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Mortality of Nile Crocodile (*Crocodylus niloticus*) Eggs Caused by the Flour Beetle (*Tribolium castaneum*)

Kosta Y. Mumcuoglu
Department of Microbiology and Molecular Genetics, The Kuvin Center for the Study of Infectious and Tropical Diseases, The Hebrew University-Hadassah Medical School, Jerusalem, Israel
Email: kostam@cc.huji.ac.il

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ABSTRACT

It is estimated that quarter to half a million specimens of the Nile crocodile (*Crocodylus niloticus* Laurenti, 1768) live in liberty. Ranching crocodiles for their skins has been successfully implemented in several African countries but also in Israel. Recently, in one of these ranches, an increased mortality of crocodile eggs was observed and it was thought that insects were causing their death. Two crocodile eggs were kept together with 100 adults of *Tribolium castaneum* (Herbst, 1797), while the third egg was kept without beetles. No food for beetles was added to the boxes. The eggs were observed twice a month for any kind of changes on their surface. After two months, at least 39 holes were observed in one egg and 146 on the second egg, which was exposed to beetles, while no holes could be seen in the control egg. Some of the holes were deep enough to see the inner layers of the egg. There is enough evidence to believe that adults of *T. castaneum* are able to damage the eggs of the Nile crocodile and in some cases lead to their death; measures should be taken to protect the eggs from this and similar species of beetles.

Keywords: *Tribolium castaneum*; *Crocodylus niloticus*; Mortality; Israel

1. Introduction

The Nile crocodile (*Crocodylus niloticus*) is the largest crocodilian in Africa and is sometimes regarded as the second largest crocodilian after the saltwater crocodile. The male crocodile usually measures from 3.5 to 5 m, while the mature female measures 2.4 to 4.0 m. Today, it is estimated that a quarter to half a million specimens of the Nile crocodile live in liberty, especially in east and southern Africa, including Somalia, Ethiopia, Kenya, Zambia and Zimbabwe, as well as in Madagascar. As its name suggests, it is present in the Nile River, whereas it is absent from the Sahara Deserts. They are found in rivers, lakes, waterholes, mangrove swamps, estuaries, and freshwater marshes. They are mostly aquatic, but travel easily on land. They nest during November to December, which is the dry season in the north of Africa, and the rainy season in the south. Preferred nesting locations are sandy shores, dry streambeds or riverbanks. The female digs a hole, close to the bank and lays her eggs (usually 25 - 80) up to 50 cm deep in the soil. The eggs resemble hen eggs, but have a much thinner shell [1-3].

The only enemies of the Nile crocodile are members of the same species and humans. They have been overhunted by humans for their skin, which is good for tanning, and their meat. Habitat destruction also diminishes their numbers. The young are preyed upon by Nile monitor lizards, marabou storks, herons, ibises, turtles, and catfish [4-8].

Ranching crocodiles for their skins has been successfully implemented in African countries as well as in countries outside this continent such as in Israel. In 1993, 80,000 Nile crocodile skins were produced, the majority from ranches in Zimbabwe and South Africa [4].

In Israel, there are at least three Nile crocodile ranches (Moshav Fatzael in Jordan Valley, Hatzeva in Dead Sea area and Hamat Gader in the southern Golan Heights), where thousands of crocodiles are bred for their skin and as an attraction for tourists. Lately, the owners of one of these ranches observed a high mortality of eggs and had the impression that insects were responsible for the mortality.

The aim of this study was to investigate whether the flour beetle, *Tribolium castaneum*, was able to damage the egg surface of the Nile crocodile and cause its death.

2. Case Report

On invitation, one of the crocodile ranches in Israel was visited on 14. 09. 2011 and together with those responsible for the breeding, the egg incubation facilities and the pools with the young and old crocodiles were visited.

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The egg breeding facility was composed of two incubators and three rooms, which were used for storage. There were many Styrofoam boxes, which were used for keeping the eggs during the incubation period, as well as large quantities of small particles of golden colored foam, which was used as "nesting material" for the incubated eggs.

In most of the Styrofoam boxes with eggs and nesting material there were eggshells and dead or dying embryos. According to the breeders, the nesting material had not been changed during the last 8 - 9 years and it was full of egg remains. The Styrofoam boxes in use and those, which were stored, were filthy. Due to a recent insecticidal spraying large numbers of dead beetles could be seen on the floor.

