# H_H0072: DAILY FLUCTUATION OF THALLUS WATER CONTENT AND SEASONAL CYCLE OF ATMOSPHERIC MOISTURE OF THE TRANSPLANTED LICHENS *Parmotrema* SPP. AND *Usnea* SP. IN THE TROPIC

Supranee Santanoo,*Kansri Boonpragob
Department of Biology, Faculty of Science, Ramkhamhaeng University, Bangkok 10240. Thailand
*e-mail: supranee4705@hotmail.com

**Abstract:** Lichens depend on atmospheric water, rain fog, dew and water vapor to activate metabolic activities. Their photosynthesis terminate when relative humidity is below 75-80%. Therefore lichens have low biomass production and slow growth rate. This study observed daily fluctuation of thallus water content of the transplanted lichens *Parmotrema tinctorum, P. gardneri*, *P. reticulatum* and *Usnea* sp., as well as microclimate of the transplanted habitats in 19 and 21 November 2008 at KYNP. Diurnal cycles of relative humidity in summer, rainy and cold seasons of the transplanted site were recorded periodically during 31 March 2009 to 30 April 2011. The study found that daily thallus water content of the three foliose lichens ranged from 11-44% dry weight, and the fruticose lichen was 17-45% dw. The lowest water content of the thalli occurred during 12-16 hour, when RH was 40-50%, and regain moisture to reach the highest quantity at 6 hr. when RH was above 90% during the night to early morning, 19 to 8 hr. However, nighttime relative humidity lower than 75 % resulted in maximum thallus water content of the foliose and fruticose lichens were only 19 and 22% dw. Whilst those of the humidity above 80% achieved 39% and 41%. Daily fluctuation of atmospheric, moisture during the three season revealed that RH lower than 80% occurred at 8, 9 and 11 hr. in summer, cold and rainy seasons, respectively. The result of this study will be used for proper treatment of watering time to enhance biomass production of lichens for sustainable utilization and conservation.

**Introduction:** Lichens are poikilohydric, which thallus water contents vary with atmospheric moisture. Their photosynthesis (Psn) and growth depend on water resources from the atmosphere i.e. fog,dew, atmospheric vapor and rain water.[1, 2] Lichen had low growth rate and low biomass production in nature. Their photosynthesis active about 3 hours after sunrise and terminate after thallus desiccate.[3]Pangpet and Boonpragob (2007)[4] showed that photosynthesis of lichen in the tropic decline when relative humidity is less than 80%.This is the main causes of slow growth of lichens. In the tropic average growth rates of crustose and foliose lichens are 2.23 and 4.4 mm./year.[5] While, Armstrong (1976)[6], Lange et al. (1986)[1] and Santanoo (2013)[7] reported that prolong wetting could increase photosynthesis period and growth of lichens. However, moisture absorbing capacity of lichen in natural habitat is not known in the tropic.

The objectives of this study were to observe daily fluctuation of water content of lichen thallus and diurnal cycle of atmospheric humidity in three seasons. We hypothesis that daily thallus water content of lichens of the same growth form, foliose thalli, are not different, and fluctuate with atmospheric moisture. Thalli of different growth form, foliose and fruticose, have different water content during the day.

**Methodology:**

*Lichens materials*

Four common lichens at Khao Yai National Park (KYNP), *Parmotrema tinctorum*, *P. gardneri, P. reticulatum* and *Usnea*SP. were collected from bark of trees in November, 2008. The first three species are foliose lichens which have slightly different morphology and the

last one is fruticose lichen. *P. tinctorum* has smooth lobe tip with isidia at central of thallus, whereas *P. gardneri* and *P. reticulatum* have marginal soredia scatter over the surface (Figure 1)

Fifty five healthy thallus fragments consisting of small thalli, diameters 2-3 cm., and large thalli, diameter 3-7 cm., of *P. tinctorum*, *P. gardneri* , *P. reticulatum* , and *Usnea* sp. were attached on nylon meshes in the field at KYNP (Khao Yai National Park) (table 1).

