Personal and Tacit Knowledge: Its Concept and Implication to the Study Biodiversity and Adaptive Features of Corticolous Lichens of Hundred Islands National Park, Northern Philippines

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Weenalei T. Fajardo[1], Cristina S. Doria[1], Ruby Rosa Cruz[2] (PhD)
[1]Pangasinan State University-Lingayen Campus; [2]Pangasinan State University-Asingan Campus, Philippines
[1] *weena_lei@yahoo.com*

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Abstract - *Research has been perceived to be rested on pure objectivity, however in philosophy involving personal and tacit knowledge, the researcher is acknowledged to be the shaper of the study. Its implication was based on the study Biodiversity and Adaptive Features of Corticoluos Lichens of Hundred Islands National Park, Northern Philippines. It was shown in the meta-analysis the intricate relationship of philosophy and science that two fields could not be separated from each other. Tacit knowledge, intellectual passion and conviviality lead to the acceptable results of the researchers. Also, the survey of the corticolous lichens in the six Islands of the Hundred Islands show so much diversity that it encourages further study of the lichens in the other islands despite the risks of doing so. It also gives the challenge of determining the factors that cause species similarity to be very low between the islands. The lichens have the structures that enable them to withstand the stresses caused by excessive radiation and saline precipitation. All these features cooperatively interplay to provide protection against predators, maintain lichen thallus moisture content, and facilitate gas exchanges that enable metabolic processes to occur thereby allowing lichen growth, survival, and ultimately existence.*

Keywords: *tacit knowledge, personal knowledge, biodiversity, corticoulous lichens, Hundred Islands National Park,*

INTRODUCTION

Science and philosophy share an intricate relationship that it is perceived to be nearly impossible for the two themes to reconcile. However, this love-hate relationship between these thoughts has revolutionized how scientists think and changed the scientific values as researcher. It is through philosophy that scientists renewed their commitment and passion as they continue their career in the academe performing the four-fold functions of instruction, research, extension and production.

In the research entitled Diversity and Adaptive Features of Corticolous Lichens of Hundred Islands National Park, Northern Philippines, Michael Polanyi's notion on Personal Knowledge has transformed how the researcher see the research as a whole from its conception to making its results known through presentations in various fora and publications. Although, the paper appears to be highly technical and its importance to society may not be appreciated immediately, Polanyi's philosophy does not only defend a research on its impact but also how the researcher shapes the study and in effect affecting the values of the researcher himself. Thus, the objective of this meta-analysis is to establish the intimate relationship of our research to the concepts of objectivity, tacit and explicit knowledge as part of the personal knowledge.

METHODS

Meta-analysis using Polanyi's Personal Knowledge[1] and the paper Diversity and Adaptive Features of Corticolous Lichens in Hundred Islands National Park, Philippines[2] was used in this analysis.

Diversity and Adaptive Features of Corticolous Lichens in Hundred Islands National Park, Philippines

Air pollution is considered as one of the major threats to human health and environment. Several efforts are done nowadays to reduce the concentration of pollutants as well to monitor them to understand their spatial and temporal distribution and ultimately to minimize their harmful effects. However, determination of quality of air is as expensive as maintaining clean air. Philippines has few air monitoring devices which are present only in highly urbanized cities like in Makati, Cebu, Pasig, Quezon and Baguio. Thus, tracing and monitoring air pollution for other areas lacking budget for a high-cost-air-monitoring device, still remains a problem.

Current endeavors are now made for monitoring air pollution without using expensive devices which are done using biological indicators or otherwise known as bio indicators. These are any biological species or group of species whose function, population, or status that are used to determine ecosystem or environmental integrity. These are the organisms or organism associations which respond to pollutant load with changes in vital functions, or which accumulate pollutants [3]. Furthermore, bio indicators provide qualitative analysis of what air-monitoring devices measure quantitatively by revealing the presence of the pollutants by the occurrence of typical symptoms or measurable responses. These organisms (or communities of organisms) deliver information on alterations in the environment or the quantity of environmental pollutants by changing in one of the following ways: physiologically, chemically or behaviourally.

