RELATIVE CONCENTRATION OF MAJOR AND TRACE ELEMENTS IN ADULT AND IMMATURE STAGES OF THE RED IMPORTED FIRE ANT DETERMINED BY ION INDUCED X-RAY FLUORESCENCE[1]

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ABSTRACT

Ion induced X-ray fluorescence indicated that relative total body concentrations of P, S, Cl, K, Ca, Ni, Cr, Ti, Mn, Fe, Cu, Zn, Pb, Sr, Mo, and Rb could be detected in adult and immature stages of the red imported fire ant, *Solenopsis invicta* Buren. In general, adult imported fire ants contained a higher total body concentration of major and trace elements than the immature stages, with the following trend being noted: workers > pupae > larvae.

Research on the concentration and distribution of major and trace elements in insects has been hampered by lack of suitable analytical techniques having adequate sensitivity, selectivity, and practical applicability to allow precise microanalyses of the elements accumulated in insect tissues. Recently, techniques such as atomic absorption spectroscopy, neutron activation analyses, and X-ray fluorescence spectroscopy have been used to determine the concentration of various major and trace elements in insect tissues. Levy and Cromroy (1973) have used atomic absorption spectroscopy to determine the total body concentration of several major and trace elements in 41 species of adult and immature insects. Ion-induced X-ray fluorescence has been used to study the relative concentration of 14 major and trace elements present in the tissues of 9 species of adult and immature insects (Van Rinsvelt et al. 1973).

The purpose of this study was to compare the relative concentration of several major and trace elements accumulated in the tissues of adult and immature stages of the red imported fire ant, *Solenopsis invicta* Buren.

METHODS AND MATERIALS

Two-3g samples of larvae, pupae, and a mixed sample of major and minor workers were obtained from a red imported fire ant colony maintained at the Insects Affecting Man Research Laboratory, ARS-USDA, Gainesville, Florida.

Tissue preparation and analyses

Each fire ant caste was freeze-killed by lyophilization and ashed in a low temperature radio frequency furnace. A few milligrams of the ash were glued to self-supported pure carbon films with a drop of diluted polystyrene glue. The dried samples were then bombarded with 4 MeV helium ions produced by

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the University of Florida Van de Graaff accelerator and the emitted X-rays were detected by a Si(Li) detector, and stored in a 512 channel pulse height analyzer which finally delivered a complete spectrum of the emitted X-rays. This permitted the identification of the elements present in the sample via their characteristic X-rays. Specific instrumentation, techniques, and methods of analysis were reported by Van Rinsvelt et al. (in press).

Results and Discussion

Results from ion induced X-ray fluorescence indicated that relative total body concentrations of P, S, Cl, K, Ca, Ni, Cr, Ti, Mn, Fe, Cu, Zn, Pb, Sr, Mo, and Rb could be detected in the adult and immature stages of *S. invicta* (Fig. 1-3). However, Mo and Sr in *S. invicta* larvae and pupae respectively could not be distinguished from background levels and were subsequently assumed to be present in fire ant tissues in extremely low concentrations. Levy and Cromroy (1973) have determined the parts per million total body Cu, Fe, Na, Mg, K, and Na in the tissues of a mixed sample of major and minor red imported fire ant workers.

Results from pulse-height comparisons (Fig. 1-3) indicated that P, S, Cl, K, Ti, Cr, Fe, Ni, Cu, Zn, Pb, Rb, Sr, and Mo were more concentrated in the pupal stage than in the larval stage. However, the total body concentration of Ca in the pupal stage was found to be approximately equal to or less than the Ca level found in larvae. Mn was approximately equal to or greater than the level found in larvae. All major and trace element concentrations were greater in workers than pupae and greater in workers than larvae.

In general, adult red imported fire ants contained a higher total body concentration of major and trace elements than the immature stages, with the following trend being noted: workers > pupae > larvae. Results indicated that many biologically active major and trace elements as well as environmental contaminants can easily be detected from the ash of red imported fire ants with the ion induced X-ray fluorescence technique. Therefore, imported fire ant workers may serve as an effective biological indicator of metallic pollution (e.g. Ti, Pb, Sr) in the environment.

