

GREENING THE GREAT INDOORS FOR HUMAN HEALTH AND WELLBEING

Milestone Report No. 103 to HAL and NIPA HAL Project NY06021 January, 2008

Submitted by:

Prof. Margaret Burchett, Dr Fraser Torpy & Dr Jane Tarran,
Plants and Indoor Environmental Quality Group, Faculty of Science, UTS
Email: Margaret.Burchett@uts.edu.au

Note: This is the UTS scientific progress report for the project, which will be supplemented by a report from NIPA, industry sponsor/collaborator, on awareness-raising for industry and the community, and marketing strategies.

1. SUMMARY

1.1 Aims

The aims of the collaborative project (with respective responsibilities of UTS and NIPA indicated) are to:

- a) Investigate the ability of indoor plants to improve the health, wellbeing and productivity of office staff (UTS);
- b) determine the minimum numbers of plants that can be beneficial to both human health and indoor air quality (UTS);
- c) provide information on plant types and placement in offices for health promoting benefits (UTS);
- d) examine, via laboratory test-chamber studies, the capacity for removal of air-borne volatile organic compounds (VOCs) (a major class of indoor air pollutants) in at least two previously untested interior plant varieties (UTS);
- e) increase industry and public awareness of the health benefits of indoor-plants (UTS & NIPA) and develop a marketing strategy for their use in any type of building (NIPA).

Aims (a-c) involve a study of plants in UTS staff offices.

1.2 Delays

As mentioned in our previous Milestone Report, after lengthy delays with the proposal (over about 18 months) the Faculty of Science, UTS, received confirmation for this project from HAL mid-May, 2007.

1.3 Progress

Office study Planning for the office study has been completed, in consultation with other UTS colleagues and with NIPA, and plants will be installed in offices in the latter half of February, 2008. Fifty five offices will be used, with five treatments (ie, 11 replicate offices per treatment) being randomly assigned, over each of two experimental period of approximately 4 months each (ie, 110 sets of readings). The treatments are as follows: 0 plants (reference/control offices); 1 'floor' *Dracaena* 'Janet Craig' (300 mm pots); 2 floor *D.* 'Janet Craig'; 1 'desk' *Spathiphyllum* 'Petite' (200 mm pots); 3 desk *S.* 'Petite'. NIPA has undertaken the supply of plants and containers for the project.

The choice of species and plant numbers follows from the results of our previous office study on the effects of pot-plants on office air quality. The same two species and pot sizes were used in that study (but previously in greater numbers [3-6 pots per office]^{1,2}). In that study we found that the three planting treatments trialled were all equally effective, ie, they were all more than enough to reliably reduce indoor ambient loads of total VOCs to less than 100 ppb (ie levels regarded as negligible as a human health hazard).

In the current project a simultaneous study will be made of the effects of pot-plants on both office air quality and human wellbeing; such a study has never previously been undertaken. To study occupant wellbeing, participants will be asked to complete a series of questionnaire surveys several times during the two projected experimental periods. The internationally validated surveys have been selected in collaboration with UTS colleagues, Professor of Psychology, Dr Ashley Craig, and Lecturer in Design and Architecture, Ms Leena Thomas, who will be responsible for data handling and evaluation of survey responses. Surveys include questions relating to satisfaction with the indoor space; direct comments on the presence or absence of plants in the office; short- and long-term feelings of fatigue; general health parameters; factors affecting concentration; and mood indices. In December 2007 we obtained final approval from the UTS Human Ethics Committee for use of the surveys. We also have approval from the UTS OHS Unit and the Personnel Management Unit, to obtain anonymous, treatment-grouped, staff absentee records, which are needed in estimating any productivity benefits of the indoor plants.

Laboratory studies We have tested VOC removal capacity in two 'new' species (ie, which we have not previously trialled), *Philodendron* 'Congo' and *Sansevieria trifasciata*. Six replicate specimens of each were used, in 200 mm pots, in the same sealed perspex bench-top test chambers (60x60x60 cm; 216L) as we used in previous studies². Benzene was selected as the test VOC, since it is a very common urban air pollutant, derived from sources both outdoors (from fossil fuel emissions) and indoors (as component in synthetics/plastics); it is also a confirmed carcinogen. Three consecutive doses of 5 ppm benzene were administered, to ensure full induction of the removal response at that dosage. Finally, a 25 ppm dose was applied, to test the capacity of the pot-plant system to respond to increases in VOC concentration. With each species, the initial dose took several days to eliminate, however, by the third 5ppm dose, each species showed full induction of VOC removal capacity, the benzene dose being reduced to nearly zero within about 24 hours. Both species also responded to the subsequent, 5-fold higher dose, it being again removed in little over 24 hours. The 5 ppm dose is equal to the maximum allowable, 8-hour averaged, occupational air-borne exposure level in Australia³, and is therefore much higher than would be found in office environments normally (unless in a factory using the solvent, a garage workshop, etc). However, the results also showed that, with each species, the system could remove remnant, very low VOC concentrations effectively to zero (ie, below detection limits of the gas chromatograph: < 20 ppb). Our previous studies have demonstrated that it is the microorganisms of the potting mix that are the main agents of VOC removal, the role of the plants in the process being the establishment and maintenance of their root zone microorganism community (a symbiotic microcosm). The results indicate that these two pot-plant species show exactly similar patterns of response as the nine species previously tested in this laboratory. This is, they would be equally as useful as the species previously tested, in reducing indoor VOC pollution.