Lichens are sensitive to their surrounding environment wherein suitable habitat conditions and substrates are vital to the prosperity of lichens. Moreover, they were identified based on their requirements of substrates, pH and ambient nutrient status thus studying lichen communities can illuminate the surrounding environmental change. In fact, epiphytic lichens have been recognized as indicators of air pollutions since the 1800s [3]. Lichens are useful bio indicators, especially where technical instruments are not economically feasible [4]. Moreover, a correlation was established between air pollution and lung cancer in NE Italy by studying lichen biodiversity [4] suggests the potential use of lichens to monitor human health

Hundred Islands National Park, a tourist spot in Panagasinan, is accessible only through the use of motorized boats or bancas. Thus with more than 150, 000 tourists going to Hundred Islands, the use of these motorized boats is necessary [5]. Nevertheless, mobile source emissions come from these vehicles wherein ambient concentrations of CO are predominantly influenced by this source emission. Particulate matter (PM), volatile organic compounds (VOCs), and nitrogen oxides (nitric oxide, NO, and nitrogen dioxide, NO2, collectively referred to as NOx) are emitted from both mobile and stationary sources. Also, fine PM is also formed when emissions of NOx, sulfur oxides (SOx), ammonia, organic compounds, and other gases react or condense in the atmosphere [6]. Thus with the use of lichens, the relative air pollutant load in the Hundred Islands National Park brought about by the ecotourism is indispensable since air monitoring device is absent bin the said area.

However, the study focuses on the identification of biodiversity of lichens present on Hundred Islands National Park and their adaptive features which could be used as a benchmark study in the choosing of the species that will be used for biomonitoring air pollution in Hundred Islands National Park, Alaminos City, Pangasinan.

The study aimed to find out what species of corticolous lichens are present in the Hundred Islands and describe their morpho-anatomical features which enable them to thrive under such harsh conditions.

Lichen collection

Collection of lichens was conducted in July 2013 at the start of the rainy season of that year. Lichens collected in the islands are expected to have established residence in the tree barks for a number of years. Only six accessible islands were visited: Children's Island, Clave Island, Lopez Island, Governor's Island, Marcos Island, and Quezon Island. This study made use of quadrat sampling technique. The quadrats were subjectively laid for the following reasons: (1) trees were not evenly distributed in some of the islands; hence, we chose only the areas with trees; (2) sampling was done only in safe areas; some areas were off limits due to the presence of snakes.

Depending on the size of the island, four to six quadrats with an area each of 25 m2 were laid. Depending on the abundance and number of species of trees in a quadrat, three to five trees were examined for lichen epiphytes. In quadrats where trees are of the same species, at least three trees regardless of age were surveyed of lichen epiphytes. In quadrats with more than one species of trees, all tree species were observed for the presence of lichen epiphytes. Different tree species vary in their bark characteristics, hence, may vary in lichen epiphytes. Studies have shown that bark structure affects epiphyte colonization and growth [7]. From the base of the tree at a height of 1.0 1.5 m, a clear transparent grid having an area of 600 cm2 was laid out on the tree trunk where there is abundance of lichens. This method was adapted from Gradstein et al. (2003) although the area of the grid was decreased. Only the lichens that are inside the perimeter of the grid were counted. Lichen samples were then carefully removed from the bark. Tree cuts were covered with colorless nail polish to protect exposed areas from microbial infection. Collections were placed on paper bags, properly labeled and/or tagged [8].

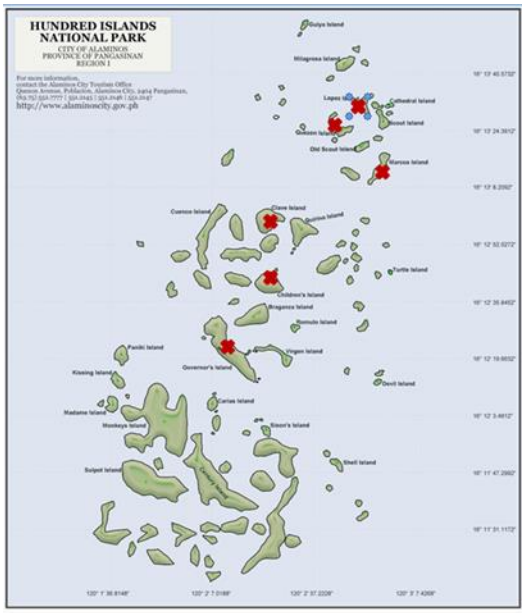

Figure 1. Map of the Hundred Islands. Marked islands (X) are the collection sites (Source: http://www.alaminoscity.gov.ph).

Lichen identification and biodiversity indices.

Taxonomic features of the lichens were carefully examined using a Nikon YS100 binocular light microscope and Axio Zeiss Scope.A1. Chemistry of the lichens was determined through spot tests (K, P, C and I) and thin layer chromatography (TLC). Taxonomic keys available online [9] and in print [10], [11], [12] were used as guide to identify specimens collected. To verify identification of lichens, reference was made to pictographic guides. For lichens which are difficult to identify, images and features were also sent to consultant lichenologists for the confirmation of initial identification. Taxonomic treatment and characterization of the lichens, however, will be presented in another article. Herbarium vouchers are stored at the lichen herbarium of the Fr. Braeckman Museum of Natural History, Saint Louis University, Baguio City, Philippines. Biodiversity indices were determined using an online biodiversity calculator [13].