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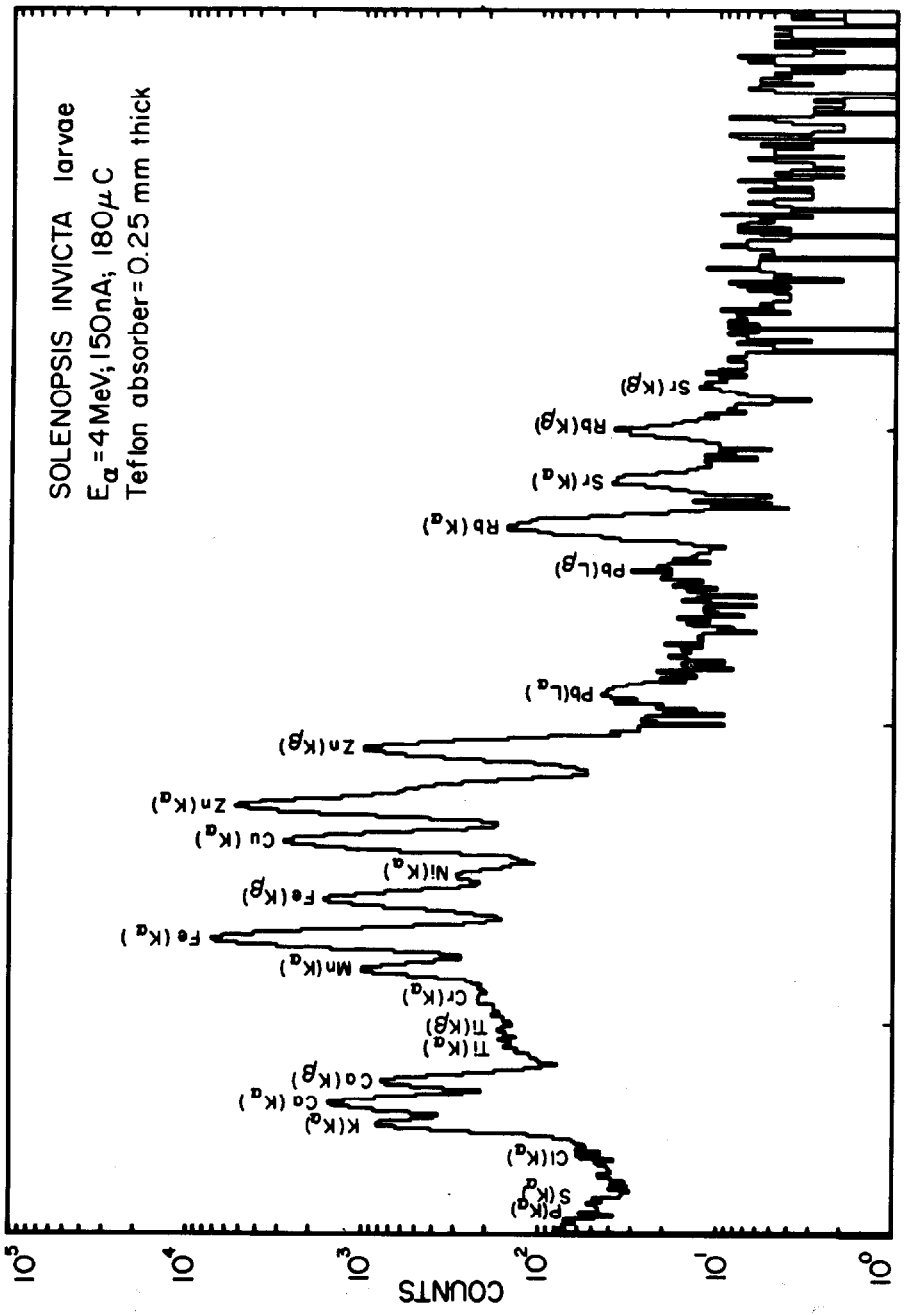

Fig. 1. Ion induced X-ray fluorescence analysis of red imported fire ant larvae.

