Effect of Red Imported Fire Ant Envenomization on Neonatal American Alligators

CRAIG R. ALLEN,1 KENNETH G. RICE,1 DANIEL P. WOJCIK,2 AND H. FRANKLIN PERCIVAL,3 Florida Cooperative Fish and Wildlife Research Unit, Biological Resources Division, U.S. Geological Survey, and Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida 32611, USA, 4United States Department of Agriculture, Agricultural Research Service, Center for Medical, Agricultural, and Veterinary Entomology, P.O. Box 1465, Gainesville, Florida 32604, USA.

Alligator populations in the southeastern United States have substantially recovered since the late 1960s when they were placed on the federal Endangered Species List (Joanen and McNease, 1987). In Florida, both early age class and adult animals currently are harvested for commercial and recreational purposes (Hines and Abercrombie, 1987). In addition, the alligator is ecologically important as a keystone species and as an indicator of wetland health (Mazzotti and Brandt, 1994).

Recently, the nonnative ant Solenopsis invicta (the red imported fire ant) has surfaced as a potential threat to alligator populations. Solenopsis invicta is a relatively new (approx. 65 yr) non-indigenous addition to the invertebrate fauna of the United States. Solenopsis invicta is an opportunistic generalist; its main food items are other invertebrates (Wilson and Eads, 1949), but vertebrates also may serve as prey (Allen et al., 1994). Pipping young of oviparous vertebrate species may be especially vulnerable to direct mortality (Allen et al., 1994 and references therein), but indirect
effects also are possible (Allen et al., 1995; Guiliano et al., 1996; Pedersen et al., 1996). Indirect effects have been documented for juvenile northern bobwhite (Colinus virginianus), including lower survival rates and body mass gain (Giuliano et al., 1996) and behavioral changes including reduced time spent foraging and nesting (Pedersen et al., 1996). Anecdotai reports of S. invicta impacting herpetofauna are plentiful, but published evidence is limited (e.g., Landers et al., 1980; Mount, 1981; Mount et al., 1981; Freed and Neitman, 1988; Donaldson et al., 1994; Montgomery, 1996).

Since its introduction to Mobile, Alabama, S. invicta has spread throughout the southeastern United States (Vinson and Sorensen, 1986), and its range now completely overlaps the range of the American alligator. Solemynis invicta prefers marshes and wetlands with full to partial sun exposure for nesting (Tschinkel, 1988). In inundated marsh systems, alligator nests appear to meet the nesting requirements for S. invicta. Alligator nests generally nest in fairly open microhabitats, and their clutch cavities are raised above the substrate (Deitz and Hines, 1980). In habitats that are saturated with water, alligator nests may provide sufficient exposure and disturbance to become the preferred nesting location for fire ants. Surveys of central Florida lakes by the authors indicate that up to 20% of alligator nests in marsh habitats contain colonies of S. invicta.

We tested the hypothesis that envenomation by S. invicta has an impact on hatching alligator survival and body mass. Additionally, we tested whether eggs of the American alligator were attractive food sources for S. invicta. Whereas our tests were restricted to eggs and young of alligators, our results may be more generally applicable to oviparous herpetofauna.

Alligator eggs were collected as part of an ongoing long-term study from Lake Apopka in central Florida (see Woodward et al., 1993). Eggs used in experiments with S. invicta were collected from two partially flooded nests at risk of total loss due to inundation. The remaining viable eggs from these nests (18 and 12, respectively) were incubated separately from all other collected eggs, and monitored closely when they approached full term (see Woodward et al., 1989 for collection and incubation techniques). When initial pipping was noted, eggs were transported to facilities at the United States Department of Agriculture (USDA) Imported Fire Ant Laboratory, Gainesville, Florida. The clutches pipped approximately two weeks apart, and each clutch was divided randomly into a control and a treatment group.

Two days before the estimated hatch date of viable eggs from clutch A, we collected ten entire S. invicta colonies from Alachua County, Florida. Colonies were placed in 19-L plastic buckets simulating alligator nests with natural nesting material. Colonies were not collected directly from alligator nests because of logistical difficulties. It was important to collect entire colonies of S. invicta because worker behavior changes when queen(s) and brood are not present (Stringer et al., 1976). Solenopsis invicta colonies were maintained at the USDA Imported Fire Ant Laboratory, Gainesville, Florida.

