Patterns in the toxicity of synthetic pyrethroids to aquatic species

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Abstract
The Pyrethroid Working Group (PWG) has worked for several years to evaluate all available data on the toxicity of synthetic pyrethroids to aquatic organisms, and identify relevant, reliable studies for use in risk assessment. The PWG aquatic toxicity database now contains endpoints and supporting information from more than 700 open literature publications and register-sponsored toxicity study reports on 8 pyrethroids and nearly 350 species. From the available data, objective criteria were applied to select the most reliable and representative toxicity values for each species. Acute Species Sensitivity Distributions (SSDs) were derived for each pyrethroid for crustaceans, insects, and fish. The 5th percentile (HC5) and the median or 50th percentile (HC50), points that are often used as regulatory benchmarks and assessment endpoints, were calculated for each SSD. The data were further explored to characterize the positions of standard test species in the SSDs. The relative positions of many species are similar on the SSDs of different pyrethroids. For example, the most sensitive invertebrates are invariably amphipods (e.g., Hyalella azteca) and mysids. Daphnia magna, which is near the low end of SSDs for many pesticides such as organophosphates, is typically in the mid-range of pyrethroid SSDs for crustaceans. The Eastern oyster, Crassostrea virginica, is, like other mollusks, near the upper end of pyrethroid SSDs. Such generalizations are useful for interpreting pyrethroid toxicity data for standard test species and for characterizing risk to aquatic communities.

Objectives
• To provide a publically-available compilation of high quality ecotoxicological data on pyrethroids.
• To identify trends in ecotoxicological profiles across pyrethroids as a group.

Methods
Data Compilation: Open literature publications and study reports from PWG member firms were evaluated for use in this analysis (Figure 1). In the first step, a single result from each usable study was designated as the Key Value for that study. In the second step all Key Values for a species were examined, and a single SVF was selected. When multiple equally-acceptable values were available, Key Values and SVFs were based on geometric means.

Results
Species Sensitivity Distributions: Most SSDs for different pyrethroids have similar slope and position (Fig. 2). Crustaceans are more sensitive than insects, and fish are less sensitive than both groups of invertebrates. There are insufficient data to construct SSDs for mollusks or other taxa.

Conclusions
• SSDs for different synthetic pyrethroids are similar in slope and location, within each taxonomic group (crustaceans, insects, fish).
• Crustaceans are most sensitive, insects less sensitive, fish still less, and mollusks extremely insensitive.
• Positions of standard test species on SSDs are generally consistent across pyrethroids.
• Which species and endpoints are available for each SSD can influence HCx values.

Figure 1. Process used to select Species Final Values from aquatic toxicity database.

Figure 2. SSDs for pyrethroid acute toxicity: crustaceans, insects, and fish.

Figure 3. HC5 and HC50 values for pyrethroids.

Figure 4. Positions of standard test species on pyrethroid SSDs for all animals.

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