Examination of the stored breeding material as well as of the breeding material inside the Styrofoam boxes with the eggs, revealed the presence of large numbers of beetles (adults and larvae). In addition, small numbers of ants, cockroaches and flies could be seen in and around the incubators, while spiders and spider webs could also be seen in several Styrofoam boxes.

According to the man responsible for the breeding, the beetles were often seen on the upper part of the eggs and succeeded making holes and ingesting the contents of the eggs. He also observed that crocodile embryos usually open one of the two ends of the egg for hatching (**Figure 1**), while the holes which the beetles were causing were most of the time on the convex part of the eggs (in the middle) (**Figure 2**). The same worker also observed that the number of beetles had increased significantly in the last two months.

Samples of the breeding material (golden colored foam) were examined in the laboratory and over 150 beetles and 130 larvae were isolated. The beetles were identified as the red flour beetle (*Tribolium castaneum*).

3. Experiment with Crocodile Eggs

Three eggs of *C. niloticus* were taken from the breeding colony and transported to the laboratory, where they were kept at 30˚C + 1˚C and 85% + 5% RH.

One hundred adults of the flour beetles were isolated from the material taken from the crocodile farm.

All three eggs were examined under stereomicroscope for any kind of abnormalities, including holes, and found to be intact. Two eggs were kept together with the 100 flour beetles, while the third egg was kept without beetles. No food for beetles was added to the boxes. The eggs were observed twice a month for any changes on their surface. Beetles were often observed walking and staying on the egg surface, as well as under the eggs, but started moving immediately after they were exposed to light (**Figure 3**).

Figure 1. Hatching embryo of the Nile crocodile.

Figure 2. Holes, which were apparently caused as a result of the activity of red flour beetles on the surface of three Nile crocodile eggs.

After one month the first holes has been observed on the surface of both eggs, which were kept together with the beetles and their number increased during the following observations. After two months, at least 36 holes were observed in one egg and 149 on the second egg, while no holes could be seen in the control egg (**Figure 4**). Some of the holes were deep so deep that the inner layers of the egg were visible (**Figure 5**). None of the eggs hatched.

4. Discussion

The flour beetle is known as a worldwide stored product pest. It usually breeds in damaged grain, grain dust, high-moisture wheat kernels and flour, pasta, biscuits, beans, nuts, oats, rice and crackers [9].

In the present study, it was shown that they are able also to damage the surface of the Nile crocodile eggs and eventually also ingest their contents. In any case, some holes on the surface of the two exposed eggs were deep enough to see the interior layers of the eggs. It is assumed that changes of the water balance inside the eggs, and the super infections caused by bacteria, caused the

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Figure 3. Adult of *Tribolium castaneum* active on the surface of the Nile crocodile egg.

Figure 4. Two Nile crocodile eggs exposed to adults of *Tribolium castaneum* beetles (below), on which some of the areas with holes are marked, while the control egg is seen above.

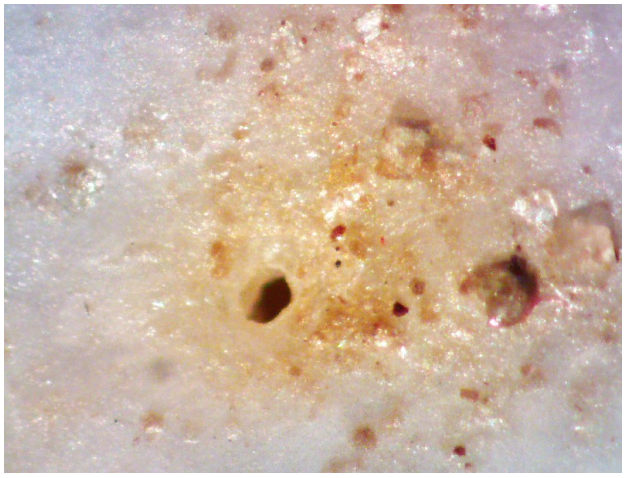

Figure 5. Hole caused as a result of *Tribolium castaneum* beetles on the surface of the Nile crocodile egg.

death of the eggs, while the mortality caused to the control egg, could be explained by the changed breeding conditions and transportation and handling under the microscope for photographing and observation.

To our knowledge, this is the first report on damage caused to the surface of crocodile eggs by insects in general and by flour beetles in particular.

Regarding the crocodile ranch, it is believed that the flour beetles easily found their way to the incubators and the storage rooms of the crocodile farm due to the special construction of the building (first floor and in the middle of garden). The fact that the nesting material was re-used and large quantities of organic material deriving from damaged eggs were used as food by the larval and adult stages of the beetle, as well as the high temperature and humidity in and around the incubators were probably also the cause of the population explosion of the beetle colony.

