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Research

Folktales and Chants of Tadian, Mountain Province*

By
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The folktales and chants is one of the cultures that has been rooted in the life of man since creation. It embodies the ideals, beliefs and values and life patterns of the people that make them distinct from others.

These folktales played a vital role in maintaining solidarity and close knit interaction among the people of Tadian. This is evidenced by the *bayanihan* relationship system being practiced in the community. Old folks from the neighboring barangays sacrifice to vigil overnight as they take turns to share own folktales and chants. This is one way of not only comforting the bereaved family but also an informal means of learning from each other and internalizing their indigenous practices imbibed by the listeners thereby enhancing g their indigenous personality.

The folktales however, in the past were not so well appreciated. What was local was not given much attention as compared to the foreign write-ups that were readily accepted and recognized by the Filipino readers. Village people regarded the stories being narrated by the old folks as consumption only for them. This misconception was influenced by the colonial mentality of the people. Another misconception is, if you go for local movies and literature such as comics, you are a *bakya* (*inferior to those who go for foreign stuffs*).

The chants according to *Lakay* Bayang of Sagada in Aguilan's (1981) study give life to everyday activities. One's potential in music can be developed to compose a chant while performing on the spot. When working, the weariness and boredom of the work tends to be eased out when an old folk starts chanting a dad-at. People working will not realize that they have finished their work not minding the long awaited hours that have passed by.

Change in inevitable. As civilization progresses, man has to live with changing norms which he has to follow throughout life. So that what is emulated, assimilated and practiced by the young generations are either the modified or the authentic.

To date, Tadian is fast assimilating the culture of other people from different localities. Considering its proximity to its surrounding boundaries, the folktales and chants are seldom heard in some of the barangays. The old folks who are very good in chants no longer go to wakes and other occasions where they can share their talents. This is due to the absence of a counterpart to give a chant. This was asserted by Mr. Manuel Ayobo, a member of the Council of Elders of Poblacion, Tadian, Mountain Province, when he tried to initiate the revival of the performance of a ritual wherein they are going to drive away *mayas*—birds feeding on their crops. They were not able to do so, because the old men were not sure of what to do.

Accessibility to the road had also contributed to the fast pace of acculturation which facilitated the influx of reading materials. The Filipino romance novels by Filipino romance writers have captured the attention of the young particularly the students. The youths/students have become avid readers of these reading materials wherein they learn that premarital sex is a part of the courtship process. They have forgotten the very essence of *inayan* that the folktales and chants contain.

The need therefore, to publish a book on the folktales and chants is vital before the key informants and the authentic culture vanish. These will be used by the young generations as reading materials as well by educators and students as instructional materials in Literature,

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Music, Social Sciences and Values Education classes. This is in response to the constitutional mandate (De Leon, 1999) which states that, the state shall foster the preservation, enrichment and dynamic evolution of a Filipino national culture based o n the principle of unity and diversity in a climate of free artistic and intellectual expression. This will broaden the awareness of the Filipino people that the Igorots, through they belong to the cultural minority, have a rich cultural heritage to be treasured and shared. It would rekindle in them one's culture, enhance cultural identity, and in a nutshell in all aspects of personality development.

Problem and Methodology

This research aimed to document the folktales and chants of Tadian, Mountain Province.

Specifically, the following objectives were attained:

1. Document the folktales of Tadian with regards to socio-economic activities, courtship, healing and death; and the chants in the forms of oggayam, day-eng, daing, liwa and baya-o.
2. Produce reading/instructional materials for use in teaching Literature, Music, Social Science, and Values Education classes.

The descriptive/qualitative method of research was used. Interview of key informants was largely used. This was usually done whenever there were occasions like weddings, wakes, community assembly and by chance. To make the presentation more concrete and reliable, pictures depicting the folktales and chants were taken and the chants audio recorded.

Findings of the Study

1. Folktales in content depicted the Supreme Being, Kabunyan, as the key to economic development in the family and in the community. This is shown by the story, "The Stone at Gao", which narrates that the stone after it was erected and left by Lomawig has withstood the strong winds and water during typhoons. It was never drawn by the water. Even if there were landslides, the Stone can still be seen to where it was erected. To date however, it is found near to where it was erected. Another, the "GIPI", also narrates—We are now calling on you Kabunyan to help us also because we are now going to harvest our palay. May it become plentiful. The palay in the entire community, wherever it may be, may it give us bountiful harvest to sustain us in our life.
2. Courtship was simple, practical and free from deception. These are reflected in the Stone in Gao wherein Lomawig said in their course of conversation, "Would you like to be my wife?" and the lady answered, "Yes, if you like me."; and in the story of Madolawan and Gatan, when Gatan said, "That is not the point my dear young lady. To me, what is important is that, it is you whom I like. My parents understand how I feel. They don't have standards when it comes to the lady I court to be my wife."
3. Healing is a narration of how the healing practice evolved. Examples of these are the folktales in, Two Orphan Brothers, and the Kaykaybo.
4. Orphaned children being exploited and abused by their relatives experience economic prosperity and abundance if they adhere to what the old folks taught them. Example of this is the story of "Entegtegey".
5. The various forms and context of chants (oggayam, day-eng, daing, liwa and baya-o) differ in the melody pattern depending upon the occasion.

The oggayam and the the day-eng are usually done to entertain oneself and other people during programs or special occasions.

The daing is only held during wedding, while the liwa is done when somebody performs the senga. This is the occasion when a family butchers pigs and chickens in thanksgiving to Kabunyan for a bountiful harvest or any fortune bestowed upon the family or to celebrate any occasion. The baya-o on the other hand, is done during vigils. It is however done if the dead is either an old man or old woman with children.

Conclusion

Based on the results of the study, the following conclusions were drawn:

1. The people of Tadian have similarities in the folktales and chants. The slight difference lie in the terminologies used and the pronunciation of the letter "s" to "h".
2. The people of Tadian have a set of folktales and chants with regards to socio-economic activities, courtship, healing and death for social, mental, spiritual, and moral personality development.
3. The folktales are either narrated or chanted depending upon the occasion.

Recommendations

Based on the findings and conclusions, the following recommendations are given:

1. Schools like MPSPC should document more folktales that can be used in Literature and Values Education classes, and chants in the Music classes to sustain it.
2. There is a need to publish the folktales and chants as reading materials.
3. A follow-up study on the content of the Folktales and Chants, and on the notations of the chants of its melody pattern.

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* Presented during the Regional Sectoral Commodity Review of HARRDEC at BSU in 2007. It won second place for best paper. Publication of a book on **Folktales and Chants of Tadian, Mountain Province** as an offshoot of this study is underway.

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Excerpt of Bato ed Ga-o and some Folktales and Chants in this study:

Gipi

(Gipi)

By
Yasen Diwayan of Poblacion

Wada kano nan apon di i-Cagubatan ay nabakes. Umey kano isin ninsiyanan di danan ay mensese-ed si omey men-ani.
Loma-os pay kano nan ado-ado ay omey men-ani yaket kanana kano, "Maka-eyek kad ta enak maki-ani."
"Ay maka-ani ka et abe issa," kanan da kano danda et malaos danda pay mentogtogpa.

(There was an old woman from Cagubatan who went to the junction waiting for people who will go and harvest palay.
When a group of harvesters passed by, the old woman said, "May I go with you? I'll join you in the harvest."
"You cannot harvest!" they said and spat before her then off they went.)

Wada et kano san menbanat, "Maka-eyak kad?"
Kanan kano nan menbanat, "Umalika adi, at-atik man-adi dat ulay umalika ta enta menbadbadangan."
Omey dapay kano domadak, somigbo san menbanat ay dey et men-ani dapay itotokdon din nabakes isnan baneng.

(There was a mother who left her young baby at home because she was going to harvest palay.
The old woman said again, "May I go and harvest palay with you?"
The mother said, "Yes you may come, if you like. I have but little to harvest, however you may come and help me harvest it."
So the mother and the old woman went and started harvesting palay.
The mother began harvesting palay, while the old woman sat down at the rice paddy island.)

Kanan din menbanat isdin nabakes, "Nay di pangbedbed mo sina aniyem."
Sumungbat pay din nabakes yaket kanana, "Ulay, wayak si ikkak."
Ilan pay din menbanat sidin nabakes yaket tobtobpa-a na dana pay alan nan bu-ok na et siya di pangbedbed nas inanina.

(The mother offered the old woman bamboo strips to use in binding what she will harvest;
but the old woman said, "Don't mind me. I have my ways."
When they were harvesting, the mother saw the old woman using her saliva and her hair to bind what she harvested.)

Wada kano ay map-mapno din baneng ya din taban da si pagey ay inani na dapay maid ma-ila si na-aniyana isnan payew.
"Tomakdeg ka et ta mangan ta no waday baon mo," kanan kano din menbanat.
Tomakdang et mangan da. Dengnge na pay kano san kankanan din nabakes yaket sika, gabay, tago, ya oban.

(The rice paddy islands are being filled with harvested palay, yet the area where these were harvested was narrow.
This surprised the mother. After some hours of work, the mother told the old woman to join her in eating if she has provisions.
The old woman said, "I have."
When they were about to eat, the old woman prayed for abundance, prosperity, good health and long life.)

