A Preliminary Investigation on Some Specific Aspects of Latex Balloon Degradation

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PURPOSE

The purpose of this preliminary investigation is to study some specific aspects of latex balloon degradation. This will be done in two ways. The first will involve a laboratory simulation in which balloons will be subjected to the conditions they would be exposed to following a release and subsequent entry into a marine environment. The balloons will be examined at different times during this simulation to qualify changes that take place. The second will consist of collecting balloon debris that has undergone natural degradation processes and comparing it to the results of the simulation.

MATERIALS AND METHODS

Outdoor Simulations

On 21 August 1989, 50 9" helium-filled Qualatex latex balloons were delivered to the Florida Marine Research Institute (FMRI), 100 8th Avenue Southeast, St. Petersburg, Florida. The balloons were purchased from and filled and delivered by Balloon Expressions, 8500 Ulmerton Road, Largo, Florida. These balloons were said to contain a clay additive to speed degradation.

The balloons were tied to cinder blocks on the white tile roof of the three story FMRI building and left in full sunlight for six hours. Exposure began at 12:00 noon and ended at 6:00 PM. The weather was mostly sunny and highs were in the nineties. The balloons had no respite from the sun except for an approximately thirty minute period near the end of exposure when the sun was partially occluded by clouds.

During the six hours of exposure, twenty balloons had burst. These were discarded and the only balloons used in further study were those that had remained fully inflated. Twenty-six of the survivors were ruptured using an open pair of scissors and four were slowly deflated by making a small hole in the latex. All of the balloons were then placed into a floating pen consisting of a six foot by three foot, three inch PVC rectangle, framing a one inch mesh net. The sides of the pen floated to keep the balloons inside, but the open meshed net allowed water to flow freely through the pen. This pen was placed in Bayboro Harbor and secured to a dock behind the FMRI building. Buildings shaded the area at sunrise, but ninety minutes after sunrise, the area was no longer shaded at any time of the day except by cloud cover.

On 1 September 1989, 70 helium-filled balloons were again filled and delivered to the FMRI by Balloon Expressions. Twenty-five were 10" Tilly latex balloons and 45 were 9" Qualatex latex balloons. These balloons were placed in the same area during the same time as before. The weather was again mostly sunny and highs were in the nineties, but from 4:00 to 6:00 PM there were intermittent rain showers. After exposure, the remaining balloons were deflated and placed in the floating pen.

Freeze-Dry Machine

After three hours of sun exposure on the FMRI roof (done as before), thirty five Qualatex latex balloons were put into a Northstar freeze-dry machine (Model# 48104) used by Preservation Specialties, Inc., Pinellas Park, Florida. After reaching a temperature of 0°C, the chamber was evacuated until all the balloons burst. An altimeter placed inside the chamber allowed for an estimation of the altitude at which various pressures would be encountered.

Collection of "Natural Debris"

During August and September of 1989, those conducting sea turtle nesting surveys in Florida were asked to collect any balloon debris found during those surveys and send it to the FMRI. These surveys consisted of patrolling the beach in search of sea turtle tracks and most of the balloon debris found was associated with stranded debris lines.

RESULTS

Outdoor Simulations

After six hours of exposure to the sun, the balloons were noticeably faded. When placed into the floating pen, all balloons floated. Two weeks later, five balloons were removed from the pen and found to have changed little from their original form. Aside from a thin coating of algae, no recent change was noticed. At four weeks, all the balloons had sunk to the bottom of the pen (approximately three feet underwater). Five were removed and found to be partly covered with heavy-bodied epifauna (e.g., barnacles, clams, etc.).

After one month, five balloons were removed every month to examined changes. From month to month, the tensile strength of the latex was gradually reduced and it became more tacky. At five months, the last month sampled, the latex would begin to tear with only moderate stretching and was fairly tacky. By six months, tunicates overgrew the lines holding the balloons and the balloons were lost.