**Table 1.** Number of thallus fragments of lichens withand without asexual reproduction, small/large thalli used for transplantation.

| Lichen | Isidia/Soredia absent | | Isidia/Soredia present | | Total |
|---|---|---|---|---|---|
| | small thalli | large thalli | small thalli | large thalli | |
| *P. tinctorum* | 5 | 5 | 5 | 5 | 20 |
| *P. gardneri* | 5 | 5 | 5 | 5 | 20 |
| *P. reticulatum* | - | - | 5 | 5 | 10 |
| *Usnea* sp. | 4 | 1 | - | - | 5 |


**Figure1.** Four common lichens in natural habitat at KYNPA) *Parmotrema gardneri* B) *P. tinctorum* C) *P. reticulatum* and D) *Usnea* sp.

*Water content of thalli*

Thallus fragments were weighted every 1 hour by electric balance (Navigator Balance, USA) on 19, 21 November2008and microclimate was monitored during the same period. Dry weigh of thalli were measured after incubation at 65 °C, 24 hrs.

*Study site andmicroclimate*

Khoa Yai National Park, Nakhon Ratchasima province, Thailand is situated in the tropical region (14° 24' 52" N, 101° 22' 36" E), where high biodiversity and luxurious lichen flora could be found. Climate is under the influence of Asia monsoon, which is characterized by extremely wet and dry cycle.Heavy rainfall occurs during May to October, whilst dry period prevails during November to Mach.

Microclimate, air humidity, temperature and illuminationwas measured every 5 minute for 24 hours by using Licor-1400 (Licor Inc., Lincoln, Ne, USA)in every mid-season; summer 31-2 March 2009, 27-30 April 2011, rainy season 2-4 July, 5-9 August 2009 and cold season 19-24 January 2010, 10-16 January and 26-28 February 2011.

**Results and Discussion:**

*Relative humidity (RH) and water content of thalli*

Relative humidity of the lichen habitat averaged 72 %, (ranged 37-94%), mean temperature was 22 °C ranged from 17-34 °C during 19 and 21 November 2008 (Figure2A). Water content of the three foliose lichensduring the dry period averaged 13% dw. Duringhigh relative humiditymaximum water content of *P. reticulatum*, *P. gardneri* and *P. tinctorum* were 44, 43 and 42% of dry weigh, which werenot significant different ($P>0.05$)(Figure 2B). However, that of the fruticose lichen, *Usnea* sp., maximum water content was 45% dw, which was significantly higher than *P. gardneri* and *P. tinctorum* ($P<0.05$), except *P. reticulatum*.

Water absorption capacity of three *Parmotrema* spp. and *Usnea* sp. had similar pattern (Figure 3, 4). Thallus water content increased after relative humidity rise. However, low relative humidityof less than 75% the foliose and fruticose lichens absorbed moisture only 19% and 22% dw, which were much less those during high relative humidityof over 80%. This slightly increased in atmospheric moisture enable these lichens to absorb moisture up to 39% and 41% of dry weigh. Larson (1981) and Merinero (2014) showed that growth form and surface areas of thallus are a main driver for hydration traits.However, Nash III (1997) reported that water relation of lichen is controlled by thallus structure, anatomy and physical process.