Mangan da pay kano yaket, ati-atik din baon da dapay napitong da ya egay ka-abos din baon da.
"Siya san iyat yo di tasay adi kayo ka-owat," kinwanin din nabakes.
"Anggay soma-a ta et. Alam adi din lagbom," kanan kano din menbanat issan nabakes.
Dat kanan san nabakes, "Adi tan menbadbadangak et anggay.
Soma-a ka kadet ta kanam din ap-om ta umali da ay mang-obo issan inani ta, ta mai-isa-a isin baey yo."

(They began eating their provisions and it was surprising that they were full and yet there were still plenty of leftovers.
The old woman said, "This is what you should do so you won't go hungry."
Then the mother said, "You get you pay." But the old woman refused telling her, "NO, I am only helping.
You better go home and tell your grandchildren, your children and husband to come and carry home what we have harvested.)

"Ipa-ey yo sin da-o ya sin agamang yo et mapno da et adi kayo ma-aw-awanan si ka-enyo," kanan kano din nabakes.
Sida pay iyat kano din initdon din nabakes et tet-ewa ay sinmika din pagey ay inpaey das nan da-o yanan agamang da.
Danda et igdang isnan Tadian et ipeyas da isnan ipogaw.
Nay pay ay inayagan mi abe sik-a ay Kabonyan, badangam abe dakami ta nay ay men-ani kami isnan pagey isna Tadian.
Olay no into di kad-ana, somika koma di kaniyana.

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(You shall put them under your house and in your rice granary.
Those shall be filled and you will have excess food," said the old woman. They did just what the old woman told them.
It was true that they had more than enough than what they needed. Then they brought it to Tadian and shared it to the people.
We are now calling on you Kabunyan to help us also because we are now going to harvest our palay. May it become plentiful.
The palay in the entire community, wherever it may be. May it give us a bountiful harvest to sustain us in our life.)

Bato Ed Ga-o

(The Stone in Ga-o)

By
Felix Napaldet and Jacinto Balitog of Bantey and Masla

Ad sang-adum, wada nan ik-ikkan di a-amam-an di i-Masla, i-Sumade, i-Bantey no tumiyagew tasay umudan.
Nan istorya ay nay et menlugi issan dinmatingan si Lomawig ed Bantey ay nagapu ed Besao.
Issan dinum na-ana ed Bantey, wada san bato ay ginagatinana danapay papay-yongan san nalawa ay um-a.
Nan um-a ay nay et wada ed Taba-an isnan nen baetan di Sumade ya Bantey.
Nalayda-laydan si Lomawig isnan i-ilaena ay um-a isunga dat lomayog et ena lebba-en.
Linebba na san nalawa ay um-a et nenbalin ay payew.
Wada et san babassang di i-Sumade ay mang-iyadi tay um-a na san linebban Lomawig.
Kinwanin Lomwawig issan babassang ay ta men balinena es payew tasay ad adu ma-apit na.
Nilayad san babassang ay menbalinenda ay payew san um-a na.

(The story started when Lomawig arrived from Besao and erected a stone in Ga-o.
In the story, Lomawig stepped on a rok at Ginawang (a creek in bantey). He was viewing the scenery of Sumadel and Bantey.
He was attracted by the site of a crops field in Taba-an, so He went down to the crops field and started working on it.
While He was working, a lady from Sumadel came and asked Him, "Why are you working on my crops field?"
Lomawig told the lady, "I would like to turn the crops field into a paddy.
The farm would have a better yield than if the land remains to be a crops field."
Then the lady said to Lomawig, "If that is what you think, you may go on with what you are doing.")

Daet kanan si Lomawig ken siya en, "Ay laydem ta men-asawa ta?" Nakayat san babassang et men-asawada.
Kana net san babae ay asawan Lomawig,
"Ta suma-a-ak ta umeyak men-uto si esa ta kanen ta, ituloy mo pay ay lebbaen nan payew ta."
Kanan et si Lomawig, "Owen suma-a ka, ngem no umalika mem-eskag ka sakapay umali isnan men leb-lebba-ak."

(In the course of their conversation, Lomawig asked the lady, "Would you like to be my wife?"
The lady answered, "Yes, if you like me."
After sometime, the lady said, "Lomawig, I will go home and cook for our food while you continue working in the field."
Lomawig answered, "Yes you may, however, every time you come, you cough before coming to the field.")

Mawakas pay et umey san babae ay asawan Lomawig et nasda-aw tan aped nalawa-lawa nan linebban Lomawig dampay es-esa na.
Kanan et san babae isnan nemnemna, "Ta kad si-imek ta tungoek nan sekreto na."
Et isnan ena nangyan isnan kanen Lomawig san mawakgat, egay nen-eskag.
Inmey nen gago tai la-ena san ik-ikkan Lomwawig. Nakigtot san babae tan am-in nan parting di awak Lomawig et wada ik-ikkana.
Nan bu-okna yanan losina dampay men-ob-obla.

(In the morning, the lady brought the food for Lomawig to eat. She was surprised to see what Lomawig had accomplished.
The lady was telling to herself, "Oh My God, what Lomawig has accomplished cannot be finished in a short span of time.
This is impossible for one to have finished such a wide area of land. I will try to discover his secret.
The following morning, the lady went to the farm where Lomawig was working.
She did not cough, instead, she hid herself and saw what Lomawig was doing.
She said, "This is unbelievable! All the parts of Lomawig's body are working including His hair and penis."
She then discovered the secret of Lomawig.)

Makwas pay ay mangan si Lomawig issan inyey san babae danat kanan, "Ngawi ka obpay si asawa, adi ka katalek.
Taynak et sik-a." Menbab-babawi san babae ngem epdas et kinma-an si Lomawig.

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Adina tinungo ay wada pannakabalin Lomawig ay mangtungo isnan nemnemnemen di ipogaw ya ikakkan da ulay egay na ilan.

(After Lomawig had eaten, He told the lady, "I have to leave you because you cannot be trusted."
The lady was saying, "I am very sorry for what I had done."
She didn't know that Lomawig has powers that human beings don't have.)

Tinaynan Lomawig ed Sumade et umey ed Ga-o below Masla.
Ed gao, inalan Lomawig san pilad ay bato et ipadsek na isnan igid di ginawang ay mendad-anan di nadum.
Nalpas nay tu-uden san pilad ay bato ed Ga-o daet menka-os ay koma-an menliblib isnan bil-bilig et umdan ed Kay-ang.
Isdi san ena naki-asawa-an issan anak Batanga et mawada san anak na ay esay lalaki. (. . . . . .)

(When Lomawig left Sumadel, He passed at Ga-o *(a creek below Masla)*.
In Ga-o, Lomawig got a flat stone *(boulder)* and erected it before going to Kayan where He again go married to a daughter of Batanga and had a son.) (. . . . . .)

Kaykaybo

(Kaykaybo)

By
Wanay Songag of Poblacion

Wada kano si Bangan ay baey da ed Balaoa.
Inmey kanon nangidis yaket igibek na pay yan mensaksakit san eges na tay bomala obpay san anak na.

(This kaykaybo is a practice of the i-Tadian when a woman gives birth.
This started long time ago when Bangan went to the fields to gather field peas.
While gathering field peas she had a severe stomach ache. Bangan realized, she was about to give birth.)

Yaket papayongan kanon ama na ay si Lomawig, sana et akopanen san etag ya makan et enan datngan si Bangan.
Sipay bakwa-en Bangan san anak na et soma-a da, ib-a da si Lomawig ay amana.
Umdan da pay ed baey da et pabalaen kanon ama na ay Lomawig
san inakopna ay etag ya makan et menkaykaybo da tay binmala nan onga.

(While Bangan was on labor, her father, Lomawig, was looking down upon her.
So, Lomawig got his acupan and put some salted meat and rice and then went to see Bangan.
After Bangan gave birth, Bangan carried her baby and together with her father went home.
When they reached home, Lomawig brought out the salted pork and rice which he placed in his acupan and performed the kaykaybo.
The prayed to Kabonyan to stop undue bleeding and to restore the woman's strength after giving birth.)

Kinwanen et kanon ama na ay Lomawig, "Adi takon bokodan na, ta ikewag tako et si batawa.
Ta no way omanak ya menkaykaybo da tasay sumaldeng naburos ay panapadara, ya pomigsa nan ina ay omanak.
Ipaytok da et kano ed Tabeyo sipay dawaten Kaldo-ongan et no omanak da pay danda et alaen din etag ya makan et mankaykaybo da.

(Then Lomawig said, "Let us share this to other people of the earth."
They brought it down to Tabeyo, a place where the people of Tadian originated.
It was received by Kaldo-ongan so that when a woman gives birth, he gets some salted meat and rice and performs the kaykaybo.)

Nay omanak kami pay isna et ta mankaykaybo kami.
Dakayo ay apo mi ay nindemademang, dakayoy nangyanangyat isnan naey ay kaykaybo,
nay menkaykaybo kami isna yaket say kas-iten di asi-asi mi, say bomsilan mi.
Kaman kami egay omanak tay wiswisingam dakami.

(Now, if somebody gives birth in Tadian, they peform the ritual.
They include in their prayers that their great ancestors of both sides
who have done this before will be the ones to guide them in their performance.
Since they had performed the kaykaybo, all undue bleeding and discharges shall stop.
It shall restore the mother's strength, as if she had not given birth. She shall be fit and look good again.)