High Altitude Simulation

Twenty-eight of the balloons placed in the freeze-dry machine burst into shreds approximately 2 to 3 millimeters wide. Eleven of the these balloons were completely reduced to unattached shreds and a neck, but seventeen, although partly or mostly shredded, remained intact (all or most parts still connected). Seven balloons burst without shredding.

The altimeter indicated that seven of the balloons burst prior to 20,000 feet while the others ruptured between 28,000 feet and 34,000 feet, with one lasting until 36,000 feet.

"Natural" Balloon Debris Collection

Natural balloon debris collected along the beaches of Florida demonstrated a wide variety of debris that had apparently undergone many different degradation processes. Most appeared to be little changed by environmental exposure while some had become very tacky or brittle. Many of the collected balloons had burst at a high altitude (as evidenced by shredding) but landed intact.

DISCUSSION

The main concern with balloon debris is the hazard to wildlife posed by ingestion. In the case of sea turtles, as many as 6.3% may die with balloon debris in their gastrointestinal tracts (Plotkin and Amos, 1989). The current study was undertaken simply to get some idea of the changes that a latex balloon undergoes when exposed to certain environmental conditions and how long it might be available for ingestion by animals such as sea turtles. Because the only obvious point of degradation at which a balloon would not pose an ingestion hazard to wildlife is upon total disintegration, changes in normally monitored characteristics such as tensile strength (Andrady, 1988) were not quantified.

Initially rising, some balloons lose air and descend intact. Others continue to rise, expanding as pressure decreases until the combination of cold temperature and low pressure causes them to burst. Balloons that rupture in this fashion are often shredded into strips approximately 2 to 3 millimeters wide. Burchette (1989) estimates that more than 95% of released balloons are reduced completely into these strips ("dozens of tiny pieces which float harmlessly back to earth"). Balloons that burst under the simulated conditions of high altitude in the freeze-dry machine and samples of "natural" balloon debris collected in Florida demonstrate that many if not most of the balloons that burst at a high altitude, although partly or mostly shredded, remain intact.

During flight, winds transport balloons laterally. In Florida, balloons may end up as debris in terrestrial, freshwater, or marine environments. In the sea, floating balloon debris may be particularly dangerous to young sea turtles. We know that the habitat for the initial developmental stages of sea turtles is at the surface of the open ocean. Here, advection from downwelling brings both the young turtles and their shelter and food (typically sargasso weed and its invertebrate fauna) together (Carr, 1987). This action also draws in floating debris. In a small pilot study, Lutz (1989) found that when presented small pieces (approx. $1cm^2$) of colored latex, young loggerhead sea turtles actively swam towards and ingested these pieces. Adult turtles are known to feed at the surface where floating debris collects (Carr, 1987) and may also encounter and ingest debris that has sunk due to a coating of heavy-bodied epifauna.

Ingestion of balloon debris poses a hazard both physically and chemically. Physically, plastic debris can block a portion of the GI tract, leading to other problems such as erosion of the intestinal mucosa, chronic diarrhea, reduction of nutrient absorption, necrosis, gangrene, and peritonitis. The degree of this physical pathogenicity usually depends on the amount of material ingested; however, small turtles may be severely affected by a relatively small amount of debris. Also, balloon debris appears to gather up in the gut so that material ingested over many months may collect to gradually create a dangerous blockage (Lutz, 1989). Chemically, digested balloon debris may release harmful constituents. Pieces of balloons that have passed through the GI tracts of sea turtles do deteriorate and this may have deleterious metabolic effects (Lutz, 1989).

In this study, balloon debris survived intact for six months. Although it floated during the first month in saltwater, heavy-bodied epifauna caused it to finally sink. Had the balloons not been attached to a line and resting along the bottom of the net in the pen, tunicates probably would not have overgrown the balloons and they may have lasted much longer. Balloons that are submerged in saltwater have been found to remain intact for periods of at least one year (Andrady, 1988).

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