Fayoum University
Faculty of Science
Zoology Department

Embryonic Development Of Fangs And Venom Glands In Snakes

By
HAGAR IBRAHIM HOSNI BAYOUMI

A thesis submitted in partial fulfillment
Of
The requirements for the degree of

Doctor of Philosophy

In

Zoology
(Comparative anatomy and embryology)
Zoology Department
Faculty of Science

FAYOUM UNIVERSITY

2023

Fayoum University
Faculty of Science
Zoology Department

Embryonic development of fangs and venom glands in snakes

By
HAGAR IBRAHIM HOSNI BAYOUMI
Master in Zoology
(Comparative anatomy and embryology)
Zoology Department
Faculty of Science
Fayoum University

Supervisors:

Prof. Dr. Naglaa Refeat Ismael

Professor of physiology, Zoology Department, Faculty of Science, Fayoum University.

Dr. Ahmad Ali Kandeel
Assistant Professor of Comparative Anatomy and Embryology, Zoology Department, Faculty of Science, Fayoum University

2023

ABSTRACT

Comparative analysis of normal developmental stages of squamates (lizards and snakes) has increased recently. It explains the basic concepts in development and evolution not only in reptiles but also in vertebrates generally. Viperidae and Elapidae are two main families of venomous snakes whose venom poses danger to humans. These snakes are front fanged snakes within Caenophidia (advanced snakes). These advanced snakes have the most specialized venom system. The fang and the postorbital venom gland are the main components of the venom delivery system. The tubular fangs are part of the front-fanged trait, which are thought to have evolved independently several times in snakes. Also, the venom gland expresses the phylogenetic relationships among taxa of caenophidian snakes. The structure of venom gland and related fangs is the focus of attention among many previous descriptive papers. Here, we establish the post-ovipositional development of the viperid snake *Cerastes cerastes* and compare it with the previously published embryonic table of the elapid snake *Naja haje*. Also, we documented the comparative development of the venom gland and fang in *C. cerastes* and *N. haje,* showing how the fang differs in development and in structure from rest of teeth using serial sections, immunohistochemistry (TUNEL), and Micro-CT scanning. This study show that post-ovipositional development of *C. Cerastes* could be discriminated into eight stages. The common external features between *C. cerastes* and *N. haje* are developed by the same developmental pattern at the same incubation temperature, with different timing, though. Here we confirm that the venom canal inside the fang makes is different from rest of teeth in structure and

development. This work shows how the venom canal of fangs is formed by combining the infolding theory and the brick chimney theory. Briefly, there are similarities in fang and venom gland development between *C. Cerastes* and *N. haje*. This supports the previous observations that morphology of developing elapid and viperid fangs is essentially the same. Conclusively, the venom glands of the various Caenophidian snakes, which include the front-fanged Viperidae, Elapidae, and Atractaspidinae as well as non-front-fanged species, are homologous and originated from a single origin at the base of colubrids radiation 80 million years ago.