Correlation Analysis Between Doubling Time and Relative Growth Rate of Azolla (*Azolla* sp.) Grown in Tadian, Mountain Province

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Keywords: doubling time, relative growth rate, correlation, diazotroph, nitrogen fixation

ABSTRACT

Fourteen strains or varieties of *Azolla* were studied in Tadian, Mountain Province for two specific objectives; (1) to determine the Dt and RGR of some *Azolla* strains, and (2) to determine the correlation between RGR and Dt. Findings showed that *Azolla* growth was limited both by the medium and temperature resulting to a very slow Dt of 24-119d from November-December and 18-60d from December-January, and a low RGR of 0.008-0.030 g/g/d from November-December and 0.017-0.040 g/g/d from December-January. There was no significant difference among treatments and treatment means at 5% alpha of the F-distribution table and DMRT table, respectively. RGR is negatively correlated to Dt but is positively correlated to 1/Dt implying an inverse proportion between RGR and Dt.

INTRODUCTION

Background of the Study.

Azolla, also known as auckweed fern, water velvet, mosquito fern, ferny azolla, feathered water fern (Armstrong, 1998; College of Tropical Agriculture and Human Resources, 2000; Kay and Hoyle, 2000; Pacific Island Ecosystems at Risk, [n.d.]) and *kul-kulip* or *kudip-kudip* in some locales of the Cordillera Region in the Philippines, belongs to the Salvinia family (*Salvineaceae*) although some authorities now place it in the monotypic family, *Azollaceae* (Armstrong, 1998; Bergersen ed., 1980).

Lamarck established the name *Azolla* in 1785 (Svenson (1944) as cited by Quebral, 1989). It was derived from the Greek words *azo* (to dry) and *ollyo* (to kill) meaning, "when it dries it dies".

Fossil record of *Azolla* Lam. dates back around 100 million years ago (Fowler (1975) as cited by Payawal, 1989) and seven extant *Azolla* species (*A. filiculoides, A. caroliniana, A. mexicana, A. pinnata, A. nilotica, A. microphylla, A. rubra*) are reported (Armstrong, 1998; Bergersen ed., 1980; College of Tropical Agriculture and Human Resources, 2000; Croft, 1986; Darbyshire, [n.d.]; Kay and Hoyle, 2000; Ladha and Watanabe 1987; Pacific Island Ecosystems at Risk, [n.d.]; Payawal, 1989; Singh, [n.d.]; University of Wisconsin, 1999; Watanabe, 2001).

Depending on species, *Azolla* varies in size and or diameter from 1-2.5 cm for small species like *A. pinnata* to 15 cm or more for *A. nilotica* (College of Tropical Agriculture and Human Resources, 2000; Croft, 1986; Kay and Hoyle, 2000; Pacific Island Ecosystems at Risk, [n.d.]; University of Wisconsin, 1999; Watanabe, 2001).

Azolla is commonly described as small, floating aquatic fern, capable of rapid vegetative reproduction by fragmentation and forms a mat on still waters like rice paddies, canals or ponds (Lumpkin, 1987). It is found both in the temperate and tropical regions of the world (Armstrong, 1998; Bergersen ed., 1980; College of Tropical Agriculture and Human Resources, 2000; Cosico, 1985; Croft, 1986; Hera, [n.d.]; Kay and Hoyle, 2000; Pacific Island Ecosystems at Risk, [n.d.]; Postgate, 1998; Quebral, 1989; University of Wisconsin, 1999; Watanabe, 2001).

The water-fern has been used as green manure for wetland rice to increase production in Southern China and Northern Vietnam as far back in the 12th and 11th century, respectively (Armstrong, 1998; College of Tropical Agriculture and Human Resources, 2000; Hera, [n.d.]; Lumpkin and Plucknett (1982) as cited by Payawal, 1989; Watanabe, 2001).

The origin of *Azolla* in the Philippines and how it came to the Cordillera region is not fully documented, but is likely to have originated from China considering the history between the two countries since pre-colonial times.

Based on reports of Mabbayad (1987), the distribution of *Azolla* from Luzon to Mindanao may be owed in part to government projects such as the national azolla action program (NAAP). *Azolla* in the Cordillera indigenously abounds and is commonly observed forming a mat on rice paddies and along still waters of tributaries and canals. Some Cordillera rice farmers are reported utilizing kul-kulip as organic fertilizer for rice.

Examining any sample of *Azolla* under a microscope shows it to have filaments of *Anabaena* living within ovoid cavities inside the leaves (Armstrong, 1998; Bergersen ed., 1980; Brady and Weil, 1996; College of Tropical Agriculture and Human Resources, 2000; Croft, 1986; Gebhardt and Nierzwicki-Bauer, 1991; Nierzwicki-Bauer and Haselkorn, 1986; Postgate, 1998; University of Minnesota, [n.d.]; Watanabe, 2001). This symbiotic association of a filamentous *Anabaena*

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(a.k.a. blue green algae) with *Azolla* and the ability of the association to fix considerable amounts of atmospheric nitrogen are fully documented (Armstrong, 1998; Bergersen ed., 1980; Buchanan et al., 2000; College of Tropical Agriculture and Human Resources, 2000; Darbyshire, [n.d.]; Ladha and Watanabe, 1987; Lejeune, 2001; Lumpkin, 1987; National Azolla Action Program, 1990; Nierzwicki-Bauer and Haselkorn, 1986; Postgate, 1998; 1982; Watanabe, 2001).

The *Azolla-Anabaena* association can fix nitrogen proportional to its biomass produced (National Azolla Action Program, 1990). It can fix from 450 kg N/ha/yr to as much as 600 kg N/ha/yr (Quebral, 1989). This makes *Azolla* a suitable inorganic nitrogen substitute not only for wetland rice but for other crops as well, not to mention other benefits from its use (e.g. soil conditioning effects).

Plant biomass, defined as the quantity of living vegetation in a given area (Harding, 2000), contains variable amounts of nutrients depending on plant uptake and assimilation, and plant species.

In each *Azolla* species, the optimum nutrient levels may vary as the plant may have excess uptake. At sufficiently supplied levels, these amounts have been noted on a dry matter basis: nitrogen, 4.5%; phosphorus, 0.5%; potassium, 1.0-2.0% (Quebral, 1989). Cosico (1985), on the other hand, reported that *A. pinnata* contains 4.0-5.0% nitrogen (dry weight basis), 0.5-0.9% phosphorus, and 2.0-4.5% potassium.

Doubling time (D_t) defined by Stewart and Boyd (1999) as the time required for a relative amount to increase in value from one to two, undoubtedly affects biomass production in *Azolla*.

The average D_t of *Azolla* (in different soils) ranges from 4-17 days (San Valentin et al. (1986) as cited by Tilo et al., 1989) although Cosico (1985) cited Khan (1983) reporting the plant doubles its weight in 3 to 5 days. The faster the *Azolla* D_t, the more biomass can be produced per unit time.

On the other hand, albeit Barko et al. (1986) as cited by the Institute of Food and Agricultural Sciences (2003) stated that there are few substantiated reports of nutrient related growth limitation for aquatic plants, Canfield and Hoyer (1992) as cited by the Institute of Food and Agricultural Sciences (2003) mentioned that while the above information suggests that nutrients do not limit growth of aquatic plants in oligotrophic (nutrient-poor) lakes, these lakes generally maintain less total biomass of aquatic plants and usually different species than eutrophic (nutrient-rich) lakes. This may be interpreted that for macrophytes (aquatic plants), nutrients from the soil or sediments and water may have in one way or the other an effect to their biomass productivity and thereby doubling time.

Since doubling time is expressed in time, a better way to express biomass accumulated per unit of time shall be the relative growth rate (RGR). There is no certainty though that the RGR of each *Azolla* strain and species or both are the same if they have equal doubling time. Yet, both may be positively correlated.

Objectives of the Study

Specifically, the objectives of the study are:

(1) to determine the doubling time and relative growth rate of some *Azolla* strains or varieties, and

(2) to determine the correlation between doubling time and relative growth rate.

Importance of the Study

Although *Azolla* was described nearly 150 years ago, it is only in the past 20 years that the morphology, genetics, and biochemistry of the diazotrophic *Azolla-Anabaena* system have been meticulously studied (Scharpenseel and Knuth, 1987).

It is no wonder that until now, the symbiotic association is still poorly understood or that some phenomenon (e.g. evolution of the association remains to be further elucidated) of the system still puzzles researchers and scientists alike. This is the current situation inspite of advances in researches at the genetic or molecular level and biochemical level.

This study attempts to further our knowledge on the growth variability of some *Azolla* strains or varieties and tries to elucidate the correlation between doubling time and relative growth rate of *Azolla*.

Results of this study may be used for comparison to results or data obtained in earlier studies on doubling time under La Trinidad, Benguet climatic conditions, because similar species will be used for evaluation in this study.

Furthermore, anyone (e.g. agricultural estensionists and technicians, farmers) who may gain access to this research material will be guided as to which strain or variety of *Azolla* has faster doubling time and produce more biomass per unit area per time, which is appropriate in producing substrates for compost, feeds for livestocks, poultry and fish, weed suppression, and decontamination schemes.

Place and Time of the Study

The study was done at the College of Engineering and Technology, Mountain Province State Polytechnic College, Tadian, Mountain Province, Philippines from November 2003 to January 2004.

