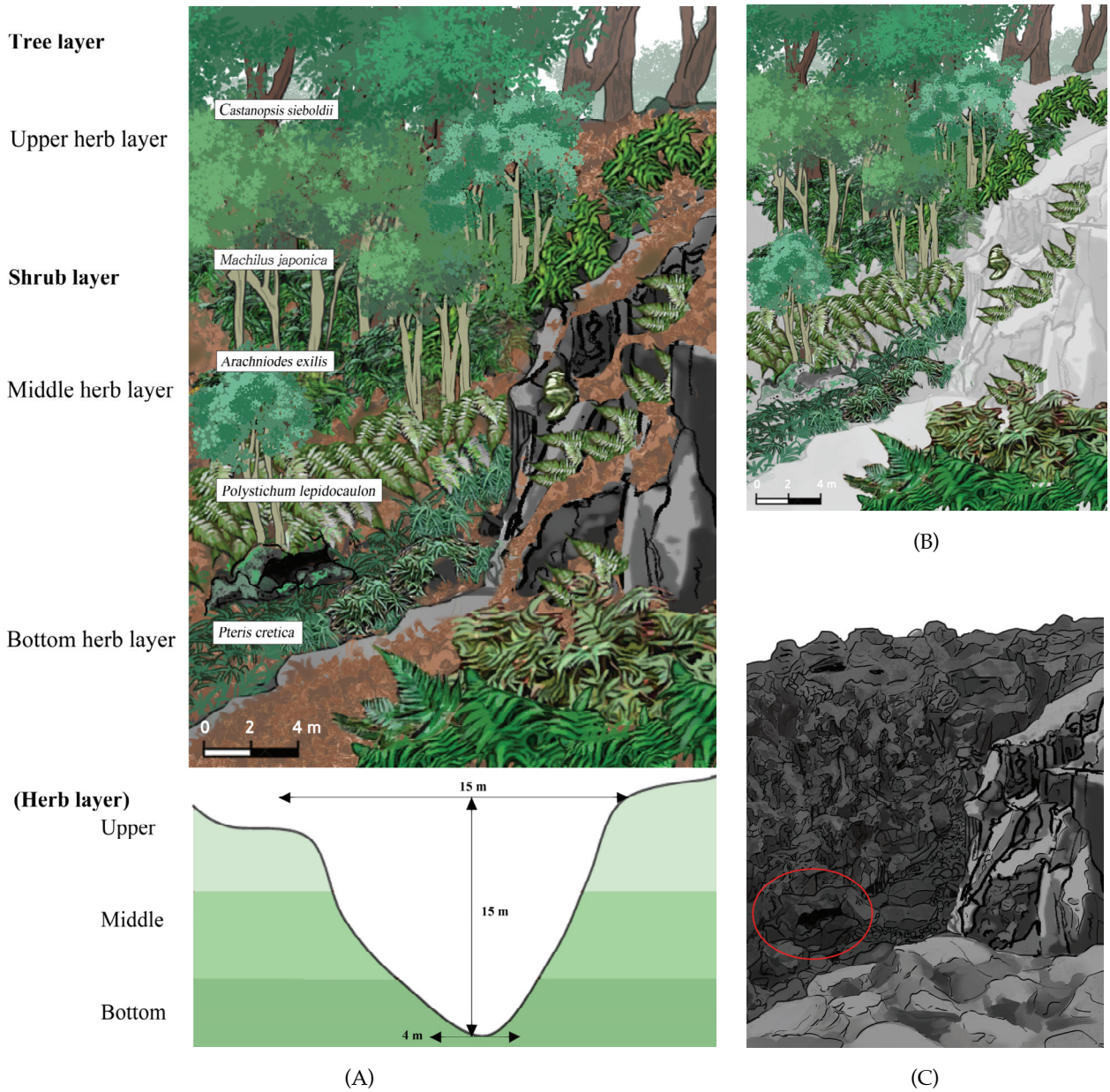

Fig. 2. (A) Cross-sectional overview of Sanyang Gotjawal on Jeju Island, South Korea. The forest is divided into tree, shrub, and herb layers. The dominant species is shown. Vegetation in this area consists mainly of subtropical evergreen broad-leaved trees.
(B) Vegetation found in Sanyang Gotjawal, which is located in southwest Jeju at 100 m above sea level (a.s.l.) and comprises collapsed trenches. The Gotjawal Forest is a species-rich ecosystem of coexisting broad-leaved trees and ferns. In Sanyang Gotjawal, the dominant tree species is ring-cupped oak (*Quercus glauca* Thunb.) in the tree layer and the fern *Neolepisorus ensatus* (Thunb.) Ching. in the herb layer at the bottom of the subsidence slope.
(C) Lava morphology of Sanyang Gotjawal; temperature and humidity are generally constant due to the passage of wind through openings in the Sumgol (red circle). Rainfall flows through the Sumgol via holes between rocks and trees and provides water to the aquifers below.

