RESPONSE

Errata

- A formula was incorrectly printed in "A Method to Increase Control Efficiencies of Wet Scrubbers for Submicron Particles and Particulate Metals," by Jinjun Sun et al. on page 184 of the February 1994 issue. The correct text and formula should read: For a stationary water droplet situated in a relatively large control volume of supersaturated water vapor, droplet growth rate can be expressed as:

$$\frac{dD_p}{dt} = \frac{4DM\,(P_o - P_s)}{\rho_p - RTD_p} - \frac{2}{3}\,\pi\,D_p^2 ND$$

- A sentence was misstated on page 198 of the February issue in the article titled "1993 Update of the U.S. Environmental Protection Agency's SITE Emerging Technology Program." The first sentence in the section on International Technologies incorrectly reads "IT Corporation has develpoed the Eimco Biolift slurry reactor..." The sentence should read "IT Corporation has utilized the Eimco Biolift...".

Response

Editor:

The Journal of the Air & Waste Management Association has been duped! The cover photograph as it appears on the August 1993 issue and the accompanying description of the photo as it appears on page 1051 is of mortality of Fraser fir [Abies frasen (Pursh.) Poir.] as directly caused by the balsam wooly adelgid (Adelges piceae. Ratz.) The scene of devastation has no scientific foundations in the cause being within the realm of acidic cloud water and/or air pollutants in general. The suggestion that the widespread death of high elevation spruce-fir forests of the Southern Appalachians is due to "A complex interaction of a variety of biotic and abiotic stress factors, including air pollution..." has been offered in obvious ignorance of the direct cause of the death of the photographed trees being due to an insect which kills slowly but very efficiently. Note the young green trees coming up through the understory and the standing live red spruce (Pecearutens Sorg.) which are not attacked by the adelgid. Red spruce comprises only eight percent of the stand at these high elevation sites and thus the death scene is of Fraser fir killed by the adelgid.

The photograph has been published with direct connection to the article "Chemical Dynamics of Clouds at Mt. Mitchell, North Carolina" by V.P. Aneja and D.S. Kim within the issue. Thus, I must assume that they volunteered the print for your consideration as a cover photograph to accompany their feature article. The cover photograph could not have been more misleading to the readership of our journal. I am certain that many young scientist members who would not have the biological/forest protection backgrounds to know the difference have accepted the visual connection of supposed forest devastations to the article by Aneja and Kim. This is fraudulent science at best.

Please note that I have not criticized the article by Aneja and Kim nor would I be able to seriously do so as a forest pathologist/air pollution forest effects specialist. The article offers abundant and well summarized data on cloud water chemistry and for all intents and purposes may be an exceptional contribution to our understanding of these important phenomena. In truth it appears to be very well written. But also note that the authors make absolutely no cause and effect connections within their article to the scene depicted on the front cover of the Journal. Indeed no citations descriptive of the decline scenario nor the known direct cause being long term adelgid activity appear in the article. Furthermore, the authors do not even attempt to place the collected data on cloud chemistry into an ecological perspective. The article does not relate to the photograph in any manner other than an ill-founded and highly emotional manner.

It is difficult to perceive that the authors are unaware of the devastating effect that the balsam wooly adelgid has had on the spruce-fir forests of their study area. It is likewise difficult to accept that they and at least one of the reviewers acknowledged at the end of the article should be so ill-informed of this well described and scientifically accepted phenomenon; scores of citations have been selectively ignored.

The forest science community should be concerned, upset, and perhaps even angered at the continuing attempts of a few to insist that our forests are dying as depicted because of cloud water chemistry. Using this deceptive approach in the 1920s and 1930s it would have been appropriate to publish photographs of the devastation of the great American Chestnut by an introduced fungus and still make claims of an association with exposures to air pollutants on a regional scale basis. Balderdash!

The environmental engineers and industries who have dedicated a large portion of their professional careers and financial resources, respectively, towards the development of the best available pollution control technologies should likewise be angered over this continuing nonsense. Shame on us who know better about our current healthy and productive forests for not speaking up sooner and perhaps louder over these past 10 to 20 years. Environmental emotionalism has no place in science. Such scare tactics should be stopped lest we all become known as the chicken littles and the wolf criers of our scientific and environmental engineering communities.