MATERIALS AND METHODS

Azolla Strains and or Species. Fourteen strains and or species of *Azolla* were evaluated for their doubling time and relative growth rate from November 2003 to January 2004. The strains were obtained from the Benguet State University Azolla Center and some farms in Mountain Province. The strains studied and their corresponding treatment labels are shown in the table that follows.

Azolla Medium. Each *Azolla* strain was grown in a small pail over an open area beside a building at Mountain Province State Polytechnic College—College of Engineering and Technology, Tadian, Mountain Province. The pail has an inner diameter of 18.5 cm and a depth of 15.0 cm. Five holes for water overflow were made with a four inch common wire nail, 2.5 cm from the brim and equidistantly around it. One kilogram of forest soil was put into each pail before water is poured into it to the level of the holes. The soil was mixed thoroughly with the water and left undisturbed for 24 hrs prior to inoculation with *Azolla*. The water used through-

(Continued on page 8)

Treatment	*Azolla* species and or strains	Place of Collection
A_1	*Azolla sp.*	Dadanupan, Tadian
A_2	*Azolla sp.*	Gonogon, Sabangan
A_3	*Azolla sp.*	Namsong Ambasing, Sagada
A_4	*Azolla sp.*	Ambasing, Sagada
A_5	*Azolla sp.*	Amyang/Lacbaben Otucan, Bauko
A_6	*Azolla sp.*	Dogodog, Tadian
A_7	*Azolla sp.*	Quisop Otucan, Bauko
A_8	*A. filiculoides* 1530	BSUAzolla Center
A_9	*A. mexicanca* 2010	BSUAzolla Center
A_{10}	*A. caroliniana* 3004	BSUAzolla Center
A_{11}	*A. microphylla* 4100	BSUAzolla Center
A_{12}	BSU 010	BSUAzolla Center
A_{13}	BSU 011	BSUAzolla Center
A_{14}	*Azolla sp.*	BSU Azolla Pond (Kapangan, orig,)

(Continued from page 7)

out the duration of the experiment was fetched from communal (forest spring) water and tributary headwater. Rainwater was also used since the experimental layout was not sheltered.

Climatological Data. The minimum and maximum daily air temperatures (°C) were determined using a minimum-maximum thermometer installed close to the experimental area but hidden from direct exposure to the Sun. This was used to validate recorded temperatures for air obtained at 7-8 a.m. and 1-2 p.m with a laboratory Mercury-in-glass thermometer installed alongside with the min-max thermometer, and for water temperature of the medium.

Water Sample Collection. Water sample was collected from the water tanks where the communal and tributary headwater were stored. Rainwater sample was collected when it rains during the growth period.

Water Analyses. Water analyses were done after sample collection. Phosphorus (mg/L) and potassium (mg/L) were analyzed following the Vanadomolybdophosphoric acid colorimetric method and flame photometer method, respectively (PCARR, 1980). Water pH was determined following the glass electrode method.

Daily water temperature (°C) was measured with a laboratory Mercury-in-glass thermometer at 7-8 a.m. and 1-2 p.m. of the day to get the morning and afternoon water temperature, respectively.

Soil Sample Collection and Preparation. A representative soil sample of the medium used was taken for analyses. The sample was evenly spread over an open plastic container lined with cellophane and air-dried for a week inside a laboratory room away from direct exposure to sunlight. Air-dried soils were pulverized and passed through a 2-mm copper mesh sieve before analyses. Collection and preparation of soil sample was done before the start of the experiment.

Soil analyses. The total soil nitrogen (%) was analyzed following the Modified Kjeldahl method (PCARR, 1980).

Soil phosphorus (ppm) was analyzed following the Bray No. 2 method; and ammonium acetate extractable potassium (ppm) was analyzed following the flame photometer method (PCARR, 1980).

Soil pH_{water} was determined with the potentiometric method (Anderson and Ingram, 1993) using water as the suspending solution in a 1:2.5 (w/v) soil/solution ratio.

Doubling time (D_t) and Relative growth rate (RGR). Three grams (± 0.1g) of each *Azolla* strain, blotted-dry on a paper towel, was inoculated to each pail and allowed to grow for 30-31 days/growth period; November to December was the 1st growth period and December to January was the 2nd growth period. The *Azolla* mat in each pail was harvested at the end of the growth period (30th or 31st day), blotted-dried on a paper towel, and the final biomass determined gravimetrically with a triple beam balance. Doubling time (d) and Relative Growth Rate (g/g/d) were calculated using the formula reported by Badayos (1989) and Hechler and Dawson (1995), respectively.

$$Dt = \frac{0.693\ t}{\ln\ Af/Ao}$$

where : A_f = final biomass
A_o = initial biomass
t = growth period

$$RGR_{1-2} = \ln mass_2 - \ln mass_1 / T_2 - T_1$$

Where:

RGR_{1-2} = mean relative growth rate from time 1 to time 2, expressed as g/g per day
$mass_2$ = mass at the end of the growth period
$mass_1$ = mass at the beginning of the growth period
$T_2 - T_1$ = time interval of the growth period

Statistical Design and Analyses. The statistical design followed was the completely randomized design (CRD) in four replicates. The experiment was laid out in an open area beside a building (Plates 1 & 2) with the treatments corresponding to each strain arranged randomly along each replication as shown on Figure 1.

An analysis of variance (ANOVA) table was constructed for both doubling time and relative growth rate. Means were tested following the Duncan's Multiple Range Test (PCARRD, 1985). Correlation between D_t and RGR of *Azolla* was analyzed following the simple linear regres-

(Continued on page 9)

Plate 1. Experimental layout without *Azolla* growing

Plate 2. Experimental layout with *Azolla* growing

Replication			
R1	**R2**	**R3**	**R4**
A3R2	A9R3	A7R2	A3R1
A3R4	A10R1	A11R3	A12R2
A1R1	A14R1	A2R2	A12R4
A10R3	A10R2	A8R2	A9R2
A7R4	A4R3	A4R2	A2R1
A1R4	A14R4	A6R2	A8R4
A11R2	A5R2	A9R1	A7R3
A8R3	A11R1	A2R3	A13R4
A11R4	A14R2	A5R3	A6R4
A2R4	A4R1	A13R2	A10R4
A14R3	A12R3	A12R1	A1R2
A5R1	A7R1	A1R3	A9R4
A6R3	A13R3	A5R4	A8R1
A4R4	A3R3	A13R1	A6R1

Figure 1. Experimental layout

(Continued from page 8)
sion (Ibid.).

RESULTS AND DISCUSSION

Soil and water Analyses. Both analyses of soil and water revealed that there was obvious deficiency of the primary nutrients (Table 1). Phosphorus for instance, the most common limiting element for *Azolla* growth, is required by *Azolla* to be at least 30 mg/kg – Olsen P (NAAP, 1988). The insufficiency of these elements especially phosphorus may have posed considerable limitations on the growth of *Azolla*, thereby affected both its doubling time and relative growth rate (Tables 2, & 3).

Water and soil pHs were at optimum for the growth of *Azolla*. It may have not been a limiting factor in the experiment. The optimum range of soil pH for *Azolla* growth is pH 4-7 (NAAP, 1988), while optimum growth of *Azolla* in culture solution is in pH range of 4.5-7 (Lumpkin, 1987).

Temperature. There was an apparent significant effect of temperature on the Dt and RGR of certain *Azolla* tested. Decrease on average afternoon (both air and water) and average minimum air temperature during the 2nd growth period apparently be-

(Continued on page 10)

	N (%)	P (mg/kg)	K (mg/kg)	pH_{water}
Soil sample	0.036	4.375	13.125	5.10
Levels in Soil	0.03-0.3% in many soils	0.05-0.1% total P in soil	0.15-0.40 m.e./100g soil critical value (0.15 m.e./100g soil)	
		P (mg/L)	**K(mg/L)**	**$pH_{(at\ 25°C)}$**
Rainwater		1.00	2.00	5.69
Tributary (tank)		2.00	0.96	6.90
Communal (tank)		1.20	1.88	6.49

Table 1. Soil and Water Analyses

(Continued from page 9)
came favorable to the growth of some *Azolla* under investigation, Treatments A1-5, A7, and A12-13 (Plates 3-10). This resulted to decreased Dt and increased RGR of the foregoing strains of *Azolla* (Tables 2 & 3, Figures 2-7).

On the other hand, Dt and RGR of treatments A6, A8-11, and A14 increased and decreased, respectively during the 2nd growth period (Tables 2 & 3, Figures 2-7). Most *Azolla* strains whose Dt decreased during the 2nd growth period were collected from Mountain Province and most strains whose Dt increased in the 2nd growth period were obtained from Benguet State University Azolla Center.

Though treatments A12 and A13 trace their origin from Mountain Province, it is inconclusive still to implicate that the strains of *Azolla* from Mountain Province investigated in the study favor temperature ranges 20-25°C and can tolerate a temperature of 15°C than those obtained from BSU Azolla Center, because treatment A6 was also taken from Tadian, Mountain Province.

