ON THE ADAPTATION OF CERTAIN OF OUR SNAKE SPECIES FOR EATING BIRDS' EGGS

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I set forth my observations in 1940 on a large specimen of an Amurian runner (Elaphe schrencki Str.), taken from the Soviet Far East. In captivity it readily and repeatedly swallowed chicken eggs, even very large ones.

As a rule, the runner began to swallow the egg from its blunt end. Depending upon the size of the egg the whole process of swallowing - from the moment of its seizure to dropping into the esophagus - lasted 10 - 20 minutes. It is interesting that the shell of the egg was not damaged and bore no visible marks from the snake's teeth. After the egg entered the esophagus, the runner pressed head and fore part of the body to the floor of the terrarium and bent almost vertically the part of its body which was situated behind the egg in the esophagus. Then followed a movement of the elevated section of the body forward and downward. The noise of the shell breaking was heard, and the part of the body which was stretched by the swallowed egg, immediately very much diminished in diameter. It is very certain that the egg was crushed in the esophagus, and by no means in the intestines, as described by A. A. Emelyanov, and the contents of the egg dealt with in the stomach. In contrast to the egg snake, which apparently eats birds' eggs exclusively and regurgitates the shell immediately after it has been crushed in the esophagus, the Amurian runner passes the shell through the entire alimentary canal and it appears with the excrement. In the runner which I observed pieces of the broken shell appeared with the excrement 5 - 8 days after the egg was swallowed.

Having repeatedly observed this process in the Amurian runner living in a terrarium, I have concluded that in crushing the shell, part of the hypapophyses of the fore section of the spinal column must have participated. An investigation of the spinal column of three specimens of the Amurian runner, of which one was young, verified this assumption (Chernov 1945).

As in many other species of the family Colubridae, in the Amurian runner there are hypapophyses only in the anterior vertebrae of the spinal column. The hypapophyses of the first 10 - 11 vertebrae are turned backward and in this respect are not different from those of most other species of the family. However, beginning with the 11 - 12th vertebrae, they take a vertical position, and from the 15 - 16th curve forward and become somewhat thicker. In all vertebrae, from the 15 - 16 to the 39 - 40, the hypapophyses are directed forward and downward (fig. 2). In the following 2 - 3 vertebrae the hypapophyses again take a vertical position and later, becoming sharply diminished, again are directed backwards. Beginning with the 44 - 45th vertebrae the hypapophyses are missing (fig. 1).

The fact that in the African egg snake - Dasypeltis scabra (L.) - the lower aristate hypapophyses of the anterior vertebrae penetrate the wall of the esophagus and serve for crushing in the center of the shells of eggs, which comprise the basic, and often the only food of this snake, has been known widely and early. It was worked on and demonstrated in great detail at the end of the last century by L. Katheriner, 1898 and recently by C. Gans, 1952.

An analogous function of the hypapophyses is also assumed in the furrow-backed snake Elachistodon westermanni Reinhardt which is known only from a few specimens from N. Bengal (India and East Pakistan). The ecology of this very rare species is entirely unknown. The conclusion that it is an egg-eating snake was based on the similarity of its hypapophyses with those of the egg snake and on finding an egg yoke in the stomach of one. However, undoubtedly, this snake must eat other food also, consisting primarily of various small vertebrates. I note that Gans and Williams (1954), having re-examined specimens kept in the British Museum of Natural History, and parts of its skeleton, are agreed that the hypapophyses perforate the wall of the esophagus.

In these species of snake there are few teeth (in the egg snake, for example, there are 5 - 9 on the maxilla, 4 - 5 on the dentary, where they are situated only in its hind section, 4 - 8 on the palatine, and none at all on the pterygoid, and they are so small that they do not protrude from the mucous membrane. The reduction in the number and size of the teeth, just as in a number of other peculiarities of skeletal structure, is considered an adaptation for swallowing eggs, which have a firm shell, and, particularly, for regurgitating the latter from the mouth in a crushed state.