Morpho-anatomical observation.

Sectioning of the thallus and ascocarps was done under the Olympus and/or Meiji stereomicroscopes. The Nikon YS100 binocular light microscope and Axio Zeiss Scope.A1 were used to observe the internal anatomy of the thallus. The AxioCam ERC 5s accessory of the Zeiss Scope.A1 was used to take images of the sections. Detailed observation of desired features such as the presence and type of calcium oxalate crystals was done through scanning electron microscopy (SEM) at the Korean Lichen Research Institute (Sunchon National University, South Korea). Similar lichens were also collected from the mainland for comparison purposes.

Diversity of lichens.

Identification of specimens collected resulted to at least thirty-two species grouped into two morphological forms, foliose (3) and crustose (29), distributed in 17 genera and belonging to eight families (Table 1). The foliose lichens belonged to family Physciaceae; crustose lichens were distributed in eight families. The family Graphidaceae dominated in terms of diversity with 17 species. The highest number of species was collected from Governor Island; only two species were found in Lopez Island. Consequently, species diversity was highest in Governor Island (1-D=0.8334); lowest in Lopez Island (1-D=0.0384). There is a significant difference in the number of species of lichens present in the islands (df = 5; α=.05; χ =13.476). This result can be partly explained by the Island Biogeography Theory (Wilson

and MacArthur, 2001). Among the islands sampled, Governor Island was nearest to the mainland and also the biggest; Lopez Island was the farthest and the smallest island visited. There were more trees (consequently lichens) in terms of species and age that have colonized Governor Island; hence more lichens were found in the island than in the others. Lopez Island had few young trees, with few lichen epiphytes. Although the Hundred Islands is a protected national park, extinction through anthropogenic reasons cannot totally be discounted. They may not be a primary factor to consider due to the absence of some lichen species in some islands; rather extinctions would be more attributed to natural factors that affected the success in the immigration and colonization of plants which can serve as substrates for these lichens. Species evenness was highest in Lopez Island (SE = 0.9544); lowest in Children's Island (0. 7798) (Table 1; Figure 1). There are only two species identified from Lopez Island but one is not more dominant than the others as shown by the number of individuals (Rinodina =25 and Fissurina sp. 1=15).

Growth Form	**Taxonomy**		**Collection sites**					
	Family	Species	A	B	C	D	E	F
Foliose	Physciaceae	*Dirinariaapplanata*		x	X		x	
		*Heterodermia*sp.		x	X			
		Pyxinecocoes		x			x	
Crustose	Physciaceae	*Rinodinaoleae*	X			X		x
	Coenogoniaceae	*Coenogoniumstramineum*			X			x
	Graphidaceae	*Diorygmahieroglyphicum*			X		x	
		Fissurina. dumastii	X					
		F. subcontexta			X			
		*Fissurina*sp. 1	X		X	X	x	
		*Fissurina*sp. 2			X			
		Graphisanaloga		x				
		G. cincta	X					
		G. consimilis	X					
		G. distinct						x
		G. furcata	X	x	X			
		G. lineola			X			
		*Graphis*sp, 1			X			
		*Graphis*sp. 2	X	x				
		*Graphis*sp. 3	X					
		Cf. Thecariaquassicola						x
		Thelotremadefossum			X			
		Cf. Thelotremabrasiliensis	X		X		x	
	Lecanoraceae	*Lecanorahelva*	X	x			x	
	Pyrenulaceae	*Anisomeridiumbiforme*		x	X			
		*Pyrenula*sp. 1					x	x
		*Pyrenula*sp. 2		x				
		*Pyrenula*sp. 3		x				
		*Pyrenula*sp. 4	X	x	X		x	
	Ramalinaceae	*Bacidiamedialis*	X		x			x
	Roccellaceae	*Opegrapha* sp.						x
	Trypetheliaceae	*Marcelariacumingii*	X	x	x			x
		Trypetheliumaeneum	X	x	x			x
Number of species			14	13	17	2	8	9
Simpson's Index			.3806	0.206	0.1666	1.038	0.5121	0.4882
Dominance Index			0.6194	0.794	0.8334	0.0384	0.4879	0.5118
Shannon-Wiener Index			2.058	2.347	2.597	0.6616	1.663	1.738
Species evenness			0.7798	0.9149	0.9166	0.9544	0.8	0.7857

A - Children's Island; B - Clave Island; C- Governor Island; D - Lopez Island; E - Marcos Island; F - Quezon Island; x – indicates presence of the lichen