The optimum temperature range in which most of the *Azolla* species grow well

(Continued on page 11)

Treatment (Place of collection)	**1st Growth Period Mean**		**2nd Growth Period Mean**	
A1- (Dadanupan, Tadian)	**44.3330**	a	**37.7554**	a
A2- (Gonogon, Sabangan)	**28.1185**	a	**22.8258**	a
A3- (Namsong Ambasing, Sagada)	**118.7754**	a	**49.3221**	a
A4- (Ambasing, Sagada)	**28.8085**	ba	**17.7856**	a
A5- (Amyang Lacbaben, Otucan)	**33.5351**	a	**20.0649**	a
A6- (Dogodog, Tadian)	**28.9508**	ba	**41.7218**	a
A7- (Quisop, Otucan)	**43.3105**	a	**24.4267**	a
A8- A. fliculoides 1530 (BSU Azolla Center)	**24.0834**	ba	**27.9549**	a
A9- A. mexicana 2010 (BSU Azolla Center)	**24.8401**	ba	**33.7216**	a
A10- A. coroliniana 3004 (BSU Azolla Center)	**27.1690**	a	**30.2465**	a
A11- A. microphylla 4100 (BSU Azolla Cen-	**24.9295**	ba	**29.0402**	a
A12- BSU 010 (BSU Azolla Center)	**73.6341**	a	**60.2977**	a
A13- BSU 011 (BSU Azolla Center)	**27.3793**	a	**25.5907**	a
A14- (Kapangan/BSU azolla pond)	**28.5553**	a	**34.7623**	a
Grand Mean	**39.7445**		**32.5369**	

Means followed by the same letter are not significant at α=5% for DMRT level of significance.

Table 2. Average Doubling Time (Dt) of *Azolla*

Treatment (Place of collection)	**1st Growth Period Mean**		**2nd Growth Period Mean**	
A1- (Dadanupan, Tadian)	**0.01660**	a	**0.01979**	a
A2- (Gonogon, Sabangan)	**0.02526**	a	**0.03113**	a
A3- (Namsong Ambasing, Sagada)	**0.00812**	a	**0.01655**	a
A4- (Ambasing, Sagada)	**0.02426**	a	**0.03917**	a
A5- (Amyang Lacbaben, Otucan)	**0.02072**	a	**0.03459**	a
A6- (Dogodog, Tadian)	**0.02402**	a	**0.01680**	a
A7- (Quisop, Otucan)	**0.01692**	a	**0.02937**	a
A8- A. fliculoides 1530 (BSU Azolla Center)	**0.02938**	a	**0.02570**	a
A9- A. mexicana 2010 (BSU Azolla Center)	**0.02989**	a	**0.02489**	a
A10- A. coroliniana 3004 (BSU Azolla Center)	**0.02555**	a	**0.02514**	a
A11- A. microphylla 4100 (BSU Azolla Center)	**0.02807**	a	**0.02426**	a
A12- BSU 010 (BSU Azolla Center)	**0.01255**	a	**0.01660**	a
A13- BSU 011 (BSU Azolla Center)	**0.02554**	a	**0.02830**	a
A14- (Kapangan/BSU azolla pond)	**0.02437**	a	**0.02009**	a
Grand Mean	**0.02223**		**0.02517**	

Means followed by the same letter are not significant at α=5% for DMRT level of significance.

Table 3. Average Relative Growth Rate (RGR) of *Azolla*

Plate 3. Treatment A1 (Dadanupan, Tadian)

Plate 4. Treatment A2 (Gonogon, Sabangan)

Plate 5. Treatment A3 (Namsong Ambasing, Sagada)

Plate 6. Treatment A4 (Ambasing, Sagada)

Plate 7. Treatment A5 (Amyang/Lacbaben Otucan, Bauko)

Plate 8. Treatment A7 (Quisop Otucan, Bauko)

Plate 9. Treatment A12 (BSU 010)

Plate 10. Treatment A13 (BSU 011)

(Continued from page 10)

is 22-25°C (NAAP, 1988). But, the direct effects of temperature to *Azolla* growth are not as serious as its indirect effects, because certain *Azolla* varieties or strains can survive at 40°C though their growth is retarded (Lumpkin, 1987; NAAP, 1988). Besides, Bandaay (2003) found that temperature gave no significant effect to Dt, albeit there was positive correlation between the two.

Doubling time and relative growth rate. Results of the study showed that the doubling time of the *Azolla* strains studied was very slow ranging from an average of 24d to119d for the 1st growth period and from an average of 18d to 60d for the 2nd growth period (Table 2). The National Azolla Action Program (1990) described that a Dt of 4-6d is fast, 7-9d – moderate, and more than 9 days – slow.

Siano (2001) and Bandaay (2003) reported Dts ranging from 9-12d and 12-22d in greenhouse or 6-18d in field condition in La Trinidad, Benguet, Philippines, respectively. Siano (2001) attributed the Dts determined to both availability of soil phosphorus and slight fluctuation in environmental temperature.

As earlier discussed, the growth of the *Azolla* strains studied could have been limited largely by deficiency of available nutrients and partly by temperature.

With the very slow Dt of the *Azolla*, it is not surprising that the RGR was also low, from an average of 0.008 g/g/d to 0.030 g/g/d for the 1st growth period and from an average of 0.017 g/g/d to 0.040 g/g/d for the 2nd growth period (Table 3). The grand means of the RGR for the 1st and 2nd growth periods were 0.022 g/g/d and 0.025 g/g/d, respectively.

Fiore and Gutbrod (1987) reported RGRs of 0.25 g/g/d in the field and up to 0.3 g/g/d in nurseries in Brazil. Both added that indigenous species of *A. caroliniana* and *A. microphylla* show RGRs of 0.2-0.3 g/g/d throughout the year under subtropical and tropical conditions.

Throughout the duration of the study,

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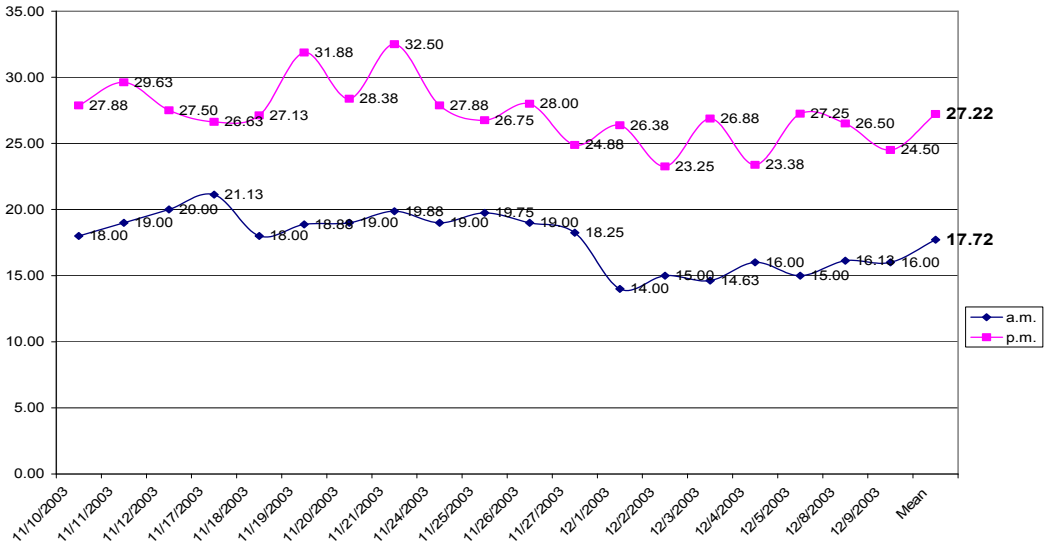
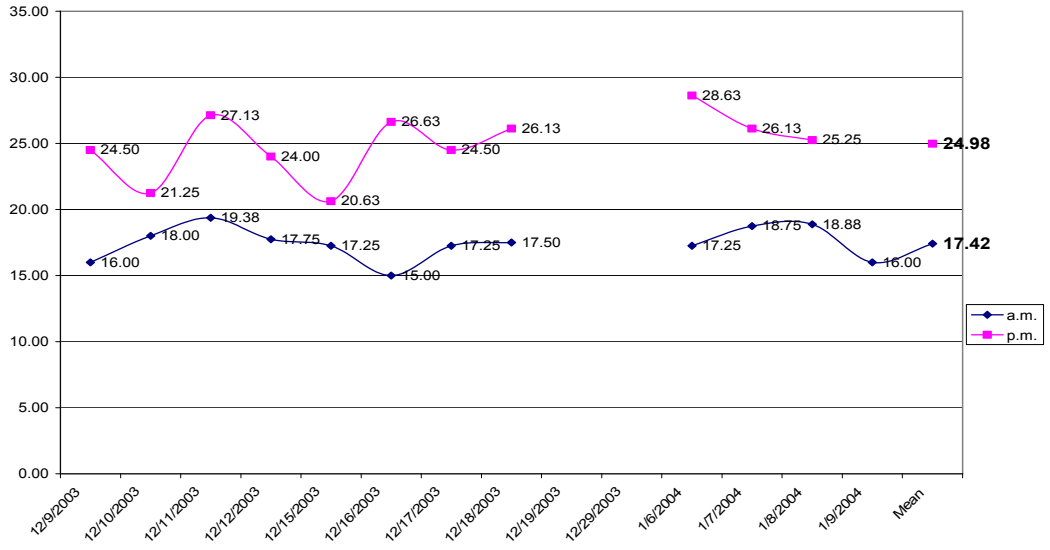