To the owners and workers of the range, it was suggested to: thoroughly clean the floor and walls and repaint the facility; use new Styrofoam boxes and breading material; transfer all the non-hatched eggs, after having cleaned them exteriorly and removed any beetles on the surface of the eggs; remove any dead, dying eggs, eggs shells and dead embryos from vicinity of living eggs; dispose of all boxes and breeding material at the end of each breeding session; spray the facility with an insecticide; keep the storerooms clean; and remove any unused material from the breeding facility.

According to the information, which was received a few months later from the owner of the crocodile farm, a decrease in the mortality of the crocodile eggs was observed.

Due to their thick skin, crocodiles do apparently not have many ectoparasites. The most significant ectoparasite of the American alligator (*Alligator mississippiensis*) is the leech *Placodella multilineata* [10].

Lately, a sharp increase of mortality among young Nile crocodiles on a rearing farm in the south of Israel was reported. Clinical inspection of the animals in the rearing rooms revealed that about 20% of the young animals suffered from severe swollen abdomens with clinical signs of dyspnea. Post mortem examinations revealed severe expansion of the stomach and extensive damage to the mucosa with the presence of partly digested traces of black beetles, which were diagnosed as *Blaps nitens laportei*. It was suggested that the benzochinons excreted by the defense glands of the beetles caused the clinical symptoms. A significant decrease in mortality was observed after the beetles were removed from the breeding facility [11].

In conclusion, there was enough evidence to believe that adults of *T. castaneum* are able to damage the eggs of the Nile crocodile and in some cases lead to its death; measures should be taken to protect the eggs from this and perhaps similar species of beetles.

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REFERENCES

[1] G. J. W. Webb, S. C. Manolis and P. J. Whitehead, "Wildlife Management: Crocodiles and Alligators," Surrey Beatty & Sons Pty Ltd., Chipping Norton, 1987, p. 552.

[2] C. A. Ross, "Crocodiles and Alligators," Facts on File Inc., New York, 1989, p. 240.

[3] B. Branch, "Field Guide to Snakes and Other Reptiles of Southern Africa," 3rd Edition, Ralph Curtis Books Publishing, Sanibel Island, 1998, p. 399.

[4] H. B. Cott, "Scientific Results of an Inquiry into the Ecology and Economic Status of the Nile Crocodile (*Crocodylus niloticus*) in Uganda and Northern Rhodesia," *The Transactions of the Zoological Society of London*, Vol. 29, No. 4, 1961, pp. 211-356. doi:10.1111/j.1096-3642.1961.tb00220.x

[5] M. L. Modha, "The Ecology of the Nile Crocodile (*Crocodylus niloticus* Laurenti) on Central Island, Lake Rudolf," *African Journal of Ecology*, Vol. 5, No. 1, 1967, pp. 74-95.

[6] C. A. W. Guggisberg, "Crocodiles. Their Natural History, Folklore and Conservation," Purnell, London, 1972.

[7] J. M. Hutton, "Movement, Home Range Dispersal and Separation of Size Classes in Nile Crocodiles," *American Zoologist*, Vol. 29, No. 3, 1989, pp. 1033-1050.

[8] D. K. Blake and N. Jacobsen, "The Conservation Status of the Nile Crocodile (*Crocodylus niloticus*) in South Africa," In: *Conservation and Utilization of the Nile Crocodile in Southern Africa. Handbook on Crocodile Farming*, Crocodilian Study Group of South Africa, Pretoria, 1992, pp. 11-21.

[9] A. Khalifa and A. Badaway, "Biological studies on *Tribolium confusum* (Duv.), *Tribolium castaneum* (Hbst.) and *Latheticus oryzae* (Waterh)," *Bulletin of the Entomological Society of Egypt*, Vol. 39, 1955, pp. 351-373.

[10] E. R. Jacobson, "Immobilization, Blood Sampling, Necropsy Techniques and Diseases of Crocodilians: A Review," *The Journal of Zoo Animal Medicine*, Vol. 15, No. 1, 1984, pp. 38-45.

[11] B. Perelman and V. Chikatunov, "Intoxication of Young Crocodiles in Captivity Due to the Ingestion of Darkling Beetles *Blaps nitens laportei* Ardoin (*Coleoptera*; *Tenebrionidae*)," *Israel Journal of Veterinary Medicine*, Vol. 65, No. 3, 2010, pp. 100-102.

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