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Assessment of insecticide toxicity in Rice fields by mouth part deformities in chironomid larvae (Diptera: Chironomidae)

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Introduction

The Chironomidae is a cosmopolitan family of dipteran insects occurring in all zoo-geographical regions of the world including Antarctica (Saether and Ekrem, 2003). Globally, chironomid midges have been known as pests and nuisance impact on human health and agriculture for a long time (Wang *et al*, 2000). Large swarms of midges frequently emanating from lakes in urban and suburban areas, cause nuisance and economic loss to the lakefront residents and business in tropical and subtropical countries (Lobinske *et al*, 2004). Chironomid related medical problems are primarily human allergies arising from the larval hemoglobin and epidermis of the adults, cause conjunctivitis, rhinitis, hay fever or asthma (Sublette, 1985). The principal allergens of larval hemoglobin are retained in the adult midge (Morsy *et al*, 2000).

According to Ree and Kim (1988); Surakarn and Yano (1995); Wang (2000), 186 species under 67 genera have been found associated with the rice paddies around the world causing significant damages to the rice. The larvae have also been implicated as glasshouse pests and suspected to damage field crops including winter wheat and maize, potato plant and several indoor horticultural crops, particularly lettuce and young tomatoes (Cranston, 1987). The larvae of *Polypedilum* have recently been proved as ectoparasites on trichopteran flies (Kobayashi *et al*, 2003).

Chironomids are considered as indicators of water pollution (Bazzanti and Bambacigno, 1987; Kawai *et al*, 1989; Wilson, 1993), acidification (Halvorsen, 1999), assessment of biodiversity (Galden *et al*, 2001; Callisto and Gonclaves, 2005; Cota *et al*, 2002) and is utilized in classification of lake system and environmental assessment (Kawai *et al*, 1989; Cranston, 1990; Grzybkowska and Dukowska, 2002; Wang and Yang, 2003). The presence of deformed individuals amongst chironomid larvae indicates toxic stress

(Rossaro, 1979; Warwick, 1990; Bisthoven, 2000). Morphological deformities along with disappearance of sensitive species are now-a-days utilized as biomonitoring and biological screening material for assessment of the nature and extent of toxic chemicals, heavy metals and benthic invertebrates of freshwater ecosystems (Bisthoven *et al*, 1992; Warwick, 1992; Moretti and Callisto, 2005; Meregalli *et al*, 2002; Carew *et al*, 2003; Bhattacharyay *et al*, 1999, 2005). Sokolova *et al* (1993) have put forth the role of larvae of *Chironomus piger* Strenzke (1959) in self purification of domestic sewage polluted water of small rivers and canals. Chironomids are used as suitable test animal in trace metal transfer research (Timmermans *et al*, 1989). Pupal exuviae are also utilized as tools in classification and management of lakes, rivers, fisheries and for monitoring and control of pollution (Wilson, 1987; Bazerque *et al*, 1989).

In spite of the complex topography, geological juvenility, vegetation make-up and variety of climatological pattern of Indian subcontinent with tremendous potentiality, the faunistic composition and biogeography of the family Chironomidae as a whole are still far from expectations (Chaudhuri *et al*, 2001).

The present study has been proposed with the following objectives for investigation:

a) Study of various biotic factors like, water temperature, pH, DO, salinity, alkalinity etc and its role in biology of the insects.
b) Correlation of the above factors with the diversity of midges.
c) Analysis of larval deformities in response to insecticides present in their habitat.
d) Determination of relationship between level of insecticides and degree of deformities.

Materials and Methods

Selection and preparation of study area: The study area for the dissertation was selected in the village Dhunui, Paharhati in Memari, Burdwan district. The selected rice field has been divided into required number of small divisions of size 2m x 2m for application of the insecticides in specific doses to see its effect on midges.

Application of insecticides: Three insecticides were applied at specific doses in two phases; Kratap-4G (Cartaphydrochloride), Fipronil-4G (Regent), Furadan-4G (Carbofuran),

Foratox-10G (Phorate-10G) were used in this study. Details of all the insecticides used in this study have been stated in appendix I.

Collection of adults and larvae: Adult specimens were collected from places near rice fields through sweeping and operation of light traps. The immature were taken with the aid of nylobolt plankton net of 30 meshes/cm.