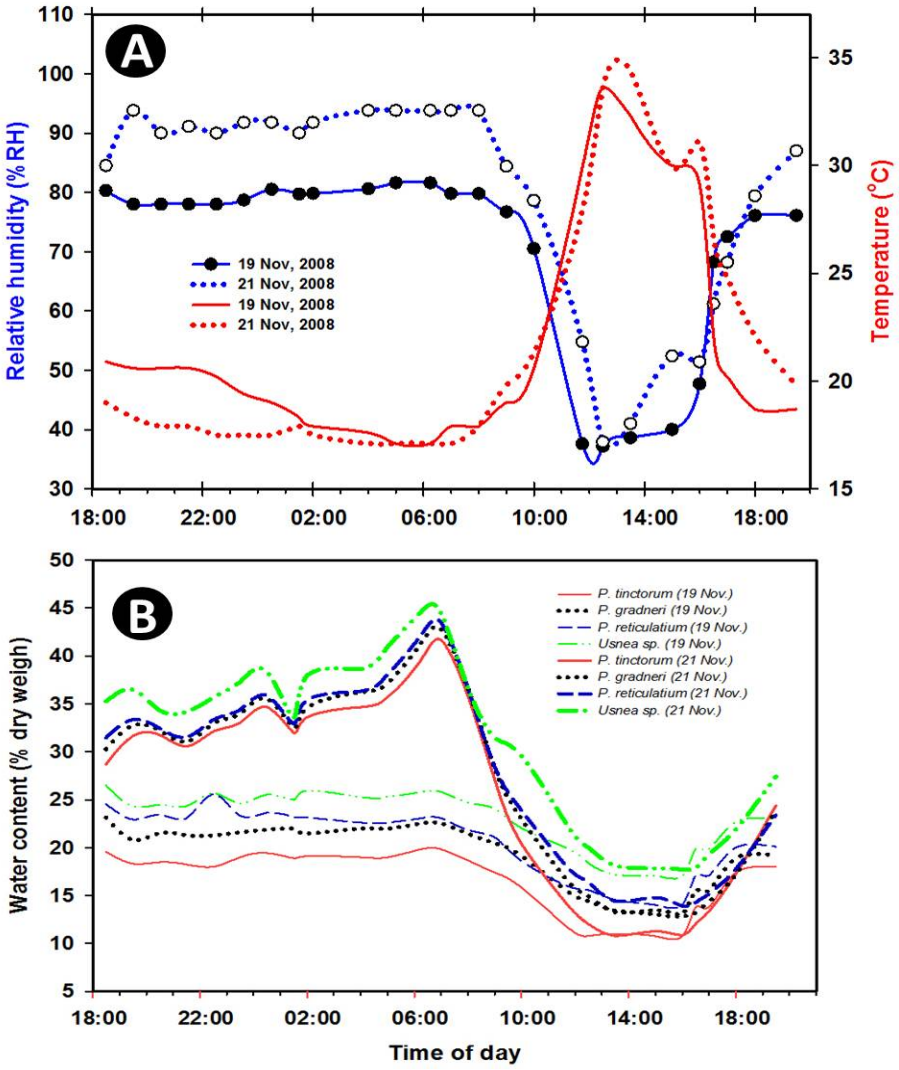


**Figure2.** Climate and water content of thalli during 19 and 20 November, 2008 A) Relative humidity and temperature and B) Water content of thalli fluctuated parallel with relative humidity all day

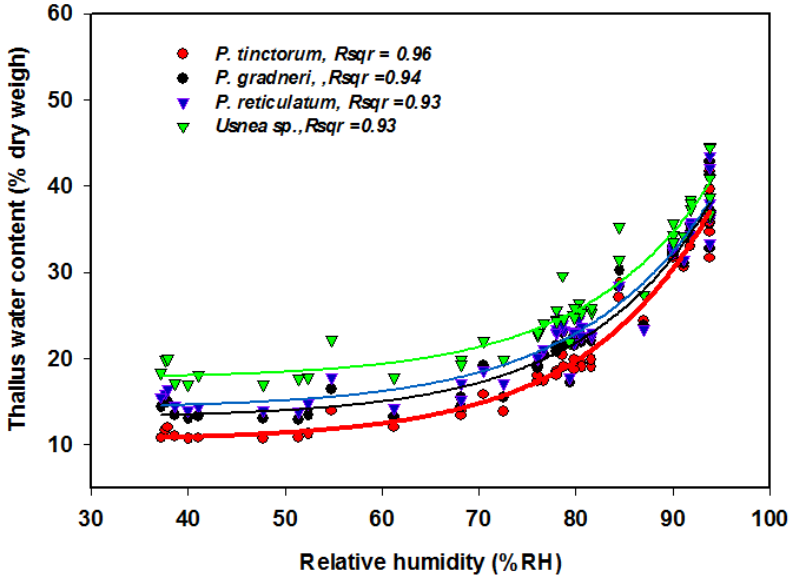


**Figure3.**Nonlinear regression of thallus water content and relative humidity of three *Parmotrema* species and *Usnea* species

