Unsynchronized disinfections favour the evolution of virulent parasites

Side effects from the use of agents to combat parasitism are well rehearsed, for example damage to both host and environment, and the evolution of resistance to agents. Here, I propose to discuss another effect and how to deal with it. Paul Ewald (e.g. 1993) pointed out that in host-parasite relations, parasites tend to be more damaging to their hosts if they can easily transmit to new hosts. There is strong empirical support for this statement, and the evolutionary logic seems flawless: A parasite having great difficulties transmitting to new hosts, should be interested in keeping the host healthy and alive, because the death of the host means the end of the parasite as well. So benevolent, mutulalistic host-parasite relations are expected when for some reason transmission to new hosts is impaired.

Quite the contrary holds when new hosts can easily be infected (Ewald 1993). Often this is the case when parasites can survive for a long time independent of the host, and can 'sit and wait' for new hosts. Or when they are transported to new hosts by a vector, for instance a mosquito, a syringe, or a sewer leaking into drinking water. In such cases the current host need *not* stay healthy and alive for the parasite to infect new hosts, so the parasite can evolve to deplete the resources of the current host while attempting to reproduce maximally and spread to other hosts. Virulently reproducing parasites mean sickness for the host.

Taking bee-hives (figure 1) as an

1. Bee-hives are often infected by parasites. Photo: Albert de Wilde
1. Bijenkasten worden vaak geïnfecteerd door parasieten.

example, I will argue here that a practical application of Ewald's ideas is to synchronize disinfecting actions. Consider a beekeeper who notices that the hives of his honeybees (*Apis mellifera* Linnaeus) are infected by damaging parasitic mites (of which a large number of species is known to inhabit this specific biotope). The problem can at least temporarily be solved with poisonous, chemical products, hopefully without contaminating the honey. But this success won't last for long if there is a second beekeeper somewhere in the neighbourhood who did not yet eradicate mites. Somehow, via flowers or other pathways, the mites will find their way to the colonies of the first beekeeper. Apart from the fact that the disinfecting measures of the first beekeeper only achieved short term success, Ewald's theory suggests that such actions select for increased virulence of the parasites.

Parasites compete amongst themselves. After infecting the hives of the first beekeeper, the mites coming from the second beekeeper will find they stumbled upon a bonanza without competing mites. Ewald's theory states that parasites damage their hosts in proportion to the ease with which they can transmit to them. Put another way, with more 'outside opportunities' (Roes 2007, 2008), the parasite will become more harmful to the host. In practice, then, the destruction of mites in beehive 1 increases the transmissability and hence virulence of mites coming from beehive 2. Crucially, in any area populated by beehives, this process will be grossed up. However, a cost-effective, simple solution suggests itself: synchronization of disinfections. All beekeepers should be urged to disinfect at the same moment. Partial disinfections not only encourage parasites to persist and evolve resistance, but to evolve more virulent forms.

Bees and mites are one example, albeit a very topical one. If valid, the rationale outlined above will apply equally to other parasites and their hosts.

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References

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Samenvatting

Ongelijktijdig desinfecteren begunstigt de evolutie van kwaadaardige parasieten

Volgens de theorie van Paul Ewald maken parasieten die gemakkelijk nieuwe 'gastheren' kunnen infecteren zich minder zorgen om het welzijn van hun gastheer dan parasieten die meer moeite hebben te infecteren. Het welzijn van de laatsten hangt immers nauw samen met dat van hun gastheer, want als die sterft, dan betekent dat meestal ook het einde van de parasiet. Het is dus in het belang van de parasiet dat de gastheer relatief gezond is en aldus de kans vergroot op contact met nieuwe slachtoffers. Het omgekeerde geldt voor parasieten die probleemloos kunnen infecteren. Zij exploiteren het lichaam van hun gastheer maximaal, want als deze sterft door ziekte en uitputting dan hebben inmiddels talloze nakomelingen zich elders genesteld. Met als voorbeeld de bestrijding van mijten in bijenkolonies wordt betoogd dat gelijktijdige desinfecties niet alleen voorkomen dat parasieten de dans ontspringen, maar ook dat de aard van het beestje steeds kwaadaardiger wordt.

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