Rearing: The larvae were sorted out of the natural habitats subjected to the laboratory rearing. These laboratory cultures were subjected to insecticide treatment in similar doses that of field cultures. Newly emerged adults were allowed to mate, oviposit and to grow further to continue its life cycle and confirmation of the species.

Preservation and storage: Adults as well as immature were conveniently preserved in 70–90% ethyl alcohol. Kahle's solution may be in use as preservative for both adults and immatures for retaining the natural colour.

Mounting/slide preparation: The phenol–balsam technique of Wirth & Marston (1968) and Epler (1995) were applied for mounting. In case of larva, the head capsules were de-chitinised with warm 10% KOH solution before processing and microslide-mounting. Larval and pupal exuviae were directly mounted in phenol–balsam. Observation with Light Microscopy and SEM was performed.

Study of diversity and level of deformity: Variation in the diversity of midges was studied applying suitable statistical method to analyze the effect of insecticides in their habitat. At the same time, larval deformities due to insecticides were also analyzed to determine the relationship between levels of insecticides by the degree of deformities.

Results

A total of 2486 adult chironomid midges comprising 4 taxa were considered. The monthly mean collection of adults by sweeping and with the aid of emergence traps was found to be 828 and 726. Morphological deformities were studied in 4 taxa of chironomid larvae of 4 sampling sites. Highest percentage of deformities (40%) was found in site Paharhati Details of the deformities found during the study have been presented

Discussion

According to Ali and Chaudhuri (1988), a direct correlation existed between different physical and chemical factors influencing the agricultural field and water body. In this study various factors as shown in the table also depicted the same. Waterhouse and Farrell (1985) outlined the importance of species level identification of chironomid community in order to establish the relationship between pollution load and change in chironomid species composition. Wilson (1989) pointed out the importance and significance of pupal exuviae for identification in aquatic ecosystem. It significantly reflected the pollution status. The number of taxa in the controlled appears to be much higher than that of the treated sites.
A direct relationship existed between the morphological deformities of head capsules of benthic chironomid worms and heavy metals and pesticides polluted aquatic sediment (Warwick, 1990, 1992; Bisthovan *et al*, 1995; Hudson and Ciboroswki, 1996 and Vermeulen *et al*, 1994). During the present study the species under the genera *Chironomus* appears to be most susceptible to the pesticide pollution. The results of this study strongly support Bisthoven (1995) that deformities occur mostly in mentum, mandible, premandible, pecten epipharyngis and antennae. The incidence of deformity appeared to be dependent to the particular sensitive structure of the species, site of occurrences and concentration of chemical contaminants available in the sediments and water of the field. Besides some obvious deviations, the present work came close to Warwick (1985) who emphasized severity of antennal deformity in *Chironomus* framing few severity and morphological response indices in order to detect the toxicant in sediment and water. It also supports Bisthoven *et al* (1995) who made qualification of the severity of deformity of different structures of chironomid larvae and used to assess concentration of pollutants in water bodies.

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References

Ali, A. and Chaudhuri, P. K. 1988. Evaluation of a new benzoylphenylurea insect growth regulator (UC-84572) against chironomid midges in experimental ponds. J. Am. Mosq. Control Assoc. 4:542- 544

Bazerque, M. P., Laville, H. and Brouquet, Y. 1989. Biological quality assessment in two rivers of the northern plains of France (Picardie) with special reference to chironomid and diatom indices. Acta. Biol. Debr. Oecol. Hung. 3: 29-39.

Bazzanti, M. and Bambacigno, F. 1987. Chironomid as water quality indicators in the river Mignone (Central Italy). Hydrobiol. Bull. 21(2): 213-222.

Bhattacharya, G., Mazumdar, A. and Chaudhuri, P. K. 1999. Incidence of deformed *Chironomus* larvae in contaminated sediment of the river Damodar, West Bengal (Diptera: Chironomidae). Poll. Res. 18(1): 79-82.

Bhattacharyay, G., Sadhu, A. K., Mazumdar, A. and Chaudhuri, P. K. 2005. Antennal deformities of Chironomid larvae and their use in biomonitoring of heavy metal pollutants in the river Damodar of West Bengal, India. Environmental Monitoring and Assessment. 108: 67-84.