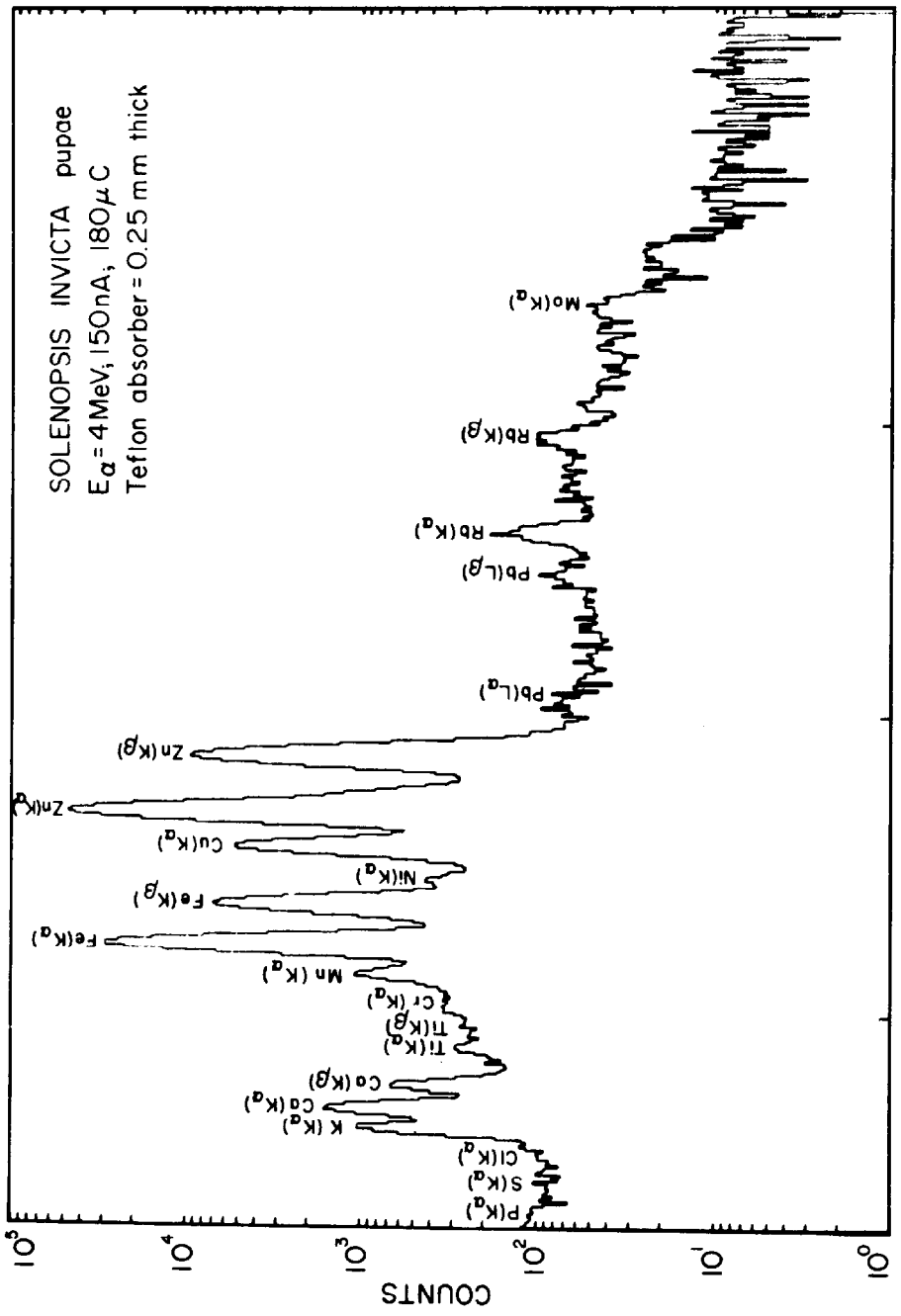

Fig. 2. Ion induced X-ray fluorescence analysis of red imported fire ant pupae.