The journal editors should possibly have caught the non-connection of cause-effect relationships between the article of Aneja and Kim and the cover photograph depicting dead trees. But, of course, depending upon their own areas of expertise they may be the equivalent of lay-persons in the specific field of air quality management and truthful forest (biological) effects. Unfortunately the "damage" is done and this letter will only appear in part (or perhaps in its entirely?) in a following issue. A real pity.

John M. Skelly
Penn State University

Authors' Reply

Editor:

Dr. Skelly takes issue with the photograph submitted (at the request of the editor) with the article by Aneja and Kim (1993) and that was subsequently used as the cover photo for the August 1993 issue of this journal. The implication of Dr. Skelly's remarks is that there was a purposeful attempt by the authors to dupe this distinguished journal and deceive its readers. We wish to respond to these accusations and also comment on the questionable if not overly-simplified logic in Dr. Skelly's letter.

In the caption supplied with the photo is the statement that "A complex interaction of a variety of biotic and abiotic stress factors, including air pollution, is responsible for the disease and injury to forest trees." The inclusion of the term "biotic" was in reference to the adelgid as well as to the other biological agents (e.g. the Ghost moth) that are associated with spruce-fir decline in the eastern U.S. It is true that the adelgid is a major factor that has resulted in mortality of thousands of acres of fir in the high elevations of the

southern Appalachians. It is also true that these forests are currently experiencing growth limiting stresses attributable to the high levels of acidic deposition that is derived primarily from industrial pollution, as reported in the article by Aneja and Kim. While it is not known whether acid deposition has enhanced the fir damage from the aphid or not, there is cause to question that the two are totally independent as Skelly asserts. A major multidisciplinary, multi-institutional study funded by the NAPAP Forest Response Program has recently concluded that acidic deposition has been a significant factor influencing the decline of red spruce in the eastern Appalachian Mountains (Eagar and Adams, 1992). Fraser fir is the codominant tree species (with red spruce) occupying high elevations in the Southern Appalachians. This study is careful to conclude that acid deposition is not the only factor involved, because of forest response to the natural environment. While it is premature to conclude that acid deposition predisposed Fraser fir to fatal attack by the adelgid, it is also not sound science to assert that they are unrelated. There is no strong evidence to support that view and there is some evidence to the contrary. As a forest pathologist, Skelly should know that most tree diseases are caused by a complex factor which gradually weaken the host until successful defense is no longer possible. Evidence from several sources indicates that Fraser fir has undergone similar recent reductions in growth rate, and shifts in nutrient availability which have unfavorably affected red spruce during the last few decades. It would be illogical to think that a similar species occupying the same ecological niche had not experienced similar stresses.

Since the nature of these stresses was not discussed in the article by Aneja and Kim, nor by Dr. Skelly, we think it germane to this discussion to provide a brief review of the types of stresses that have been observed due to exposure to acidic cloud water. Johnson et al. (1992) and DeHayes (1992) have summarized the evidence that winter hardiness has played a major role in the decline of red spruce in the North. DeHayes et al. (1991), based on research at Whitetop Mt. in Virginia, demonstrated that ambient cloudwater exposure significantly reduced the winter hardiness of red spruce foliage. McLaughlin et al. (1991, 1992), Van Miegroet et al. (1992), and Joslin and Wolfe (in press) have all demonstrated positive growth and/or physiological responses to fertilization of red spruce trees in the southern Appalachians with calcium. Calcium is an important nutrient in many types of plant defenses against disease and other stresses, and it is susceptible to leaching from plant tissues and from forest soils exposed to high levels of acidic deposition. Recent fertilization results (Joslin and Wolfe, in press) strongly indicate a calcium and/or zinc deficiency in mature red spruce. Studies are currently underway to evaluate the role of calcium in the current health of Fraser fir at these high elevations.