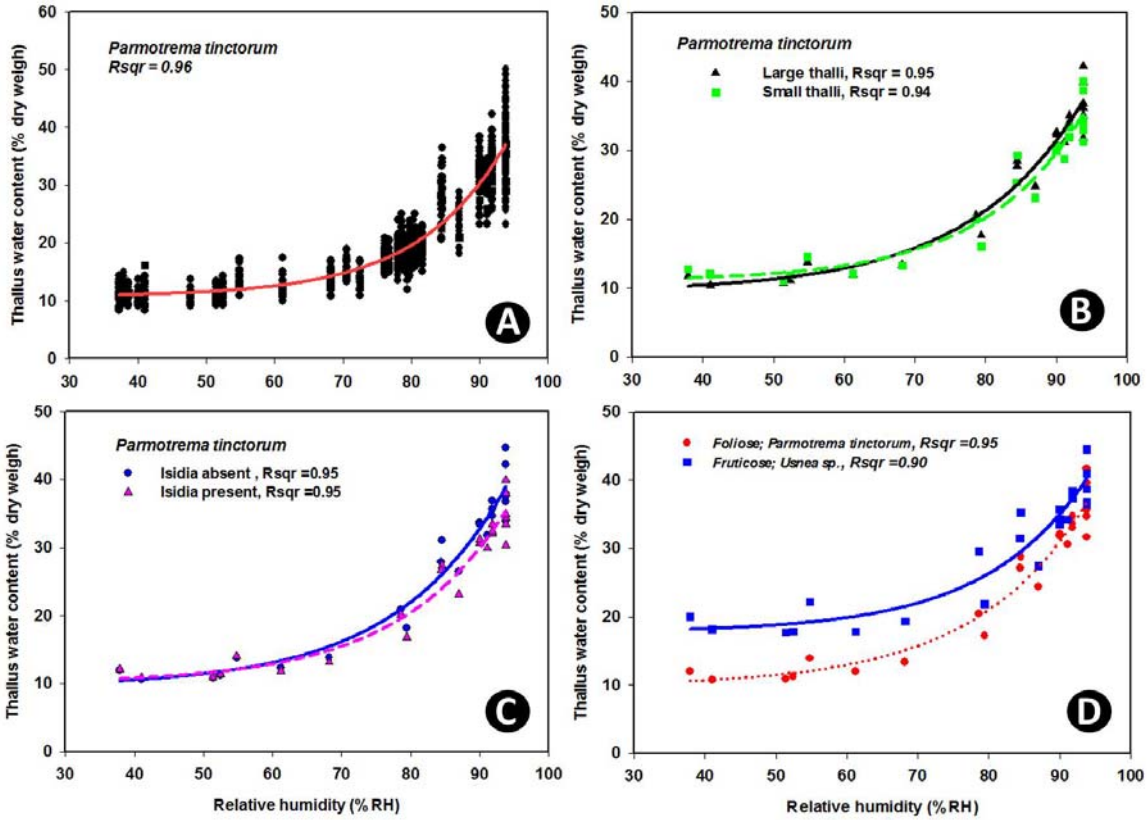


**Figure4.** Relative humidity versus water content of lichen thalli. *P. tinctorum* A) large and small thalli B) absent or present of isidia C) comparing with *Usnea* sp. D)

By absorbing moisture from the atmosphere the lichen *P. tinctorum*, achieved its maximum photosynthesis when, thallus water content is 55%[7], whereas *P. gardneri*, *P. reticulatum* and *Usnea* sp. are not known. Moisture absorbed from the air of all four lichens were much lower than the amounts need to achieve their maximum photosynthesis. Therefore, providing more water in proper time could enhance photosynthesis and growth. Santanoo and Boonpragob (2013) showed that prolong high humidity of the atmosphere by soil watering in early morning 7.00-7.15 a.m. could increase survival of lichens more than those without watering as much as 87%, and growth of thalli increased dramatically at almost triple.

Relative humidity, one of the most important factors for carbon assimilation of lichen, varied seasonally (Figure 5). Rainy season had the highest average RH of 86%, (ranges 61-96%), those of the cold season and summer were 82%, (41-91%) and 80% (42-94%), respectively.

**Conclusion**: The work concluded that RH over 80% is the threshold level of photosynthetic activity of most lichens. This level occurred before 8, 9, and 11 hr. in the cool, summer and rainy season. Beyond these time periods, lichens photosynthesis declined and enter inactive period. Therefore, providing additional water to the transplanted lichens right after the critical periods of each season could prolong photosynthesis periods, enhanced biomass production and growth of lichens.

