SESSION 8: POTENTIAL THREATS TO CONVENTIONAL CA AND/OR FUMIGATION (REGULATORY AND INSECT RESISTANCE)

F.A. EL-LAKWAH
Plant Protection Department, Faculty of Agriculture at Moshtohor, Tukh, Kalyubia, Egypt

Rapporteur's Report

Nine papers were presented during this session. The first paper, presented by L. Zettler of the USA, provided an overview of the influence of resistance on future fumigation technology. In his presentation, L. Zettler mentioned the problems arising from PH_3 resistance and the incidence of PH_3-resistant insects in the world. He stressed PH_3-control failures and recommended doses for controlling resistant strains. Measures to combat insect resistance, through efficient control, include increasing exposure periods, using proper fumigation techniques, using hermetically sealed storage structures, employing recirculation technology, using combination treatments, developing alternative fumigants, using biotechnology and using post-harvest techniques. He came to the conclusion that insect resistance to fumigants will continue to develop but can be managed with existing alternative methods.

The second paper, presented by C. Adler of Germany, was entitled "Resistance — a threat to the use of controlled atmospheres for stored-product protection?" C. Adler mentioned that there are no reports of field resistance to CA treatments. Comparison of eight laboratory and two field strains of *S. granarius* from six countries showed no significant variation in their susceptibility to controlled atmospheres of N_2 and CO_2. Tolerance in the insect populations may be stable for a long period. Indications were that the weight of both adults and pupae of laboratory-selected strains resistant to CA is higher than that of susceptible strains. He concluded that there is no proof that resistance is threatening this technology but suggested strategies to minimize the risk that this might happen in the future.

The third paper, presented by F.A. El-Lakwah of Egypt, dealt with the selection of *T. castaneum* for resistance to a combination of PH_3 + CO_2 and with biological observations on the resistant strain. The results of his work indicate that the lethal time values achieved to obtain a certain mortality were significantly longer for the 16th generation, selected for resistance to a mixture of 40 ppm PH_3 + 46% CO_2, than for the parent stock. At the 16th generation, the selected strain showed 19.4-fold resistance at 26°C, and 18.5-fold resistance at 6°C, at the LT_{50} level. In number of eggs, larval mortality and developmental period, the resistant strain also revealed significant differences from the parent strain.

In a presentation on PH_3 measurement at environmental levels, S. Pratt of Australia reviewed the present situation regarding environmental levels of PH_3 and the limits for its detection. He then reported on sensors and amplification techniques, concluding that by

using several techniques and novel sensors, laboratory detection of PH_3 in ppb is feasible, but this must be done in the field since detection must be made as soon as possible after sampling.

A paper entitled "Does underdosing select for resistance to PH_3?" was presented by P. Collins of Australia. He reported on farmers' use of tablets for fumigation and mentioned that fumigation by farmers is generally poor because most of their silos are not well-sealed. Several farm fumigations were monitored and assays were carried out in the laboratory on resistant, heterozygous and susceptible strains of *S. oryzae* and *T. castaneum*. Analysis of the response of these insects to PH_3 leads to the conclusion that any underdosing, producing incomplete kill, will select for resistance. However, poor fumigations will kill only the homozygous susceptibles, leaving the heterozygous resistants to maintain the susceptible gene in the population. Furthermore, good fumigations would use doses high enough to also kill the heterozygous resistant insects, thus eliminating the susceptible genes. Therefore, unless the dose is sufficiently high to kill all resistant stages (heterozygous and homozygous), selection pressure will be greater for the good fumigation than for the poor one.

Chris Bell of the UK presented a paper on the limitations on infestation control in cooled bulk grain and on a strategy to overcome inherent sealing and gas distribution problems by using PH_3. He mentioned that a sensor-controlled, automated dosing system (originally developed for MB mill fumigations) has been modified for use in the PH_3 fumigation of bulk grain. This system potentially maintains adequate PH_3 gas concentrations throughout the long exposure times required for PH_3 treatments at low temperatures.

Perlina Sayaboc of the Philippines presented a paper on the status in her country of resistance of *R. dominica* to PH_3. She reported on tests of field strains (collected from various areas) that showed high levels of resistance to PH_3, and she attributed this phenomenon to poor fumigation practices.

The next paper, presented by C. Reichmuth of Germany, was entitled "There is no resistance of stored-product moths against treatment with CO_2 under high pressure." He reported on experiments conducted to examine whether, during 12 generations of selection, eggs of *Plodia interpunctella* develop resistance to CO_2 under pressure. His findings showed that no significant change in sensitivity occurred over this period.

Lastly, S. Ignatowicz of Poland presented a review of the current status of MB and PH_3 fumigation in his country. He provided a detailed account of the commodity quantities treated since 1990, the registration of fumigants and the quantities employed. He concluded by remarking that, since PH_3 will continue to play a role in the fumigation of agricultural products in Poland and there are indications of development of insect resistance, a comprehensive research program has been planned to monitor resistance to this gas.