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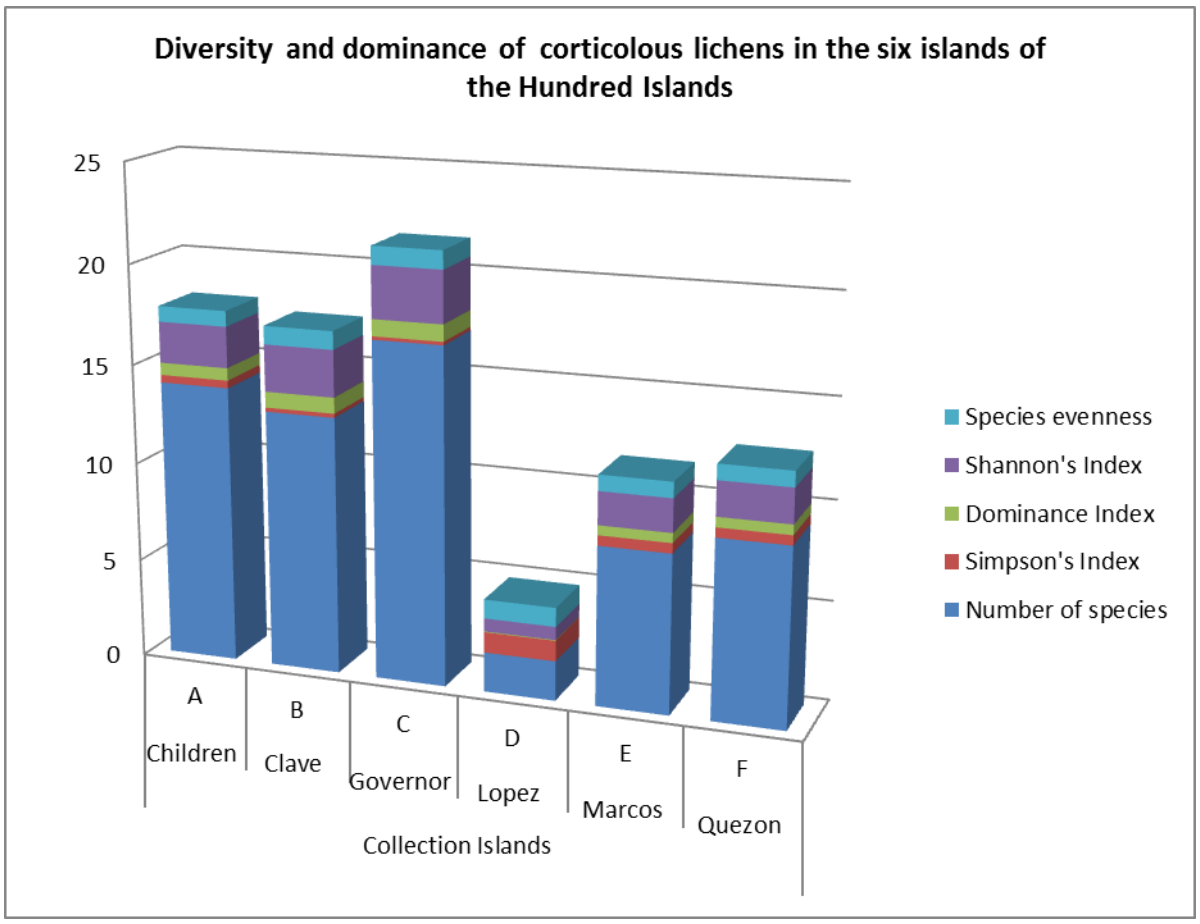

Figure 2.Diversity and dominance of corticolous lichens in the six islands of the Hundred Islands

Table 2. Species similarity between the six Islands*

	A	B	C	D	E	F
A		0.179	0.279	0.228	**0.377**	**0.098**
B	0.179		**0.292**	**0**	0.26	0.017
C	0.279	**0.292**		**0.057**	0.164	0.098
D	**0.228**	**0**	0.057		0.217	0.038
E	**0.377**	0.26	0.098	0.217		**0.028**
F	0.098	**0.017**	**0.098**	0.038	0.028	

* A - Children's Island; B - Clave Island; C- Governor Island; D - Lopez Island; E - Marcos Island; F - Quezon Island; values in red shows highest species evenness, in blue, the lowest between two islands.

Species evenness is highest in Lopez Island (SE = 0.9544); lowest in Children's Island (0. 7798) (Table 1; Figure 1). There are only two species identified from the Lopez Island but one is not more dominant than the other as shown by the number of individuals (Rinodina =25 and Fissurinasp. 1=15). On the other hand, Children's Island showed 14 species but there is dominance by some species than the others (e.g. Bacidiamedialis = 41; Graphisspp. usually have two individuals each). Based on morpho-anatomical and chemical characteristics of the lichens there is not one species that we have collected that is common among all the islands (Species Similarity = 0) but Graphidaceae and pyrenolichens are well represented in all the islands. Inter-island species similarity is also very low (Table 2). Children's Island has more similar species with Marcos Island than with the others; least similar with Quezon Island. Clave Island has more similar lichen species with Governor Island; no similar species with Lopez Island. Quezon Island has more similar lichen species with Children and Governor Islands; least with Clave Island. These results certainly are not absolute; it indicates, however, that there is much variation in the species of lichens found in the six islands that survey of lichens in the other islands may reveal other species as well.