The mechanisms leading to calcium (and other base cation) losses from foliage have been demonstrated in both field and laboratory studies. Increases in foliar leaching with the acidity of mist has been repeatedly demonstrated. Most recently, Thornton et al. (in press) have demonstrated that needle calcium, magnesium and zinc concentrations were reduced by exposure to ambient cloudwater at Whitetop Mt. Leaching of base cations is now known to be proportional to the fluxes of strong acid anions through the soil. Joslin and Wolfe (1992) have reported significantly higher concentrations of nitrate and aluminum (lower calcium: aluminum ratios) in soil solutions at a high cloud deposition site compared to a low deposition site. The correlation between elevated concentrations of aluminum in soil solution with strong acid anions is well known in areas that receive acidic deposition (Robarge and Johnson, 1992). These observations are not the results of a few, as asserted by Dr. Skelly, but are typical of the continuing research into the effects of acidic deposition on forest ecosystems by members of the forest science community both here in the U.S. and in Europe.

The photograph submitted at the request of the editor of this journal is representative of the decline and widespread death of high elevation spruce fir forests in the southeastern Appalachians. Perhaps the word "adelgid" should have modified the reference to biotic stress factors, but scenes as bad or worse are readily apparent in the high-elevation forests of the northeast with no adelgid damage. We find the assertion by Skelly that the wooly adelgid is solely responsible for the damage shown on Mt. Mitchell and that acid deposition is not in any way involved a dangerous oversimplification of an issue that is at least as complex as forest growth itself. This logic is representative of the early days of the Forest Response Program when individuals still clung to the notion that a single agent or single mechanism must be responsible for the observed decline. The forest science community has progressed much beyond this. It is now recognized that the visual expression of the results of continuous input of anthropogenic agents like acidic deposition into ecosystems must be the result of a complex interaction of a variety of biotic and abiotic stress factors. Only with this understanding will we be able to elicit through careful research, the actual mechanics at work in these stressed ecosystems. Only with this understanding can we avoid the simplified adversarial relationship exposed by Dr. Skelly and truly evaluate the effectiveness of available pollution control technologies both in terms of their cost to industry and society and their benefit to our natural environment.

V.P. Aneja, W.P. Robarge
North Carolina State University

J.D. Joslin
Tennessee Valley Authority

S.B. McLaughlin
Oak Ridge National Laboratory

References

1. V.P. Aneja, D.S. Kim, *J. Air Waste Manage. Assoc.* **43**:1074 (1993).
2. D.H. DeHayes, "Winter injury and developmental cold tolerance of red spruce," in *Ecology and Decline of Red Spruce in the Eastern United States*, C. Eagar, M.B. Adams, Eds., Springer-Verlag, New York, 1992.
3. D.H. DeHayes, F.C. Thornton, C.E. Waite, M.A. Ingle, *Can. J. For. Res.* **21**:1292 (1991).
4. C. Eagar, M.B. Adams, Eds., *Ecology and Decline of Red Spruce in the Eastern United States*, Springer-Verlag, New York, 1992.
5. A.H. Johnson, S.B. McLaughlin, M.B. Adams, E.R. Cook, D.H. DeHayes, C.Eagar, I.J. Fernandez, D.W. Johnson, R.J. Kohut, V.A. Mohnen, N.S. Nicholas, D.R. Peart, G.A. Schier, P.S. White, "Section III. Why are red spruce declining at high evaluations? A synthesis of epidemiological and mechanistic studies," C. Eagar, M.B. Adams, Eds. Op. Cit. (1992).
6. J.D. Joslin, M.H. Wolfe, "Foliar deficiencies of mature southern Appalachian red spruce determined from fertilizer trials," *Soil Sci. Soc. Am. J.* (In Press) (1994).
7. J.D. Joslin, M.H. Wolfe, *Can. J. For. Res.* **22**:893 (1992).
8. S.B. McLaughlin, C.P. Andersen, P.J. Hanson, M.J. Tjoelker, W.K. Roy, *Can. J. For. Res.* **21**:1234 (1991).
9. S.B. McLaughlin, M.G. Tjoelker, W.K. Roy, *Can. J. For. Res.* **23**:380 (1992).
10. W.P. Robarge, D.W. Johnson, "The effects of acidic deposition on forested soils," *Advances in Agronomy* **47**:1 (1992).
11. F.C. Thornton, J.D. Joslin, P.A. Pier, H. Neufeld, J.R. Seiler, J.D. Hutcherson, "Cloudwater and ozone effects upon high elevation red spruce: A summary of study results from Whitetop Mt., VA," *J. Environ. Qual.* (In Press).
12. H. Van Miegroet, D.W. Johnson, D.E. Todd, *Can. J. For. Res.* **23**:89 (1993).