After transfer to USDA facilities, treatment eggs were placed in alligator nesting material in 19-L buckets containing the viable colonies of S. invicta. Control eggs were transferred to identical 19-L buckets with nesting material but with no S. invicta. Each clutch was divided into three control and three treatment groups. For clutch A, three eggs were placed in each bucket. For clutch B, five eggs were placed in each bucket. Eggs were monitored closely during pipping. When a hatching liberated itself from its egg, the alligator was removed from the bucket and placed in water, simulating liberation from the nest by the adult female alligator.

After all eggs in a clutch pipped, the hatchlings were removed from USDA facilities and transferred to Florida Cooperative Unit alligator incubation/rearing facilities located at the Florida Game and Fresh Water Fish Commission (GFC) Gainesville Research Laboratory. Alligators were weighed on the day of hatching and web tagged in both hind feet with sequentially numbered #1 Monel tags (National Band and Tag Co., Newport, KY). Treated and untreated members of a clutch were combined and maintained in Unit facilities. Hatching alligators were fed extruded pelleted alligator feed ad libitum. Alligators were weighed at four weekly intervals. During each weighing period, alligators were weighed in water and examined for secondary effects of S. invicta envenomation. Handling of alligators was limited to weekly weighing and was minimized as much as possible during those periods. Body mass was determined with a hand-held 200 g spring scale accurate to 0.1 g. After cessation of the experiment, surviving alligators were released at their original nest sites. We pooled clutches and used a repeated measures analysis of variance on body mass with body mass at time of treatment as a covariate (SAS Institute Inc., 1989).

We tested whether eggs of the American alligator were attractive food sources for S. invicta prior to pipping by utilizing nonviable eggs collected from nests on Lake Apopka. These eggs (N = 20) were placed in colonies of S. invicta maintained in 61 cm × 36 cm × 13 cm bus trays at USDA facilities. Eggs were observed daily to see if they were breached by S. invicta.

On average, hatching alligators took about 15 min to complete the hatching process. Two animals exposed to S. invicta died. The first death occurred within five minutes of hatching. In that instance, the alligator was slow in pipping and had difficulty escaping from its egg. As a result, that alligator received numerous fire ant stings (>30). The second death occurred six days after treatment, just prior to the second weighing. That specimen was cannibalized before discovery, and the proximate cause of death could not be determined. All animals in the control group survived to release. Non-lethal injuries as a result of S. invicta stings were apparent in approximately 50% of experimental animals, and included swelling of extremities, especially digits, and visible pustules on the digits and around the eyes, where most stings occurred.

On the day of treatments, body mass did not differ between treated and control groups (P > 0.50). One week post-treatment, body mass differed between these two groups (P = 0.013). This difference in body mass remained consistent (week 2, P = 0.09; week 3, P = 0.006) for the three week period of this study (Fig. 1). An overall treatment effect was present (P = 0.002), but there were no significant time effects or interactions (P > 0.10).
weight gain of juvenile animals can result in reduced survival in the wild (Brockelman, 1975; Congdon and Gibbons, 1985; Parker and Plummer, 1987; Grant, 1991). We suggest that effects may be more pronounced in smaller and less robust species. This is the first experimental evidence documenting indirect impacts by S. invicta on herpetofauna. The results are probably applicable to other egg-laying reptile species. Of particular concern is the impact of S. invicta on hatching sea turtles and other endangered species. The authors have documented S. invicta on sea turtle nesting beaches and in sea turtle nests even on remote islands in the Lower Florida Keys, Marquesas Keys, and Ten Thousand Islands in south and southwest Florida.

Anthropogenic land use change has decreased habitat for many reptile and amphibian species (Richards, 1993). Increasingly, remaining habitat is disturbed and fragmented increasing the attractiveness of these sites to S. invicta (Tschinkel, 1988). Furthermore, at both local (Wojcik, 1993) and regional (Cokendolpher and Phillips, 1989) scales, S. invicta populations and range are increasing. We believe that the population-level impact of S. invicta on many vertebrates is chronic and incremental, and, as such, not readily obvious.

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LITERATURE CITED


GIULIANO, W. M., C. R. ALLEN, R. S. LUTZ, AND S.


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