Pattern Recognition of the Movement Tracks of Medaka (*Oryzias latipes*) in Response to Sub-Lethal Treatments of a Carbofuran (0.1mg/L) by Using Artificial Neural Networks

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The behavioral changes of medaka (*Oryzias latipes*) to the treatment by an anticholinesterase insecticide, carbofuran (0.1 mg L^{-1}), were observed through an automatic image recognition system for 4 days in semi-natural conditions continuously. The smooth patterns of the movement tracks were typically observed without treatment, while the patterns of shaking were frequently observed in the movement tracks after the treatments. The smooth and shaking movement patterns were selected and used for training with an artificial neural network for automatic detection of affected specimens. Parameters characterizing the movement tracks, such as speed, acceleration, stop duration, and etc in one-minute duration, were checked and used for input (9 nodes) to a multi-layer perceptron with the backpropagation algorithm. Two types of the movement tracks for each smooth and shaking pattern were selected and were given as the matching output (2 nodes), while nine nodes were assigned to a single hidden layer. As new input data were given to the trained network, the network was capable of recognizing the smooth and shaking patterns. Recognition rates of the smooth pattern decreased distinctively while those for the shaking pattern increased in a high degree after the treatments. This study demonstrated that artificial neural networks are useful for automatically detecting presence of toxic chemicals in environment.