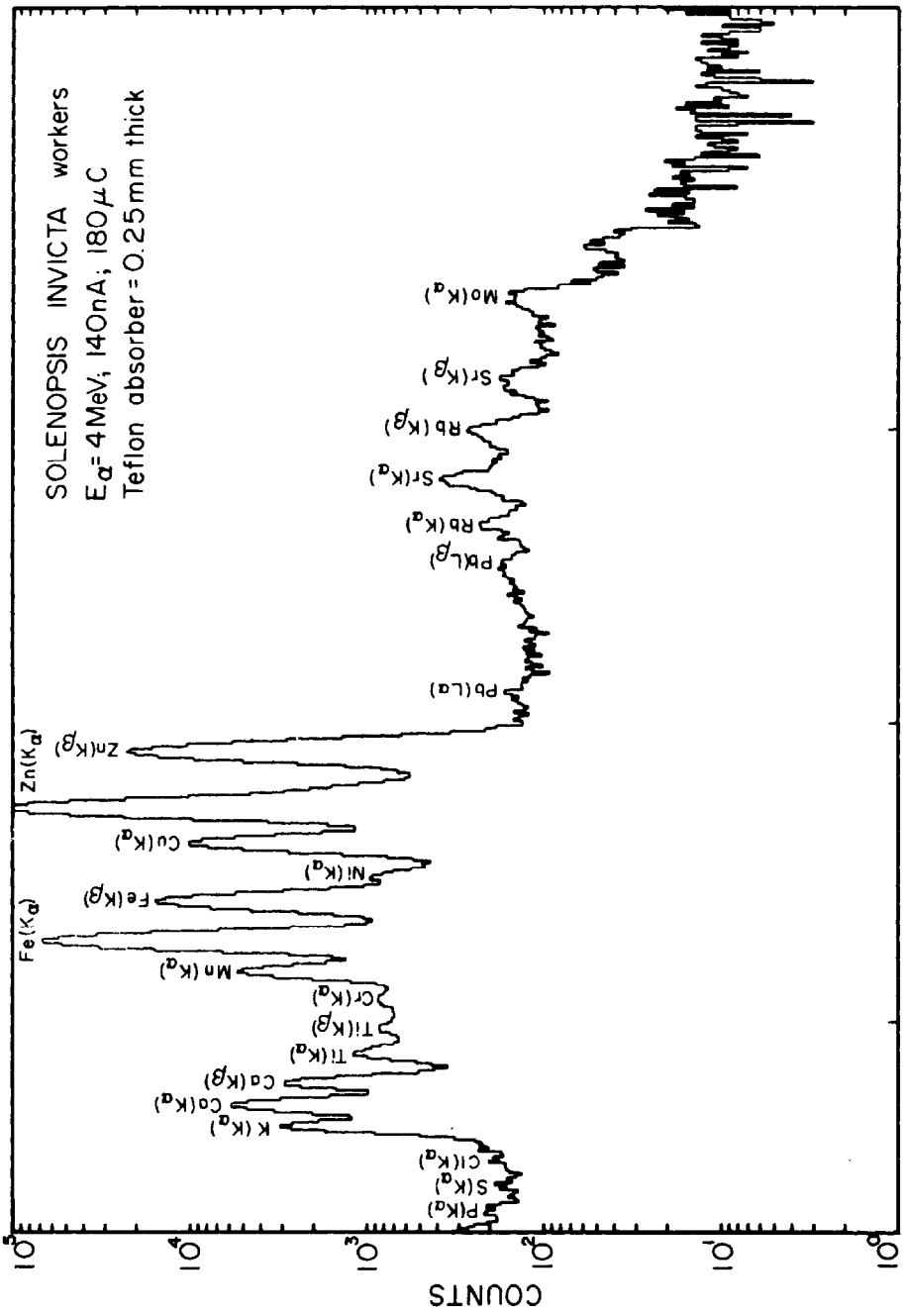

Fig. 3. Ion induced X-ray fluorescence analysis of red imported fire ant workers.