Gotjawal. In the herb layer, the dominant species at the top of the subsidence area and in the flat areas is *Arachniodes exilis* (Hance) Ching. In the middle part of the slope, *Arachniodes exilis* (Hance) Ching and *P. lepidocaulon* form a single community in the herb layer. At the lowest part of the subsidence terrain, the herb layer comprises two species: *Neolepisorus ensatus* (Thunb.) Ching and *P. cretica* L. When subsidence terrain has developed, the vegetation at the bottom of the valley has a stratified distribution that depends on the size of the area of subsidence and its mode of generation.

In conclusion, the cross-section of Sanyang Gotjawal provides useful data on its vegetation and geological characteristics; the geological characteristics with or without vegetation are described and digitized. This study provides insights into this unique landscape, including its biodiversity and unseen geological and vegetation characteristics.

Note

The authors declare no conflict of interest.

References

1. Ahn US, Sohn YK, Kang SS, Jeon YM, Choi HS (2015) The major causes of Gotjawal formation in Jeju Island. Journal of the Geological Society of Korea, 51(1), 1-19. http://doi.org/10.14770/jgsk.2015.51.1.1.
2. Jeon YM, Kim DS, Ki JS, Koh JG (2015) A proposal for geological classification of Gotjawal terrain in Jeju Island and its meaning. Journal of the Geological Society of Korea, 51(2), 235-241. http://doi.org/10.14770/jgsk.2015.51.2.235.
3. Ibraheem NA, Hasan MM, Khan RZ, Mishra PK (2012) Understanding color models : a review. ARPN Journal of Science and Technology, 2(3), 265-275.
4. Jeong KJ (2012) A study on perception and use of Gotjawal in Jeju Island. Journal of Photogeography, 22(2), 11-28. https://doi.org/10.35149/jakpg.2012.22.2.002
5. Kang HG, Kim CS, Kim ES (2013) Human influence, regeneration, and conservation of the Gotjawal forests in Jeju Island, Korea. Journal of Marine and Island Cultures, 2(2), 85-92. https://doi.org/10.1016/j.imic.2013.11.003.
6. Kang HB, Koh SR, Choi Y, Lee S, Kho Y, Oh D, Choi, K. (2013) Contamination levels of pharmaceuticals and pesticides in the Gotjawal regions of Jeju Island and associated ecotoxicities. Korean Journal of Environmental Health Sciences, 39(5), 426–37. http://doi.org/10.5668/JEHS.2013.39.5.426.
7. Lee TK, Han I, Kim MS, Seong GJ, Kim JS, Sul WJ (2019) Characterization of a nifH-Harboring bacterial community in the soil-limited Gotjawal forest. Frontiers in Microbiology, 10, 1858. https://doi.org/10.3389/fmicb.2019.01858.
8. Park JB, Kang BR, Koh GW, Kim GP (2014) Geological characteristics of Gotjawal terrain in Jeju Island. Journal of the Geological Society of Korea, 50(3), 431-440. https://doi.org/10.14770/jgsk.2014.50.3.431.
9. Park BB, Rahman A, Han SH, Youn WB, Hyun HJ, Hernandez J, An JY. (2020) Carbon and nutrient inputs by litterfall in evergreen and deciduous forests in Korea. Forests, 11(2), 143. https://doi.org/10.3390/f11020143.
10. Sin Sb, Kim HN, Lee DH, Kim TS, Kim YH, Kang CH, Song KJ, Lee HH (2022) Initial analysis of the underground air among Jeju Lava Forest (Sumgol) and its healing effect on the human body. Journal of Naturopathy, 11(1), 18-30. https://doi.org/10.33562/jn.2022.11.1.3.
11. Song ST, Koh GW, Yoon S (1996) A study on Sumgol structures and Gotjawal areas affecting groundwater recharge and pollution in Jeju Island. Annual Conference of the Korea Society of Groundwater, 68-69.
12. Yi YJ, Kim SI, Ahn US, Lee KC, Lee MK, Lee JS, Kim DS, Kim JS (2022) Hex code-based geological cross-sections describing landscape dynamics in the Jeju Geomunoreum lava tube system. Korean Journal of Environmental Agriculture, 41(1), 65-70. https://doi.org/10.5338/KJEA.2022.41.1.09.