Figure 2. Water Temperature (°C) during the First Growth Period

Figure 3. Water T (°C) During the Second Growth Period



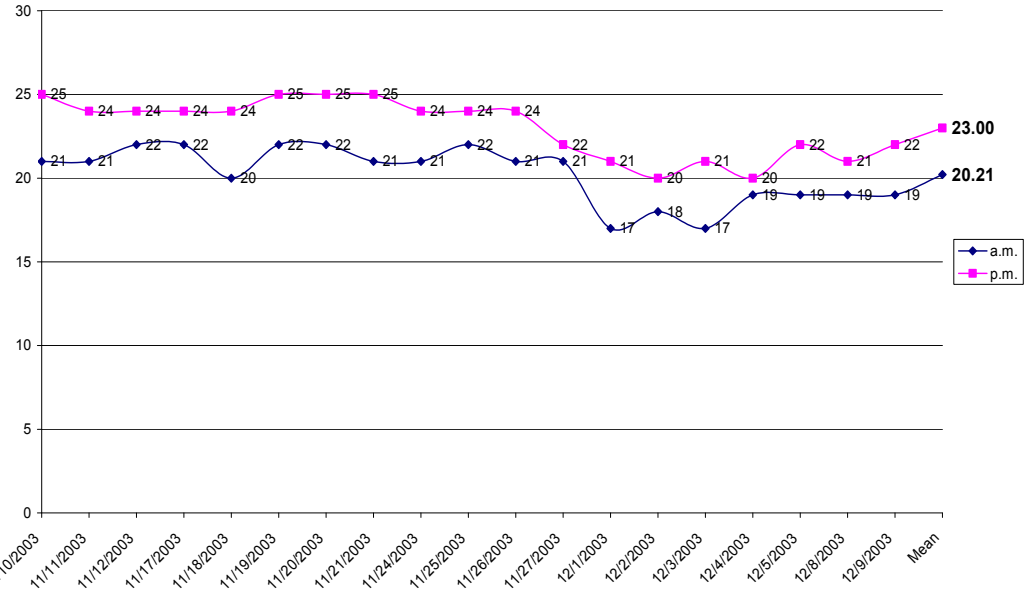


Figure 4. Air Temperature (°C) During the First Growth Period

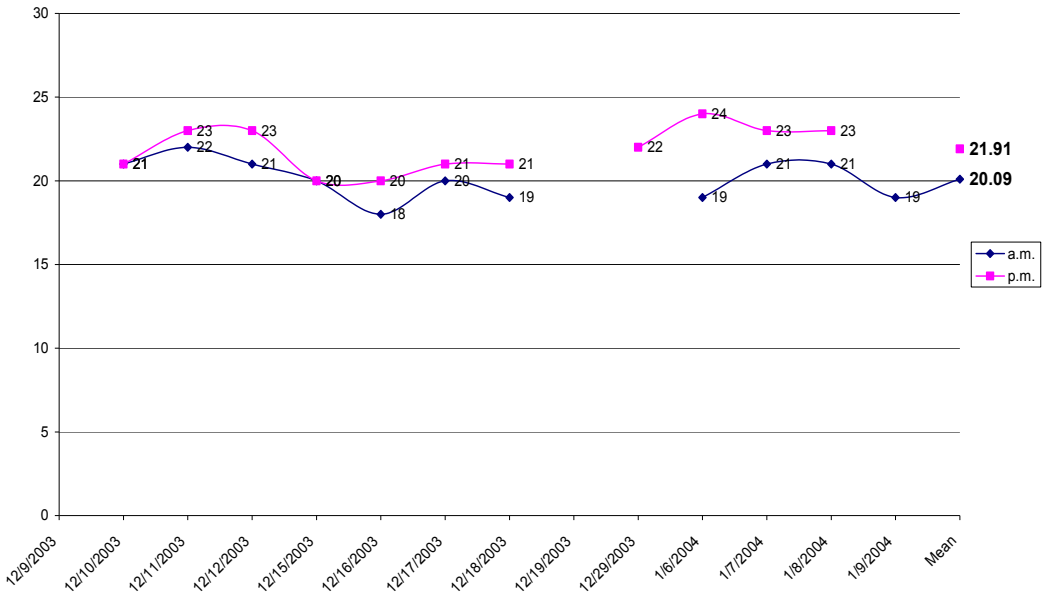


Figure 5. Air Temperature (°C) During the Second Growth Period

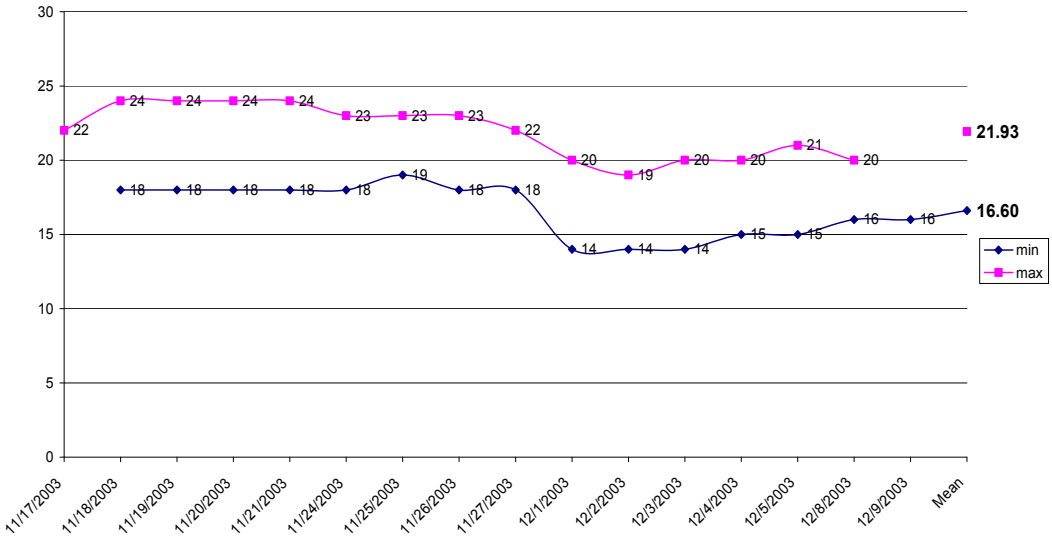


Figure 6. Minimum and Maximum Air Temperature (°C) During the First Growth Period

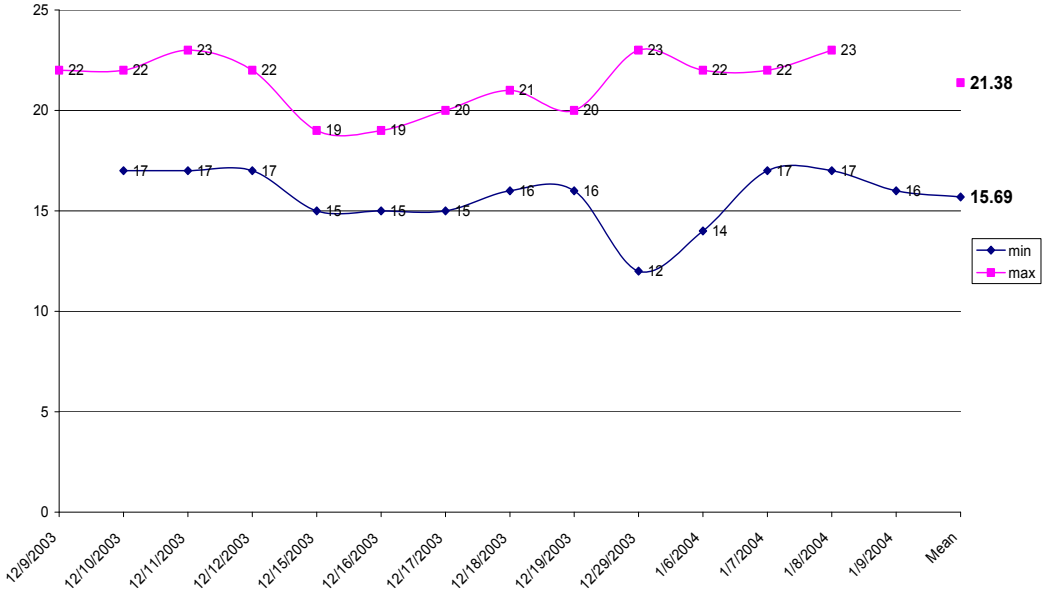


Figure 7. Minimum and Maximum Air Temperature (° C) During the Second Growth Period

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treatments A8 (*A. filiculoides*), A9 (*A. mexicana*), A10 (*A. caroliniana*), and A11 (*A. microphylla*) appeared to have better growth compared to the other treatments. Yet, there was no significant statistical difference among treatments as discussed below.

Statistical analyses on Dt and RGR. Analysis of variance on both Dt and RGR for the 1st and 2nd growth periods show that there were no significant difference among the treatments at 5% level of significance. Despite this, treatment means were tested with the Duncan's Multiple Range Test to validate results from ANOVA. The test on means showed no significant difference at 5% level of significance for DMRT.

