Variations in susceptibility to common insecticides and resistance mechanisms among morphologically identified sibling species of the malaria vector Anopheles subpictus in Sri Lanka.

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Abstract

Anopheles subpictus s.l., an important malaria vector in Sri Lanka, is a complex of four morphologically identified sibling species A-D. Species A-D reportedly differ in bio-ecological traits that are important for vector control. We investigated possible variations that had not been reported previously, in the susceptibility to common insecticides and resistance mechanisms among the An. subpictus sibling species. Adult An. subpictus were collected from localities in four administrative districts in the dry zone of Sri Lanka. Single female isoprogeny lines were established and sibling species status determined according to reported egg morphology. World Health Organization's standard protocols were used for insecticide bioassays and biochemical assays to determine insecticide susceptibility and resistance mechanisms. Susceptibility of mosquitoes was tested against DDT (5%), malathion (4%), deltamethrin (0.05%) and λ-cyhalothrin (0.05%). Biochemical basis for resistance was determined through assaying for esterase, glutathione-S-transferase and monooxygenase activities and the insensitivity of acetycholinesterase (AChE) to propoxur inhibition. All sibling species were highly resistant to DDT. However there were significant differences among the sibling species in their susceptibility to the other tested insecticides. Few species A could be collected for testing, and where testing was possible, species A tended to behave more similarly to species C and D than to B. Species B was more susceptible to all the tested insecticides than the other sibling species. This difference may be attributed to the predominance of species B in coastal areas where selection pressure due to indoor residual spraying of insecticides (IRS) was lower. However there were significant differences between the more inland species C and D mainly towards pyrethroids. Higher GST activities in species C and D might have contributed to their greater DDT resistance than species B. Malathion resistance in both species C and D may be caused by elevated GST activity and an altered insensitive target site in AChE. In addition, a carboxylesterase based malathion resistance mechanisms was also detected in species C and D. Elevated esterase levels in species C and D might have contributed to the low levels of pyrethroid resistance. However an absence of elevated activity of monooxygenases in species B, C and D indicates that monooxygenases are unlikely to be the cause of this partial resistance to pyrethroids. The differences in insecticide susceptibility and insecticide resistance mechanism shown by An. subpictus sibling species are important considerations for developing the malaria control and eradication program in Sri Lanka. Similar studies on species complexes of other anopheline vectors of malaria are necessary for effective malaria control worldwide. The differential susceptibility findings are also consistent with most, if not all, morphologically identified An. subpictus species B in Sri Lanka belonging to the An. sundaicus complex. There is a need therefore to develop molecular techniques that can be used to differentiate morphologically similar anopheline species in field conditions for more effective vector control.

Indexed keywords

EMTREE drug terms: acetylcholinesterase; esterase; glutathione transferase; insecticide; mixed function oxidase

EMTREE medical terms: animal; Anopheles; article; bioassay; disease carrier; drug effect; enzymology; female; insecticide resistance; metabolism; Sri Lanka; survival

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