Referring to the map of the Hundred Islands (Fig. 1), distance among the islands seemingly is not a factor that affects species similarity. Again, we suggest that the type and abundance of lichens present in the islands could be affected by other factors including substrate characteristic such as pH, nutrient levels [14].

Adaptive Features

This limited number of lichen inhabitants in the six islands of the Hundred Islands verifies the harsh conditions of the environment preventing a great number of species to grow and survive. Those that exist in the islands must have features that enable them to persist under such unfavorable situation. Our observation of the lichen structures in comparison to those found in the mainland revealed some of these characteristics.

Appropriate growth form. Majority of the lichens in the islands are crustose (~90%). These lichens are tightly attached to the substratum and often part of the thallus is embedded in the bark. This type of growth makes water loss restricted only to the upper surface [15]. The ten percent foliose lichens are narrow-lobed thus there is smaller surface area exposed limiting water loss. Lichens are poikilohydric; their productivity is affected by this nature [16]. Alternating wet and dry thallus condition causes a see-saw in the metabolic state of symbionts. Prolonging the wet and metabolically active state is essential for their growth and survival. Any mechanism, structural or physiological, that helps them retain the moisture in the thallus is basically essential.

Thicker upper cortex.

In addition, many of the island lichens have thicker upper cortex compared to similar lichens in the mainland. This was particularly observed in Pyxine collected from the island and from the mainland. The upper cortex of Pyxine from Clave Island (Fig. 3A) is definitely thicker than Pyxine collected from the mainland (Fig 3B, 3C). In addition, there is the distinct epinecral layer above the upper cortex in these lichens (Fig. 3A marked X).This layer which consists of dead, collapsed photobiont cells make the lichen thallus surface grayish-white due to light reflection [15]. Thicker upper cortex provides better protection against excessive light for the photobiontunderneath [17], [18]. The presence of epinecral layer, on the other hand, not only decreases transmission of incident light but the creation of air spaces by the dead cells provides CO2 diffusion paths under supersaturated conditions [19].

Homoiomerousthallus organization.

In many crustose lichens, the photobiont cells are evenly distributed among the mycobiont [15]. We confirm this with our own observations of the internal anatomy of crustose lichens collected (Fig. 3A-3C). In addition, homoiomerous organization was also observed in the foliose lichens Heterodermia, Pyxine and Dirinaria collected from the islands (Fig.3D-3F). In this type of organization, the photobiont cells occupy deeper layers of the thallus and therefore are accorded more protection by the mycobiont hyphae. Furthermore, this closer proximity between the thalli of the symbiont cells allows faster diffusion of CO2 and water from the fungal hyphae to the photobiont cells. This definitely is favorable for the photosynthetic process which is vital in the survival of the lichen and in the increase of its biomass [20]. Both photobiont and mycobiont undergo respiration but the fact that the fungal partner generally constitutes the greater part of the lichen thallus suggests that it does mostly the CO2 releasing metabolic process [21]. Faster rate of CO2 exchange between the symbionts increases the rate of photosynthesis in the lichen, consequently, its net productivity.

Presence of pruina

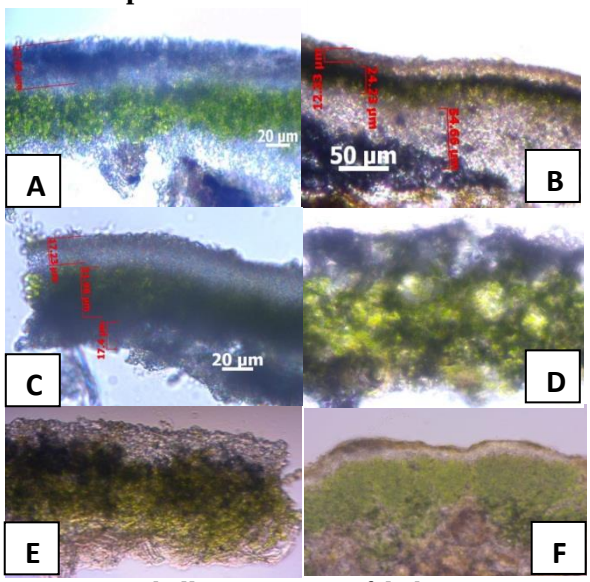

Figure 3.Thallus anatomy of lichens.Comparison of the thickness of the upper cortex of Pyxinecocoes from (A) Clave Island, (B) Alaminos City, and (C)

Lingayen City. Epinecral layer is marked (x) in A. Sections of the thallus of crustose collections from the islands showing distribution of the photobiont: (D) Graphis sp. 1, (E) Opegraphasp., and (F) Bacidiamedialis.

