ABSTRACT

EVALUATION OF *PYXINE COCOES* (SW.) NYL. (PHYSCIACEAE) AS A POTENTIAL AIR POLLUTION BIOMONITOR

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Air pollution anywhere in the world and its adverse impact to health is a major concern to various stakeholders. Reliable air quality monitoring and assessment are important to be able to set up strategies to at least mitigate deleterious impacts of air pollution if pollution sources cannot be eradicated at all. Conventional air sampling, while this affords setting up of standards, is not always available or practical. Biomonitoring for air pollution studies offers a simpler and cheaper approach which can either be used to support or as an alternative method to the conventional approach. Biomonitors that have been used for air pollution studies are tree barks, mosses, lichens and certain higher plants such as *Tillandsia*. Studies have shown that epiphytic mosses and lichens are more appropriate as air pollution biomonitors because these species take their nutrients only from the atmosphere. If the full potential of biomonitoring approach is to be utilized, however, the procedures optimized for the local or regional conditions are to be applied. To explore the potential of biomonitoring approach for the assessment of air quality in a tropical environment, local studies have to be done. A preliminary survey of potential air pollution biomonitors (specifically moss and lichens) was undertaken. This survey was in terms of availability and abundance of these species in the selected sites. This research found the lichen *Pyxine cocoes (Sw)* Nyl. to be ubiquitous in selected sites in Metro Manila and in two sites in Southern Luzon, Philippines. Subsequent potential air quality parameters were determined, based on the analysis of elemental levels in the samples of the lichen *Pyxine cocoes* (Sw.) Nyl by passive bulk sampling from a coal-fired power plant area (Calaca Power Plant or CPP). For comparative study, samples were also collected and analyzed from two traffic-oriented sites in Metro Manila (Parks and Wildlife or PW and Quezon City Mermorial Circle or QCMC). Air particulate matter (APM) elemental data of filter samples collected at the Ateneo de Manila University (ADMU) by conventional air sampling were also used for comparison. Elemental concentration levels are consistently highest for Ca, Si and Al in the lichen samples of the CPP site, and for Ca, Si and S for the lichen samples of the Metro Manila traffic-oriented sites. In contrast, elemental levels for the APM_ADMU samples were highest for S, Si and Na. Crustal materials (or the soil-related elements Al, Si, K, Ca, Ti, Mn and Fe) are well correlated with each other in the APM samples. For the lichen samples of CPP, Ca and K show poor correlations with each other and with the other five crustal elements, but correlations are good among these other five elements. The same poor correlations of Ca and K (with the addition of Mn with Ca, K and Ti in PW; and of Mn with Ca and K in QCMC) were also seen in the traffic-oriented Metro Manila sites. Comparison of the other correlations of the lichen elemental data was used to characterize two kinds of sites, coal-fired power plant area and a traffic impacted area. PW and QCMC show good correlation of Zn and Mn as expected from traffic-oriented areas while no correlation between these two elements was found for the CPP site. CPP show significant correlation of S and Al indicative of coal burning, compared to the poor correlation in the MM sites. Upon further comparison with the APM_ADMU elemental data, it is observed that good correlations of Pb and Br are seen for the lichen samples in all of the sites considered, but not with the APM sample. Resuspended soil is indicated as the most probable source of this residual correlation for Pb and Br in the lichen samples. Contour maps of these elements showed similar profiles. A comparative study with "baseline" levels (elemental

levels taken from unpolluted sites in Nepal, Kenya and the Alps in 1999-2001) showed higher elemental ratio in CPP lichen for Br compared to PW and QCMC, but lower ratios for Pb and Zn. Only for Mg and K were the ratios less than 1. Earth-related elements are higher in CPP while known anthropogenic elements such as Cu, Zn, Pb and As are lower in CPP. The most probable source of high Br is the pesticide methyl bromide sprayed in agricultural areas surrounding CPP. Comparative enrichment factors show that EF for Cl is consistently high for all the sites including that for the APM indicating that Cl is not coming from plant material. Chlorine can probably be an indication of the contribution from seaspray. Sodium data from lichens is not available for the confirmation of seaspray observation. EFs for Ca and P are consistently high for the lichens from all sites, but of no significant enrichment in the APM (ADMU). This observation indicates that Ca and P are lichen specific. The poor correlation of Ca with crustal materials further corroborates this observation. Factor analysis was used to determine elemental contribution sources for the lichen samples. A common factor is the contribution coming from the soil (Al, Si, Ti, V, Mn and Fe) and plant leaching (P, S and/or K). A high Cl factor (seaspray) is also seen in all the sites. All the three sites are impacted by the sea. Vehicular source factors are distinguishable in the traffic-impacted sites at PW and QCMC. A Ca Br dominated factor is also present in the lichen samples in all the sites, but only a Br (not correlated with Ca) dominated factor is exhibited by the APM_ADMU sample. Lichen samples were collected at different time periods, but clear-cut conclusions on time effects cannot be determined because of the nature of elemental incorporation in lichens being cumulative. The cumulative nature of elemental incorporation in lichens makes it difficult to obtain clear-cut conclusions on time effects even when the lichen samples were collected at different time periods. Further studies for time (or seasonal) effects can be done using active sampling and for the determination on which part of the lichen, whether the mycobiont or the phycobiont, accumulates elemental pollutants by using particle-induced x-ray emission (PIXE) spectrometer which can use tightly focused beams (down to 1 μm) capable of microscopic analysis.