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Sea Turtles: Old Viruses and New Tricks

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Recent years have seen an inexplicable increase in the frequency of an appalling disease in sea turtles: fibropapillomatosis, which is likely caused by a herpesvirus and causes tumors to grow throughout the turtle’s body. New research has led to the disturbing conclusion that recent, human-induced environmental changes are responsible.

Emerging diseases seemed to enter the nightmares of mainstream culture with the ebola and hantavirus scares of the 1990s. Since then, emerging diseases have become a major health concern in human populations, with such diseases as severe acute respiratory syndrome (SARS), avian influenza and West Nile virus disease sickening and scaring people around the globe.

Most people do not realize that emerging diseases are also a problem for wildlife and may be a major threat to endangered species [1]. In the last decade, there has been an increase in the number of cases of a wide spectrum of diseases in populations of diverse species of plants and animals [1,2]. Emerging diseases in wildlife are important for the obvious reason that they can cause population declines in the susceptible species. But these diseases in wildlife are important from a human health standpoint too, because many of the emerging diseases in humans have been linked to wildlife species that serve as reservoirs of the pathogen. Furthermore, the study of emerging diseases in wildlife may well provide general insights that help us to understand the dynamics of emerging diseases in human populations.

As reported in a paper just published in Current Biology, Herbst et al. [3] investigated the cause of the recent outbreak of marine turtle fibropapillomatosis by examining the evolution of the virus that causes the disease. This disease affects mainly the green sea turtle (Figure 1), but cases have also been documented in loggerhead, olive ridley and now Kemp’s ridley sea turtles. The fibrous growths typical of fibropapillomatosis were first described in 1938 and reports of the disease were relatively rare until after 1980 [4]. Now, fibropapillomatosis occurs around the globe and in one recent sample from the Hawaiian Islands more than 90% of green turtles showed symptoms of the illness [4].

From the standpoint of a wildlife enthusiast, fibropapillomatosis is a heinous disease, marring the usually noble appearance of the beloved sea turtles. The growths associated with the disease occur mainly on the soft skin of the turtle, but they can appear internally as well. The growths can be so large that they interfere with normal mobility, vision, feeding and organ function. In addition to these gross mechanical effects, the disease appears to result in suppression of the immune system and a susceptibility to bacteremia [5,6]. Consequently, death is the ultimate outcome for many of the turtles affected by the disease.

All the current evidence suggests that marine turtle fibropapillomatosis is caused by a herpesvirus that has been shown to be associated with the growths [7] (although definitive experiments involving cultured virus particles have not yet been possible). But why does the virus causes so much harm now compared to 50 years ago? Two non-exclusive hypotheses can explain the sudden increase in frequency of fibropapillomatosis (and most other emerging diseases in wildlife for that matter). One possibility is that a change in the environment caused the host species to become extremely susceptible to a previously harmless strain of virus, for example, as a consequence of immune suppression, a new vector and so on. The other possibility is that the disease is...
caused by a virulent mutant form of a previously harmless virus.

Herbst et al. [3] took advantage of the fact that these two hypotheses make distinct predictions about the molecular phylogeny of the virus, allowing a test of whether or not the emergence of this disease was due to a new form of the virus. If the disease is a consequence of a new mutation that arose in the last 50 years, then all of the new, virulent viruses should be close relatives of one another, members of a lineage that has swept through the turtle populations in the last few decades. In fact, the time frame is so short that we would expect virus particles isolated from distinct turtles to have virtually identical sequences over large parts of their genome.

The phylogeny of viruses isolated from 25 individual turtles of three distinct species — green, loggerhead and Kemp’s ridley — clearly shows that the now virulent form of the virus has been around a very long time. The viral DNA isolated from some of the tumors of individual turtles exhibited so much sequence divergence among turtles that the lineages had likely been distinct for millions of years, assuming ‘clock-like’ molecular evolution. So a recent origin of a virulent form of the virus is not consistent with the phylogenetic data.

The data also show that viruses isolated from distinct sea turtle species sometimes have essentially identical DNA, indicating that the virus can be passed across species boundaries. This observation may be somewhat troubling, as the virus does cause disease in these other species, and even though instances of the disease are rare in sea turtles other than greens now, we must remember that 30 years ago the disease was rare in green sea turtles as well.

The only reasonable conclusion from the analysis of Herbst et al. [3] appears to be that some change in the environment of sea turtles has rendered them more vulnerable to fibropapillomatosis than they have been in the past. Unfortunately, the environmental cause is not known, and may be very difficult to diagnose. This sea turtle example can be added to a fairly long list of species that have become susceptible to various types of pathogen as a consequence of environmental change — almost all of which are human-induced [2]. If biologists didn’t have enough to worry about with the relatively obvious (but difficult to solve) conservation problems imposed by human population growth, habitat destruction, overharvesting and invasive species, this and other recent studies [1,2] remind us that we can now add the relatively subtle but potentially devastating effects of increased susceptibility to pathogens to our growing list of threats to the biosphere.

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