Effect of ivermectin residues in dung pads on cattle dung associated staphylinids: Implications for toxicity tests

PHILIPP W. HOPP

Abstract

Numerous field studies and standard laboratory tests already demonstrated that veterinary pharmaceuticals, which are used to control endo- and ectoparasites in agricultural and domestic animals, such as avermectins and their metabolites, have deleterious effects on dung-dwelling and soil-dwelling non-target organisms. In particular ivermectin, a synthetic derivative of the naturally occurring avermectin B1, was often studied concerning its effect on the dung fauna. However, indirect effects of organisms, which feed upon the dung dwelling fauna as predators or act as parasites were seldom in the focus of these studies. This is especially true for dung-associated staphylinid beetles. Thus, I examine whether there is evidence that ivermectin has either direct or indirect effects on the dung-associated staphylinid fauna, which was sampled during a field study in the framework of the ERAPharm project.

Therefore, dung from untreated and ivermectin-treated Holstein cross cattle were collected. Treated cattle received a single dose of commercial 1 % solution of ivermectin. Dung from cattle of the different treatments was sampled 2, 3, 4 and 7 days after the treatment. This design of differential time points for the treatment of the cattle was chosen in order to obtain freshly excreted dung containing different concentrations of ivermectin at the start of the test and expose it in parallel in the field under identical exposure conditions. In order to obtain an adequate positive control, dung from untreated cattle was spiked with 10.8 mg ivermectin per kg dung (dry weight) using acetone as carrier. For each treatment group, the cattle dung was mixed to form standardized dung pads of the same size and shape. The standardized dung pads were exposed randomly on the surface of a typical pasture. Three dung pads from each treatment were collected 2, 4, 7, 14 and 28 days after exposure in the field. The staphylinid beetles were sampled from the dung pads by hand sorting of the animals floating on the water surface after the pads were dispersed in tap water. The staphylinid beetles were sorted to genus and species level. Additionally, the staphylinid beetles have been divided into the two functional groups “carnivores” and “omnivores” on the basis of a critical examination of the literature.

The indications from this study are that ivermectin residues in dung pads do not cause clear adverse effects on the staphylinid fauna, although reduced abundances of some species, such as *Alechara*

moesta or *Anotylus inustus* were found in treated dung pads at different sample dates. To account for the variation intrinsic to ephemeral natural systems, I defined adverse effects in this context as a significant decline of abundance or species disappearance, which can be observed over a decent time periode exceeding one sampling date. However, I found meaningful abundance and community response pattern, which could be attributed both to the successional shift of species during the different phases of dung pad disintegration and to the ivermectin treatment. Observed differences to the untreated control were mainly caused by an increase of individuals in the different treatment groups. Together, the increasing abundance of the different staphylinid taxa led to a dose-dependent deviation of the community composition of treated dung pads compared to the control group.

Based on the results and literature data I suggest that the higher number of individuals found in the treated dung pads are on the one hand caused by an attractive effect of ivermectin residues, which resulted in an enhanced colonization of these dung pads by the staphylinid fauna. On the other hand, species interactions following colonization, such as prey availability or host accessibility may also influence the found beetle pattern. For example, low numbers of larval Diptera and dung beetles in the treated dung pads have a negative effect on host accessibility, which may increase the resident time of parasitoids in these dung pads. An increased amount of dead faunal material, caused by adverse effects of ivermectin residues on dipteran or dung beetle larvae may on the other hand be beneficial for omnivorous species. Accordingly, the increased food supply increase the residence time and thus the abundance of such staphylinid beetles in the treatments compared to the control group.

The separate analysation of carnivorous and omnivorous staphylinid taxa as well as single species in this study demonstrated on the one hand that most species of both functional groups show a comparable response to ivermectin treatment and thus contribute in a similar way to an overall response pattern of staphylinids to ivermectin residues. On the other hand it revealed differences in the general occurrence pattern of carnivorous and omnivorous taxa as well as single species within the two groups, which may be important for a risk assessment and would not be recognized in an examination of all staphylinid taxa together. First, the results of the negative control indicated that most individuals of the omnivorous taxa, although generally extracted in low abundances, already appeared after 2 days exposure time. Thus, they have to deal with the highest concentrations of ivermectin in the dung pads. Together with a higher risk of ivermectin intake, omnivorous species, such as of the genus *Anotylus*, seems to be suitable taxa to evaluate toxic effects of avermectins on staphylinid beetles. Second, very high number of individuals of the abundant carnivorous species *Philonthus concinnus* and *Aleochara bipustulata* at day 2 and 4 of treatment T7 strongly influence a general abundance pattern of predaceous staphylinid beetles. However, they did not reflect the

response of other taxa, which show low abundances at the first 4 days; but, in turn influence the overall pattern at day 14. These differences in the occurrence pattern of different species could mask adverse effects of less abundant species, in this study, for example, assumed for *Aleochara moesta*.