2 NEXT STEPS

2.1 Office study

We are in the process of interviewing staff in the Faculties of Science and Design, Architecture and Building, in two or three buildings on the central campus of UTS, seeking their participation in the office study. We already have a number of volunteers, but many staff are involved in summer excursions, research field trips, or on vacation, until the end of January.

2.2 Laboratory studies

The next species for laboratory testing, agreed with NIPA, is *Chamaedorea elegans*. However, the setting up of the office study, and the initial testing and survey administration etc. will occupy the research team fully for a couple of months. A routine should by then have been established, at which stage it should be possible to conduct the next laboratory experiment.

3.COMMUNICATIONS/EXTENSION ACTIVITIES

3.1 Scientific conference presentation

Two team members (FT, JT) attended the international Conference on Indoor Air Quality (*IAQVEC*) in Japan in October (supported by other research funds), presenting a paper and poster on previous findings and research in progress^{4,5}.

3.2 Activities with NIPA

NIPA Training and Information Day Seminar Program

The event was held in the Faculty of Science Building at UTS, on 24th October, with the title 'Green Earth – Green Plants', the guest presenter being Ms Kathy Fedew, interior plant horticulturist and author from Houston, Texas. Our team presented a research update on indoor plant benefits and a NIPA/HAL project progress report, and participants received A4 copies of the wall poster presented at the Japan conference.

Reports for NIPA

Legionella report At the request of NIPA, and as an ancillary issue to the current project, we presented a report of a literature review on the risk of any drainage water in receptacles beneath indoor-plant pots as a potential cause of Legionnaire's disease⁶. (Two of our team (FT, JT) are plant-and-soil microbiologists/pathologists.) The literature search showed clearly that it would be highly improbable that the disease could ever be associated with this particular source. Any ephemeral pools of water in receptacles would be too tiny, disparate and cool for significant numbers of *Legionella* bacteria to be present. Such water would also be in too still and non-turbulent a position for any aerosols to be formed, which are a prerequisite for inhalation of the *Legionella* bacteria. The Report was placed on the NIPA website.

Research update We presented a research update to NIPA in December, 2007, also now published on its website⁷.

4/5.Any additional Commercialisation/IP or Other Issues

Nil

References

1. Wood RA, Burchett MD, Alquezar R, Orwell RL, Tarran J & Torpy F, 2006, The potted-plant microcosm substantially reduces indoor air VOC pollution: I, Office field-study, *Water, Air and Soil Pollution* 177, 163-180.
2. Orwell RL Wood RA, Burchett MD, Tarran J & Torpy F, 2006, The potted-plant microcosm substantially reduces indoor air voc pollution: II, Laboratory study, *Water, Air and Soil Pollution*, 177, 59-80.
3. NOHSC (National Occupational Health and Safety Commission)(Australia): 1995, Exposure Standards for atmospheric contaminants in the occupational environment: guidance note on the interpretation of exposure standards for atmospheric contaminants in the occupational environment [NOHSC: 3008, (1995)] and 'Adopted national exposure standards in the occupational environment', [NOHSC: 1003, 1993], Aust. Gov. Pub. Serv., Canberra, ACT.

(b)From current research

4. Tarran J, Torpy F & Burchett M, 2007, Use of living pot-plants to cleanse indoor air – research review, Proceedings of 6th International Conference on Indoor Air Quality, Sendai (Japan) Oct 28-31; Vol 3, 249-256.
5. Torpy F, Tarran J & Burchett M, 2007, Using living pot-plants to clean indoor air, 6th International Conference on Indoor Air Quality, Sendai (Japan) Oct 28-31, Poster presentation.

6 .Legionella report details??

7. Burchett M, Torpy F & Tarran J, Dec 2007, *Use of living pot-plants to cleanse indoor air – research update*; Report to NIPA for publication on website.