Bisthoven, J. L. 1995. Morphological deformities in *Chironomus* gr. *thummi* (Diptera: Chironomida) as bioindicators for micropollutants in sediments of Belgian lowland rivers. – Ph.D. Thesis, Katholic Univ. Leuven, Zool. Inst., Dept. Syst. and Anim. Ecol. 253 pp.

Bisthoven, J. L. 2000. Biomonitoring with morphological deformities in aquatic organisms. In: Garhardt, A. (ed.). Biomonitoring of polluted water, Envir. Res. Forum 9: 65-94.

Bisthoven, L. J., Timmermans, K. R. and Ollevier, F. 1992. The concentration of cadmium, lead, copper and zinc in *Chironomus thummi* larvae with deformed versus normal menta. Hydrobiologia 239: 141-149.

Bisthoven, L. J., Huysmans, C., and Ollevier, F. 1995. The in situ relationships between sediment concentrations of micropollutants and morphological deformities in Chironomus gr. thummi larvae (Diptera, Chironomidae) from lowland rivers (Belgium): A spatial comparison. In Chironomids: From genes to ecosystems, ed. P. Cranston, pp. 63–80. East Melbourne, Australia: CSIRO Publ.

Carew, M. E., Pettrigrove, V. and Hoffman, A. A. 2003. Identifying Chironomids (Diptera: Chironomidae) for biological monitoring with PCR-RFLP. Bull. Ent. Res. 93: 483-490.

Chaudhuri, P. K., Hazra, N. and Alfred, J. R. B. 2001. A check-list of Chironomid midges (Diptera : Chironomidae) of the Indian Subcontinent. Orient. Ins. 35: 335-372.

Cota, L. R., Goulart, M. C., Moreno, P. and Callisto, M. 2002. Assessment of river water quality using an adapted BMWP tool to evaluate ecosystem health. Verh. Int. Ver. Limnol. 28: 1713-1716.

Cranston, P. S. 1987. A non-biting midge (Diptera: Chironomidae) of horticultural significance. Bull. Ent. Res. 77: 661–667.

Cranston, P. S., 1990. Biomonitoring and invertebrate Taxonomy. Environ. Monitor. Assess. 14:265-273.

Callisto, M. and Goncalves, J. E. Jr. 2005. Bioindicadores Bentonicos. In: Fabio Roland, Dioeia Cesare Marcelo Marinho (Eds.). Licoes de Limnologia. 371-379.

Epler, J. H. 1995. Identification manual for the larval Chironomidae (Diptera) of Florida. Final report for DEP Contract No. WM 579, Dept. Environ. Protec. FL. 1.1-9.6.

Galden, N., Callisto, M. and Barbosa, F. 2001. Biodiversity assessment of benthic macroinvertebrates in altudinal ecosystem of Serra do Cipo (MG Brazil) Brazilian Journal of Biology 61(2): 239-248.

Grzybkowska, M. and Dukowska, M., 2002. Impact of the dam-reservoir on river macrobenthic community-long term study of Jeziorsko Reservoir, the Warta River in central Poland. Pol.J.Ecol.,49: 243-259.

Halvorsen, G. A. 1999. Chironomids as indicator of acidification. In: Raddum, G. G. Rosseland, B. O. and Bowman, J. (ed.). Workshop on biological assessment and monitoring evaluation and models. ICP-Wat. Rep. 50/99:73-79, NIVA, Oslo.

Kawai, K., Yamaagishm, and Konishi,K. T 1989. Usefulness of chironomid larvae as indicator of water quality.Jap.J.Sanit.Zool. 40:269-283.

Kobayashi. Tadashi, Ohtaka, A and Takahasi, T. 2003. Second record of ectoparasite Chironomidae on Trichoptera) from Japan. *Polypedilum (Cebregenia) kamiteritium* Sasa (Diptera). Spixiana 26: 83-91.

Lobinske, J. R., Stimac J. L. and Ali, Arshad. 2004. A spatially explicit computer model for immature distributions of *Glyptotendipes paripes* (Diptera: Chironomidae) in Central Florida lakes. Hydrobiologia. 519: 19-27.

Meregalli, G., Pluymers, L. and Ollevier, F. 2002. Induction of mouth parts deformities in *Chironomus riraparius* larvae exposed to 4-n- nonylphenol. Environ. Pollut. 111: 241-246.