Some authors (Boulenger, 1894, etc.), considering the structural peculiarities of the anterior hypapophyses, separate the monotypic genera Dasypeltis and Elachistodon into special subfamilies of the family Colubridae: the first into the Dasypeltinae, and the latter, in which there are 1 - 2 grooved teeth in the hind section of the upper jaw, into the Elachistodontinae.

Along with these species of snakes, there exist also a number of those which eat birds' eggs as well as small mammals, lizards and other animals. However, in the past 40 years the adaptations for and mechanics of crushing the firm lime shell of eggs have not been studied. I know only of A. A. Emelyanov's indication (1929) of the fact that the Amurian runner, climbing to a chicken-coop, eats chicken eggs, and, "having swallowed the egg, it [the runner -- S. Ch.] bends it and breaks it in its intestine." However, the latter, as can be expected, has not been confirmed in observations of the swallowing of eggs by this runner.

The hypapophyses of the vertebrae along the esophagus jut into its dorsal wall, adhering rather solidly to the vertical surface of the muscle by means of a connecting tissue. However, the hypophyses in the Amurian runner do not perforate the wall of the esophagus and do not enter its cavity, as in the egg snake. Also, the lower surfaces of the hypapophyses in this runner are approximately of identical form, whereas in the egg snake the hypapophyses of the 22 - 26th vertebrae are sharply different from all the others in their more or less spherical form.

The observation of the swallowing and crushing of large eggs by the Amurian runner combined with the structure of the fore section of its spinal column leads me to the conclusion that the latter is an adaptation for crushing egg shells in the esophagus. The mechanism of this adaptation consists of the fact that having swallowed the egg the runner squeezes it between the tips of the foreward-directed hypapophyses, which are wedged in the wall of the esophagus, and shortening the muscles, presses the shell and breaks it.

I have observed a similar adaptation in the spinal column in a number of other snake species which eat eggs of various birds along with other types of food. Similar structure of the hypapophyses occur on the vertebrae lying along the esophagus in the figured runner (E. dione), 4-striped runner (E. quatourlineata) and insular runner (E. climacophora), and also in the American E. obsoleta. Thus, in the figured runner the hypapophyses of the 5 - 6th anterior vertebrae are directed, as in the other species, backward and downward, the two following stand almost vertically, then their direction changes and beginning with the 8 - 9th vertebrae, they are turned forward and downward (fig. 3). The last vertebrae bearing hypapophyses are the 34 - 35th (in 3 specimens).

Gans and Oshima (1952), not knowing of my data on the adaptation of snakes to eating birds' eggs (Chernov 1945), in 1952 published an article on the same subject. The species on which their observations were based was the insular runner (E. climacophora). Their publication confirm my data[1] and -- with the addition of E. guttata, E. taeniura and E. carinata -- increase the number of species, in the structure of the spinal column of which the authors were able to observe analogous characteristics. It is interesting to add that, according to those authors, in E. carinata several hypapophyses perforate the wall of the esophagus, which is not found in other species of the genus Elaphe. It must be said that in my other investigations of species of the genera Elaphe (E. rufodorsata, E. longissima, E. hohenackeri) and Coluber all the hypapophyses are directed backward and below (fig. 4).

((1 In their material the last hypapophysis bearing vertebra in the "spotted?" ( ) runner is the 39th, which testifies to the possibility of some variations in the number of vertebra present in one and the same species.))

So far as is known, these runners do not eat birds' eggs; in any case, in their stomach-intestinal tract remains of egg shells have not been found. I note that in its external morphology the red-backed runner in general differs comparatively little from the patterned one, but in contrast to the latter, leads a semi-aquatic life, eating small fish and amphibians, and are oviviparous snakes.

This whole discussion about the structure of the spinal column in snakes in the food of which hard-lime-shelled eggs are known to occur, has led me to the conclusion that Dasypeltis and Elachistodon cannot be separated as special -- or a special -- subfamilies, as is presently done.