These are whitish, powdery materials that are mostly deposited on the surface of the lichens. Under the microscope they appear as crystals. Pruina are mostly composed of calcium oxalate with two crystalline phases: monohydrated whewellite (CaC2O4.H2O) anddi-hydrated weddellite (CaC2O4(2+x)H2O) [21]. The production of these pruina in the lichens depends partly on the chemical nature of the substrate such as the calcium content [22]. The islands are coralline; hence, the substrate for the trees is highly calcareous. The calcium content in the tree barks which served as the lichen substrate was not established in this study. Nonetheless, the presence of calcium oxalate crystals is a rule among the island lichens rather than the exception.

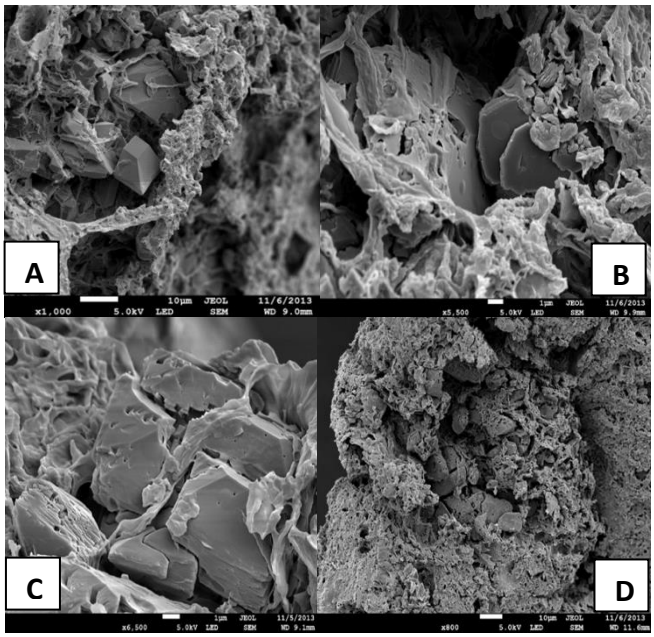

Figure 4.SEM of the calcium oxalate crystals in the lichens: (A) weddelite in Pyxinecocoesseen to be intertwined with hyphae; (B) whewellite in the thallus of Thelotremadefossum; and (C) weddelite crystals on the thallussurface of Lecanorhelva,and on the apothecium exciple(D) of Bacidiamedialis.

It was observed the two types of calcium oxalate crystals (Fig. 4A-4D). Many are intermittently distributed on the surface of the lichens (Fig. 4C); some are intertwined with the hyphae (Fig. 4A-4B) or even among the photobiont cells (Fig. 5B). These calcium crystals are also deposited on the exciple and/or discs of the ascocarps of the lichens (Fig.4D, 5A).

Assuming high calcium concentration in the substrate (in this case tree bark in the island) of the lichens, this would have affected cytoplasmic calcium concentration of the mycobiont thallus. In addition, saline water splashes may have added to mineral deposits on the lichens. Calcium oxalate formation is a mechanism for the lichen to get rid of the excess calcium [22] [23].

The calcium oxalate crystals especially the weddelite crystals are implied as possible source of water by the lichen [23]. Weddelite contains zeolitic water which can leave the crystals when they dry. This water can become available for lichen use. They are also indicated to provide mechanical protection, serve as deterrents against herbivores [24] and provide protection against excessive light by deflecting some light rays from reaching the lichens [25].

SUMMARY OF FINDINGS

A survey of the corticolous lichens in only six Islands of the Hundred Islands show so much diversity that it encourages further study of the lichens in the other islands despite the risks of doing so. It also gives the challenge of determining the factors that cause species similarity to be very low between the islands. The lichens have the structures that enable them to withstand the stresses caused by excessive radiation and saline precipitation. All these features cooperatively interplay to provide protection against predators, maintain lichen thallus moisture content, and facilitate gas exchanges that enable metabolic processes to occur thereby allowing lichen growth, survival, and ultimately existence.

Historical Definition of Personal Knowledge

The concept of personal knowledge was first proposed by the Hungarian scientist and philosopher Michael Polanyi in his 1958 text, "Personal Knowledge: Towards a Post-Critical Philosophy." Polanyi defines personal knowledge as all knowledge that depends on personal decisions. Also, all knowing, relies on our vows no matter how formalized or not. He further argued that our commitments stimulate our highest achievements.