Simple Linear Regression and Correlation revealed that RGR decreases with increasing Dt. This gave a linear but negative correlation between the two (Figures 8 & 9). However, a positive and nearly perfect correlation between RGR and the inverse of Dt was obtained (Figures 10 & 11). This means that RGR is directly proportional to the inverse of Dt, or stated otherwise, RGR is inversely proportional to Dt.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Soil and water analyses revealed insufficiency of nitrogen, phosphorus, and potassium for use by *Azolla* but the pHs were favorable for *Azolla* growth. Decrease in both air and water temperature including the minimum air temperature during the 2nd growth period seem to have favored the growth of some *Azolla* strains studied with a decrease in their doubling times and increase in their relative growth rates (A1-5, A7, A12-13). Recorded doubling time was very slow (24-119d for the 1st growth period and 18-60d for the 2nd growth period) and the relative growth rate was also low (0.008-0.030 g/g/d for the 1st growth period and 0.017-0.040 g/g/d for the 2nd growth period). Treatments A8 (*A. filiculoides*), A9 (*A. mexicana*), A10 (*A. caroliniana*), and A11 (*A. microphylla*) appeared to have better survival than the other treatments throughout the duration of the study. Statistically, there was no significant difference among treatments and treatment means. Relative growth rate and doubling time were negatively correlated; but, positive correlation was established between relative growth rate and the inverse of doubling time giving an inverse proportion between RGR and Dt.

Conclusions

1. *Azolla* growth, thereby Dt and RGR as well, were limited both by the medium and temperature.
2. Dt and RGR of all *Azolla* strains studied were very slow and low, respectively; and do not differ statistically.
3. RGR and Dt are inversely proportional; that is, RGR increases with lowering or decreasing Dt.

Recommendations

1. Since Dt and RGR of all *Azolla* strains tested were basically the same, any of the strains may be used in the practice of *Azolla* technology in Tadian, Mountain Province.
2. Reinvestigation of the findings of the study is recommended for verification and validation.

REFERENCES

ANDERSON, J. M. and J. S. I. INGRAM. 1993. Tropical soil biology and fertility: a handbook of methods. Wallingford, UK: C·A·B International, 2nd ed. 221p.

ARMSTRONG, W. P. 1998. A marriage between a fern and a cyanobacterium. –(http://Waynesword.palomar.edu/plnov98.htm.).

BADAYOS, R. B. 1989. Philippine *Azolla* extension program from 1982 to 1987. In: *Azolla*: its Culture, Management and Utilization in the Philippines. Los Baños, Laguna: National Azolla Action Program, pp. 275-282.

Figure 8. Regression and Correlation Between RGR and Dt for the 1st Growth Period

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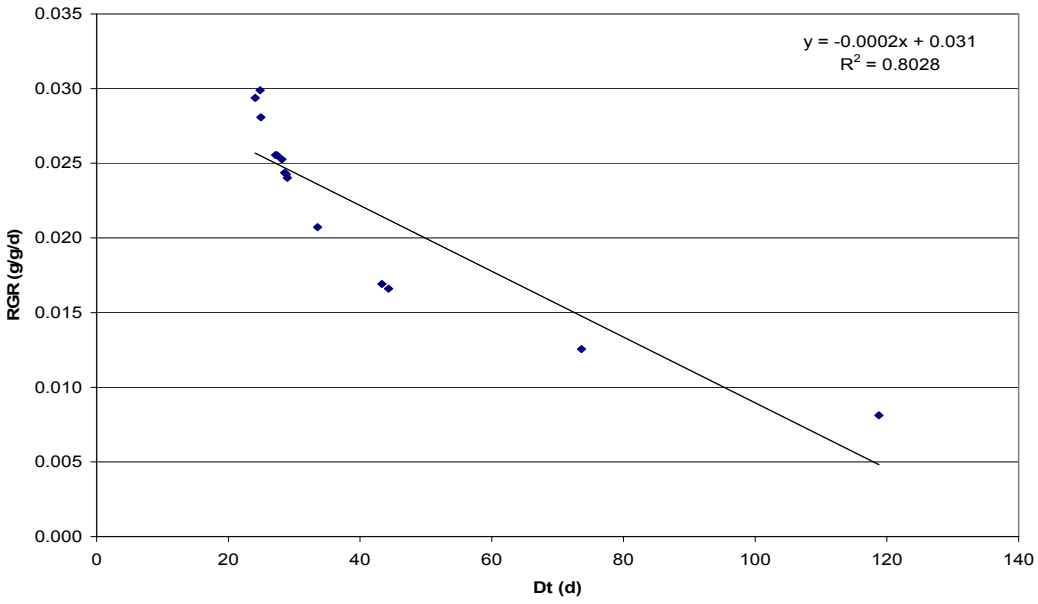

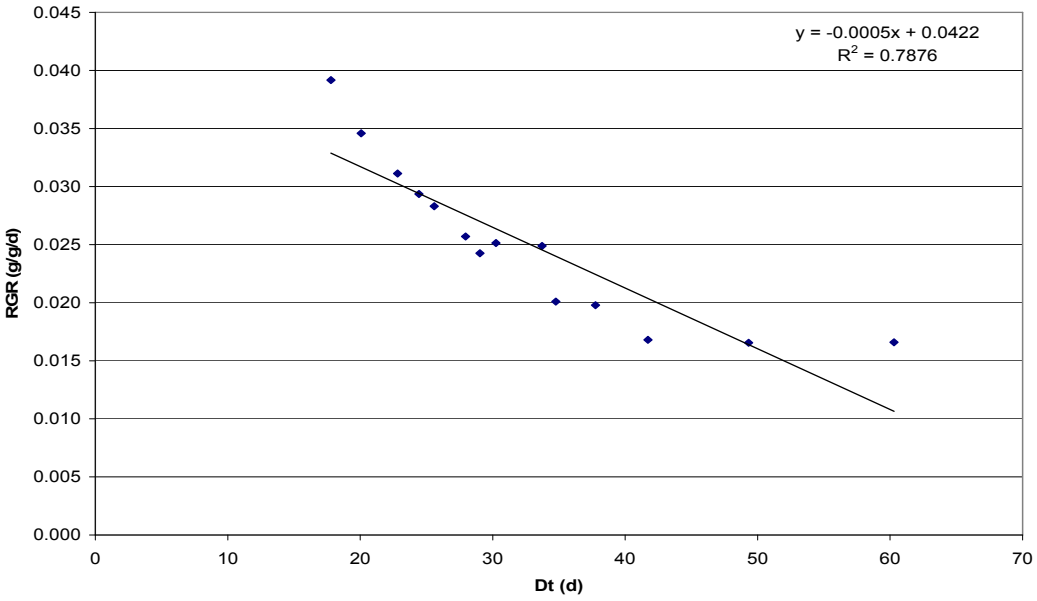

Figure 9. Regression and Correlation Between RGR and Dt for the 2nd Growth Period

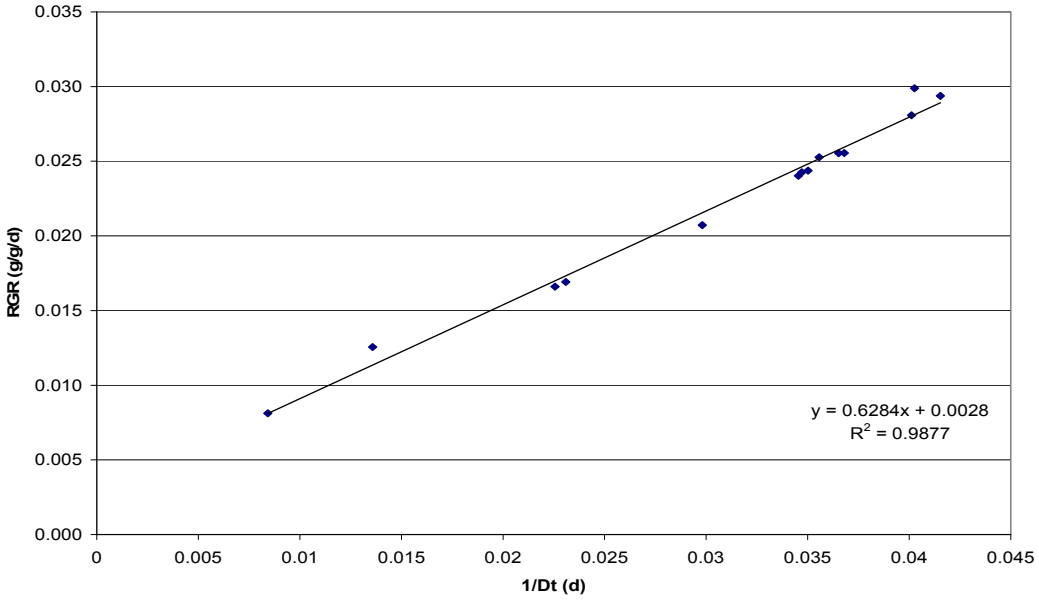

Figure 10. Regression and Correlation Between RGR and 1/Dt for the 1st Growth Period