Moretti, M. and Callisto, M. 2005. Biomonitoring of benthic macroinvertebrates in the middle Doce River watershed.Acta.Limnol.Bras. 17(3): 267-282.

Morsy, T. A., Saleh, W. A., Magied, A., Farrag, A. K. and Riffat, M. M. A. 2000. Chironomid potent allergens causing respiratory allergy in children. J. Egypt. Soc. Parasit. 30: 83-92.

Ree, H. I. and Kim, M. S. 1988. Studies on Korean Chironomidae (Diptera) III. Description of two unrecorded species from Korea and three new species. The Korean J. Syst. Zool. 2: 13-24.

Rossaro, B. 1979. Chironomid communities as water quality indicators. Holarct. Ecol. 2: 65–72.

Saether, O. A. and Ekrem, T. 2003. Biogeography of afrotropical Chironomidae (Diptera) with special reference to Gondwanaland. Cimbebasia. 19: 123-139.

Sokolova, N. Yu., Palij, A. V. and Izvekova, E. T. 1993. Biology of *Chironomus piger* str. (Diptera, Chironomidae) and its role in self purification of a river. Neth. J. Aquat. Ecol. 26: 509-512.

Strenzke, K. 1959. Revision der gattung Chironomus Meig. I. Die Imagines von 15 norddeutschen Arten und Unterarten. Arch. Hydrobiol. 56: 1-42.

Sublette, J. E. 1985. Chironomid midges as the cause of bronchial asthma. Kankyo Eisei. 32: 8–14.

Surakarn, R. and Yano, K. 1995. Chironomidae (Diptera) recorded from paddy fields of the world. A Review. Makunagi/Acta Dipterologica 18: 1-20.

Timmermans, K. P. and Paddy, A. W. 1989. The fate of trace metals during metamorphosis of chironomids. Environ. Pollut. 62:73-85.

Vermeulen, A. C., Bisthoven, L. J, Postma, J. and Ollevier, F. (1994). Mechanical wear of Chironomus riparius (Diptera, Chironomidae) larvae reared in two artificial substrates. - First Beneluxcongress of Zoology, 4-5 November, University of Leuven, Leuven, Belgium.

Wang, X. 2000. A revised check list of Chironomids from China (Diptera).13th Int. Symp. on Chironomidae. 629-652.

Wang, B and Yang, L. 2003. Bioassessment of Qinhua river using a river biological index. Acta. Ecol. Sin. 23: 2082-2091.

Wang, J., Fang, Z., Ju, F. and Zheng, S. 2000. Distributiion of Chirionomid larvae and its relation to water quality. Shengtaixue Zhasi. 19: 27-37.

Warwick, W.F. 1985. Morphological abnormalities in Chironomidae (Diptera) larvae as measures of toxic stress in freshwater ecosystems: indexing antennal deformities in Chironomus Meigen. Can. J. Fish. Aquat. Sci. 42:1881–1914

Warwick, W. F. 1990. The use of Morphological Deformities in Chironomid Larvae (Diptera: Chironomidae) for Biological Effects Monitoring. Environ. Can. IWD Scientific Series No. 173, NHRI Paper No. 43: 1–34.

Warwick, W. F. 1992. The effect of Trophic/contaminant interaction on Chironomid community structure and succession (Diptera: Chironomidae). Neth. J. Aquat. Ecol. 26(2-4):563-575.

Waterhouse, J. C. and Farrell, M. P. 1985. Identifying pollution related changes in chironomid communities as a function of taxonomic rank. Can J. Fish. Aquat. Sci. 42: 406-413.

Wilson, R. S. 1987. Chironimid communities in the River Trent in relation to water chemistry. Ent. Scand. Suppl. 29: 387–393.

Wilson, R. S. 1989. The modification of chironomid pupal exuvial assemblages by sewage effluent in rivers within the Bristol Avon catchment, England. Acta Biologica Debrecina Supplementum OecoIogica Hungarica 3: 367-376.

Wilson, R. S. 1993. Monitoring organic enrichment of rivers using Chironomid pupal exuvial assemblages. Proc. 11th Int. Symp. Chironomidae, Amsterdam, Neth. J. Aquat. Ecol., 26(2-4): 521–525.

Wirth, W. W. and Marston, N. 1968. A method for mounting small insects on microscope slides in canada balsam. Ann. Ent. Soc. Am. 61: 783-784.