Moreover he introduced tacit knowledge as "a wide range of not consciously known rules of skill and connoisseurship which comprise important technical

processes that can rarely be completely specified." Polanyi contends that the sum total of these "rules" constitutes an individual's tacit knowledge – the skills, understanding, and intuition gained "through the process of unconscious trial and error by which we feel our way to success and may continue to improve on our success without specifiably knowing how we do it."[1]. Unlike explicit knowledge, which can be learned by reading or following written procedures, tacit knowledge cannot easily be recorded or codified.

RESULTS AND DISCUSSION

Role of Intellectual Passion and Subjectivity in the Choice of Researchable Area

Scientists and researchers claim that in the conduct of the study, it should be bias- free and such could be attained by following the scientific method. However, the choosing of the research on lichens alone was clear indication that the study was not grounded on pure objectivity. According to Polanyi, total objectivity is not possible for the reason that knower is brought to every discovery. Certainly, without the person present in the research there would be no motivation for discovery in the first place.

Since the researchers have chosen the field that they are most comfortable, interested and excited to do, that is, choosing lichens and everything related to it, they defined what they should appreciate in science consequently motivating them to go further and increase our knowledge in the field. Although, there were several studies conducted on lichens already in other countries and areas in the Philippines, little is known on the biodiversity of lichens in Hundred Islands National Park. Also, few studies have been conducted on the adaptive features of lichens in the Philippines and were concentrated in mountain and forested areas.

Moreover, they had an influence on the choosing of the site, the Hundred Islands National Park is one of the most visited tourist spots in Pangasinan, which the researcher happen to be very near in the site, thus accessibility and travel were not problems. Further, since it was of cultural and economic significance, they thought that the place could be easily recalled and identified by the readers and other researchers.

With these premises, it implies that they define our scientific beauty which is actually part of their reality and this maintains and sustains their intellectual passion to do researchers related to this area.

In addition, their heuristic passion drove them to not consider only the islands of HINP but other sites such as Alaminos City and Lingayen for comparison. Likewise, the long number of years spent by the corresponding author, Dr. Paulina Bawingan, in the study of lichens was a clear display of heuristic passion.

Objectivity and Methodology in the Collection of Lichens

In biodiversity studies, protocols should be followed for the results to be accepted by the scientific community, thus in sampling in the collection of lichens, set of procedures from published literatures were adapted. Sampling design provides rules to objectively select monitoring sites within a survey area and comprises sampling strategy and sampling tactics. This refers how sampling units are chosen and located, however, sampling tactics sets how many trees are selected for sampling within each sampling unit and how they are chosen [26].

Since they adapted the protocol of Gradstein [8], the researchers initially believed that the collection was guided purely by objectivity. However, contemplating on the philosophy of Polanyi, there was a modification of research beliefs. Although they used the quadrat sampling technique which is widely accepted, the selection of where to lay the quadrat is based on their perception with the various considerations mentioned earlier otherwise, they should have done random sampling. Also, in the selection in the trees with determination of their characteristic were personally picked. Further, ocular inspection on the laid 600 cm2 clear transparent quadrat whether what they had seen belong to the same species or not was dependent on my judgment. Thus, the observations were not purely objective because these were based on personal biases.

Role of Tacit Knowledge in the Identification of Lichens, Its Biodiversity and Adaptive Features

Polanyi's assertion of tacit knowledge that "we can know more than we can tell" has an impact in the completion of the research as set in our methodology. This covers a huge amount of knowledge that people have such as attention, recognition, retrieval of information, perception, and motor control. These are skills which cannot be easily explained thus they are regarded as implicit knowledge.

In the research, the sampling in the island from which we got our lichen samples was part of the tacit knowledge, this was based on our previous knowledge that to get enough sample, the size of the trees and the number of species of trees present should be considered. Also, the collection of the lichens from the trees so that little or no harm had been done on the tree and the manner of lifting and storage so as not to destroy the lichens, formed our "silent knowledge" on the area.

Identification of species of lichens required our skills since consulting the dichotomous key and pictures alone could not provide us immediately the name of the lichens. It required accumulated knowledge on the morphology, physiology and various reactions of lichens to chemicals that have led to proper identification of species. Otherwise, if such skills did not exist, it would have been more-than-a-year research. This skill was product of several trial-and-error events which was consequently refined thus easier identification of species was done. Although, they know the exact way to do it, they believe that they will be having a hard time enumerating them in detail thus this is also known as inarticulate knowledge.

Accordingly, this tacit knowledge is directed by our focal and subsidiary awareness. Our understanding is directed by such "compelling clues" in the background, which although we are not attending to them (subsidiary awareness) still specify the object of our cognition (focal awareness). There is no focal awareness without subsidiary awareness, and in the same way, there is no subsidiary awareness without focal awareness. Though the subsidiary awareness determines the focal awareness still it is meaningless in itself, because it can manifest itself only via focal awareness. It follows that our cognition becomes necessarily tacit, since we are aware of the determining clues only in a subsidiary way.