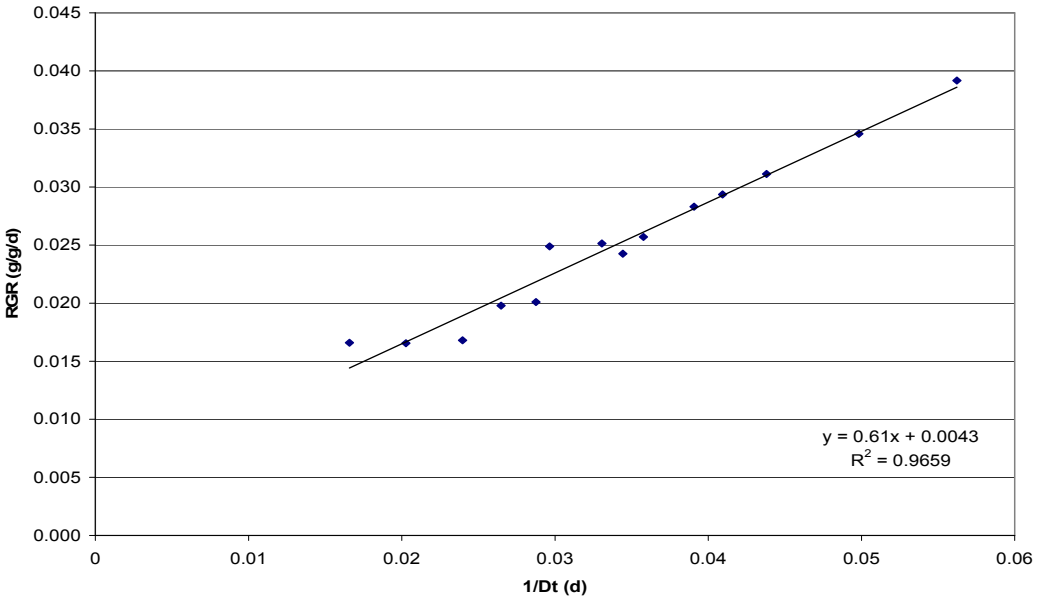

Figure 11. Regression and Correlation Between RGR and 1/Dt for the 2nd Growth Period

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BANDAAY, G. 2003. "Doubling time of some selected species and strains of *Azolla*." Undergraduate Thesis, Benguet State University, La Trinidad Benguet. 37p. –(Unpublished Thesis).

BERGERSEN, F. J. (ed.) 1980. Methods for evaluating biological nitrogen fixation. Chichester: John Wiley and Sons, Ltd. 702p.

BRADY, N. C. and R. R. WEIL. 1996. The nature and properties of soils. Upper Saddle River, New Jersey: Prentice-Hall, Inc., 6th ed. pp. 423-425.

BUCHANAN, B. B.; W. GRUISSEM and R. L. JONES. 2000. Biochemistry and molecular biology of plants. USA: American Society of Plant Physiologists. pp. 786-815.

COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES. 2000. *Azolla*; *Azolla* spp. CTAHR-University of Hawaii at Manoa. –(http://www2.ctahr.hawaii.edu/sustainag/azolla.htm).

COSICO, W. C. 1985. Organic fertilizers; their nature, properties and use. College of Agriculture, University of the Philippines at Los Baños: Farming Systems and Soil Resources Institute. pp. 21-23, pp. 134-136.

CROFT, J. R. 1986. Azollaceae. –(http://www.anbg.gov.au/projects/fern/aquatic/ azollaceae.html). [15 November 2002, last accessed.]

DARBYSHIRE, S. [n.d.]. Eastern mosquito fern invades Ottawa, Canada. Eastern Cereal and Oilseed Research Centre, Ottawa, Ontario K1A 0C6: Agriculture and Agri-Food Canada. –(http://res2.agr.ca/ecorc/staff/darbyshi/poster03_e. pdf).

FIORE, M. F. and K. G. GUTBROD. 1987. Use of *Azolla* in Brazil. In: *Azolla* Utilization: Proceedings of the Workshop on *Azolla* Use. Laguna: International Rice Research Institute, pp. 123-130.

GEBHARDT, J. S. and S. A. NIERZWICKI-BAUER. 1991. "Identification of a common cyanobacterial symbiont associated with *Azolla* spp. through molecular and morphological characterization of free-living and symbiotic cyanobacteria." Applied and Environmental Microbiology. 57 (8): 2141-2146.

HARDING, L. 2000. Effects of environmental factors on biomass. California State University @ Fresno. –(http://www.udel.edu/BLC/Harding/ 307.pdf).

HECHLER, W. D. and J. O. DAWSON. 1995. "Factors affecting nitrogen fixation in *Azolla caroliniana*." Transactions of the Illinois State Academy of Science. 88(3, 4):97-197. –(http://www.il-st-adad-sci.org/transactions/PDF/8811.pdf).

HERA, C. [n.d.]. Atoms for sustainable agriculture; enriching the farmer's field. –(http://www.iaea.or.at/worldatom/Periodicals/Bulletin/Bull372/hera.html).

INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES. 2003. Aquatic plant biology. Center for Aquatic and Invasive Plants, University of Florida. –(http://www.aquat1.ifas.ufl.edu/hoyapm4.html).

KAY, S. and S. HOYLE. 2000. Aquatic weed fact sheet. NC State University, College of Agriculture and Life Sciences, Crop Science Department. –(http://www.cropsci.ncsu.edu/aquaticweeds/factsheets/awfs009-00.HTM).

LADHA, J. K. and I. WATANABE. 1987. Biochemical basis of *Azolla-Anabaena azollae* symbiosis. In: *Azolla* Utilization: Proceedings of the Workshop on *Azolla* Use. Laguna: International Rice Research Institute, pp. 47-58.

LEJEUNE, A. 2001. Molecular aspects of akinete differentiation in the symbiotic cyanobacterium *Anabaena azollae*. Laboratory of Plant Biology, Catholic University of Louvain. –(http://www.area.fi.cnr.it/cyanofix/lejeune.htm).

LUMPKIN, T. A. 1987. Environmental requirements for successful *Azolla* growth. In: *Azolla* Utilization: Proceedings of the Workshop on *Azolla* Use. Laguna: International Rice Research Institute, pp. 89-97.

MABBAYAD, B. B. 1987. The *Azolla* program of the Philippines. In: *Azolla Utilization: Proceedings of the Workshop on Azolla Use.* Laguna: International Rice Research Institute, pp. 101-108.

NATIONAL AZOLLA ACTION PROGRAM. 1990. Growing *Azolla* from spores. College of Agriculture, University of the Philippines at Los Baños College, Laguna: NAAP.

NIERZWICKI-BAUER, S. A. and R. HASELKORN. 1986. "Differences in mRNA levels in *Anabaena* living freely or in symbiotic association with *Azolla*." The European Molecular Biology Organization Journal Online. 5: 29-35. –(http://emboj.oupjournals.org/cgi/content/abstract/5/1/29?…).

PACIFIC ISLAND ECOSYSTEMS AT RISK. [n.d.] Invasive plant species. –(http://www.hear.org/pier3/azpin.htm).

PAYAWAL, P. C. 1989. Biology of *Azolla*. In: *Azolla*: its Culture, Management and Utilization in the Philippines. Los Baños, Laguna: National Azolla Action Program, pp. 23-39.

POSTGATE, J. 1998. Nitrogen fixation. Cambridge CB2 1RP, United Kingdom: Cambridge University Press, 3rd ed. 112p.

POSTGATE, J. R. 1982. The fundamentals of nitrogen fixation. Cambridge CB2 1RP, Great Britain: Cambridge University Press. 252p.

QUEBRAL, N. C. 1989. Introduction to *Azolla* and its use. In: *Azolla*: its Culture, Management and Utilization in the Philippines. Los Baños, Laguna: National Azolla Action Program, pp. 5-19.

SCHARPENSEEL, H. W. and K. KNUTH. 1987. Use and importance of *Azolla-Anabaena* in industrial countries. In: *Azolla* Utilization: Proceedings of the Workshop on *Azolla* Use. Laguna: International Rice Research Institute, pp. 153-167.

SIANO, J. M. 2001. Study on the doubling time of four *Azolla* species (*A. filiculoides, A. mexicana, A. caroliniana, and A. microphylla*) under Benguet State University, La Trinidad, Benguet climatic conditions. 28p. –(Unpublished Paper).

SINGH, P. K. [n.d.]. National centre for conservation and utilization of blue-green algae. –(http://www.iaripusa.org/NCCUBGA.htm).

STEWART, R. M. and W. A. BOYD. 1999. The grass carp stocking rate model. In: Aquatic Plant Control Technical Note, MI-03. June 1999. –(http://www.wes.army.mil/el/aqua/pdf/apcmi-03.pdf).

TILO, S. N.; R. D. BONIAO; G. O. SAN VALENTIN and J. S. LALES. 1989. Soil fertility assessment and fertilizer use on *Azolla*. In: *Azolla*: its Culture, Management and Utilization in the Philippines. Los Baños, Laguna: National Azolla Action Program, pp. 139-166.

UNIVERSITY OF MINNESOTA. [n.d.]. Symbiotic Nitrogen Fixation; Soil 3612: Soil and Environmental Biology. –(http://www.soils.umn.edu/academics/classes/ soil3612/Symbiotic_Nitrogen_Fixation/Other.htm). [15 November 2002, last accessed.]

UNIVERSITY OF WISCONSIN. 1999. *Azolla filiculoides*—fairy moss (*Salviniaceae*). Room #4 The Tropical House, Botany Greenhouse, University of Wisconsin-Madison, Botany Department. –(http://botit.botany.wisc. edu/courses/tour/Roomfour-Az.html).

WATANABE, I. 2001. Azolla and its use. –(http://www.asahi-net.or.jp/~it6i-wtnb/azolla~E.html).

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Comments and Contributions:

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