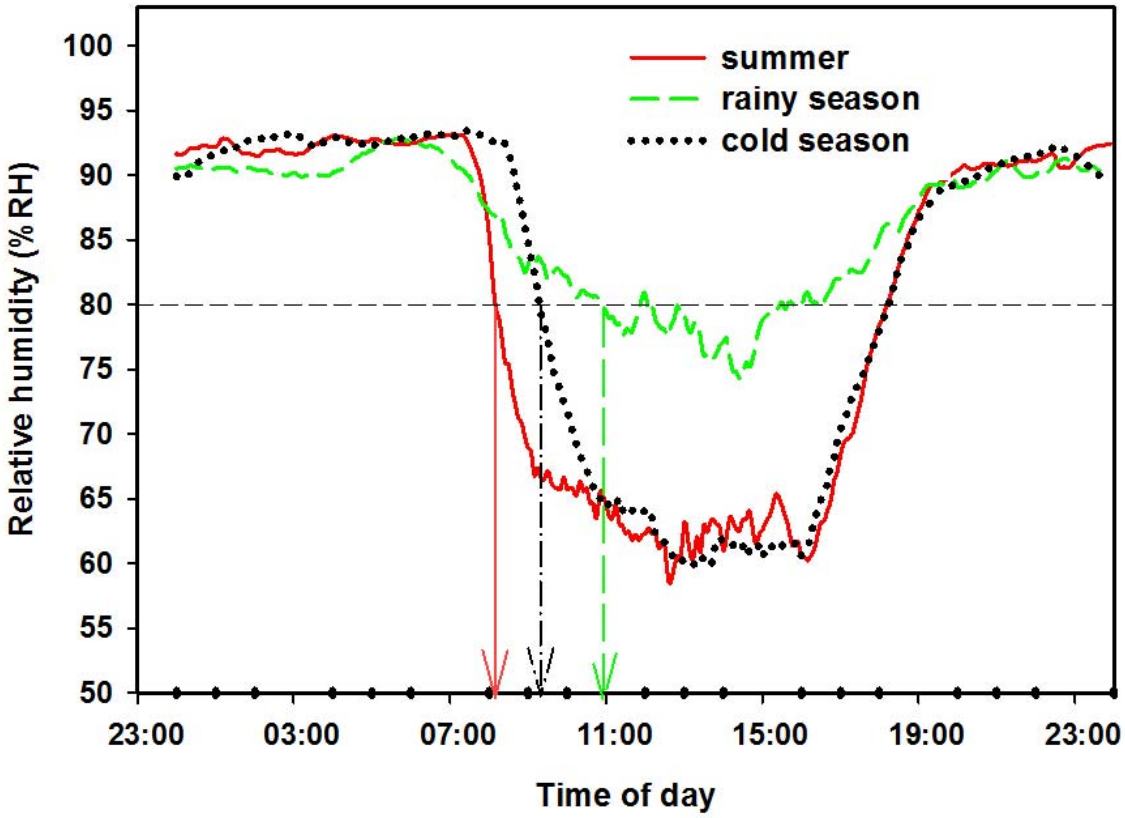


**Figure5.**Relative humidity at KYNP in summer, rainy season and cold season; the horizontal dash line is the threshold level of RH needed for active photosynthesis while vertical dash lines are approximate time of thallus dried out in summer (→), cold season (-·→) and rainy season (-->)

**References:**

1. Lange OL, Kilian E, Ziegler H. Oecologia. 1986;71:104-110.
2. Lange OL, Green AT, Heber U. JExp Bot. 2001;363(52):2033-2042.
3. Robert R, Hoftberger M, AllanG, Turk R. Flora. 2003;23:34-46.
4. Pangpet M, Boonpragob K. Proceedings of the 35th Congress on Science and Technology of Thailand. 2007;82.
5. Wannax B, Polyium W, Boonpragob K. Proceedings of the 33th Congress on Science and Technology of Thailand. 2010;61.
6. Armstrong AR. New Phytol. 1976;77:719-724.
7. Santanoo S. Master Thesis. University of Kalyani West Bengal, 2013.
8. Osathanon N. Master Thesis. Ramkhamhaeng University, 2002.
9. Larson DWB. The Bryologist. 1981;84(1):1-15.
10. Merinero S, Hilmo O, Gauslaa Y. Fungal Ecology. 2014;59-66.
11. Nash III T. Lichen Biology.Cambridge University Press, 1997.
12. Santanoo S, Boonpragob K. Thai J Bot. 2013;151-159.

**Acknowledgements:** We would like to thank the members of the Lichens Research Unit at Ramkhamhaeng University and the officers at Khao Yai National Park for their kind help in field works, the Royal Forest Department and Resource and Environmental Management Divisionfor the permission to collect data in the field. This work was supported by the Thai government.