In the usage of equipment needed for the identification of the species of lichens and their adaptive features such as the binocular dissecting and scanning electron microscopes, subsidiary awareness operated when we manipulated the microscope such as adjusting the various knobs which was subconsciously done to bring the microscope into focus. Using the previous definition that subsidiary awareness is manifested only via focal awareness, concentrating our efforts in the recognition of parts peculiar to the species necessary for the identification of species is known as focal awareness.

In addition, the wet mount preparation of lichens was done with expertise. Thin dissection of the specific part of lichen and the steps involved required tacit knowledge. My first encounter to this task took me a semester to produce a good section; however, because of frequent exposure such was done with ease without consulting books and the experts (our professors). If they will be asked to write or verbalize how it is done exactly, they believe they would be having a difficulty in doing so. Thus, tacit knowledge is an inarticulate or implied knowledge, the "I know more that I can tell", which brings me to the realization the times they always say "basta".

On the other hand, comparison of biodiversity between and among other islands was computed using an online calculator. Although, it was not manually done, values were placed in the program, this needs expertise since errors in running he program itself or results may not be accepted because of very high or low output value may be encountered.

The analyses of various results required tacit and personal knowledge. Their experiences in the field and our previous readings of literatures that would support their claims molded the presentation and discussion of their results. The interpretation and establishment of relationships were determined by our personal knowledge. Comparing the thickness of the upper cortex of the Pyxinecocoes lichen species in the various islands of HINP and mainland (Alaminos City and Lingayen) and its relationship to their adaptive abilities required a profound understanding of the typical morphology and anatomy of the lichens which is possible only through years of working experience on lichenology. Also, in the thallus organization whether the algae are interspersed with the fungi or they've shown distinct layers, tacit knowledge allowed us to immediately pinpoint whether the structures belong to the algae or fungi. Therefore, our observation, further analyses and validation were based on our personal judgments.

Although the researchers were students of of Dr. Paulina A. Bawingan, an expert on lichens, they became one of her co-authors; their acquired knowledge and skills were products of connoisseurship. They learned by example the correct ways of collecting and identifying lichens, preparing of wet mount samples and using the biodiversity index which formed gradually my tacit knowledge. Their

standards of what is correct and proper were based on the teachings and work of my mentor, Dr. Bawingan and their passion to continue in this field is sustained by my personal commitment.

Role of Articulation and Conviviality in the Publication of the Results

Michael Polanyi believed that animals have sound complex knowledge since they can learn tricks, understand signs, and gain "latent knowledge". However, human intellect exceeds beyond the abilities of animals to speak which makes a big difference because we can create symbols to represent knowledge, and then we can manipulate and rearrange those symbols, and read off from that manipulation of new understandings.

The writing of the proposal presenting the importance of the biodiversity and adaptive features of lichens and identifying the step-by-step process to accomplish the research was forms of articulations. It means that they could codify their personal knowledge since the researchers could translate them to words and figures. The writing of results in terms of tables and graphs and eventually interpreting them were manifestations of their ability to use language. However, Polanyi introduced the concept of "ineffable" knowledge which means they could not precisely codify all the things that they have observed and done in the research. Thus, they could not write all the realities they've experienced during the conduct of the research from the sampling, collection, use of equipment, use of dichotomous key and others which implies that they have limitations in their power of expression, Nevertheless, articulation is needed in making the results known so that it could be used by other researcher for further study and as baseline data for formulation of some local policies in HINP.

The research was a collaboration of three institutions; Pangasinan State University has its connections with Saint Louis University which has its partnership with Kunchon National University. Thus, the research was a product of civic coefficients of their intellectual passions. Since they belong to a like-minded social group who share and respect similar passion, it's a manifestation of our conviviality in this scientific community. The delegation of works to every member of the mentioned institutions for us to come with a research output and coordination of our own results which led to interpretation of results, conclusion and recommendations were displays of our conviviality.

Furthermore, the research was submitted and was accepted in Philippine Journal of Systematic Biology. Conviviality is also achieved; since they allowed that the paper to be peer reviewed thus they submitted themselves to a "mutually imposed society" who shared the same intellectual passion. Also, their various presentations to forum signified their intent to establish scientific rapport with other researchers since during presentations; others were encouraged to make suggestions and inputs for the further improvement of the paper. Results of the research were submitted to Tourism Office of the city of Alaminos for their future reference such as conservation of the biodiversity in HINP.

CONCLUSION

The researchers believed that there was a paradigm shift from a believer of objectivity to personal knowing; that they could not separate themselves from the research since their intellectual passions and personal knowledge motivated and shaped the research.

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