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PREHENSILE MECHANISM BASED ON THE SNAKE BIOMECHANISM

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Abstract: We start with the anatomical data of the snake masticatory apparatus and we study the possible movements of this biological mechanism. It highlights the features of this mechanism and his similarity with the free opening mechanisms of the electrical devices. It is designed a prehensile mechanism based on findings during the study of the snake biological mechanism.
Keywords: *prehensile mechanism, biomechanism, snake*

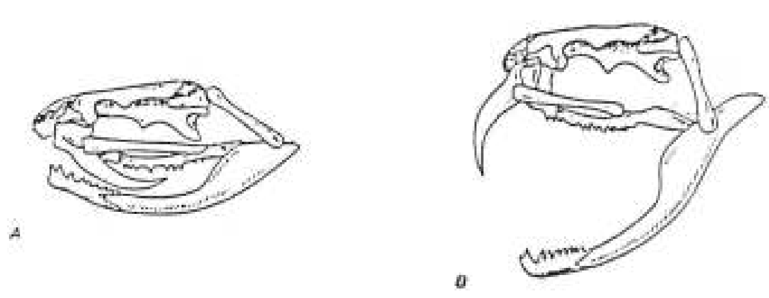
1. INTRODUCTION

The living world has become in the last decade a vast field of study for experts in biomechanics and bionic, as constructive solutions are best found by living beings, based on a long evolution.
Research in this area were also made by the following authors: Dudița F., Popescu I., Stareţu I., Wittenberger C., Opris T.

The domain is currently studied by various researchers in the world. Thus, Freek Vonk from Netherlands has a website [http://www.news.leiden.edu/news/serpent-had-fang-at-back-of-mouth.html] where details the biological problems of the snake masticatory apparatus . Other biological data appear in the website [http://science.jrank.org/pages/6207/Snakes.html] and in other pages on the Internet.

2. MASTICATORY APPARATUS OF THE SNAKE. MORPHOLOGIC ANALYSIS

The serpent is a celomat animal, vertebrate phylum, reptile class. The skull of a poisonous snake is given in fig.1.



A -closed mouth, B- open mouth.
Figure 1: The snake skull [3]

The prehensile biomechanism of the snake shows some particularities that distinguish it from domestic mammalians presented earlier.

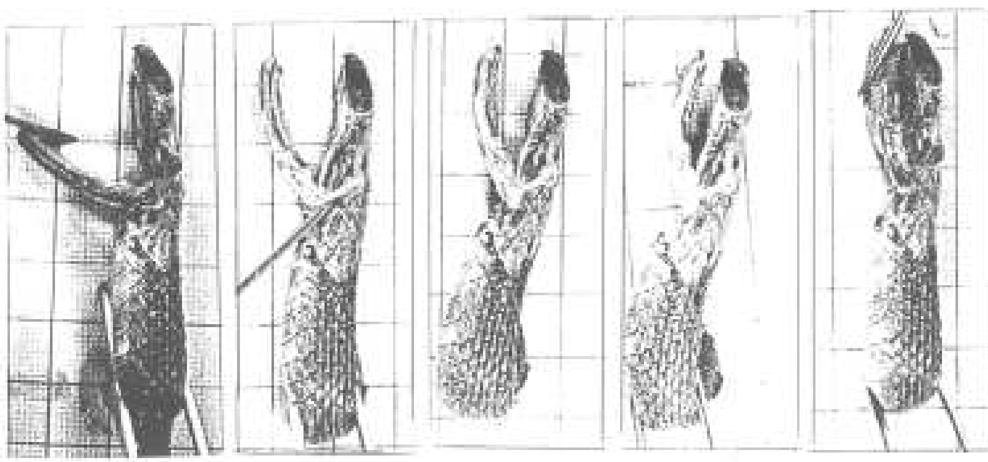
The mandible links to the skull by a bone called "square", which lies horizontally in rest and when the animal opens its mouth the bone takes the vertical position, allowing a very wide opening of mouth. In this case, the prey is swollen without chewing. The proximal extremity of the square is poorly fixed to skull and mobile in the joints, allowing wide open mouth.

The upper jaw bones of snakes have the form of sticks, thus allowing a certain independence from the skull and they articulate movable with each other.

3. THE MOVEMENTS STUDY

. Based on observations made on the skull of the viper, from figure 1 and from studies on a dead snake head, were determinated the particularities of the skull mobile bones.

In figure 2 are given the photographs taken on a snake skull, to establish mobile bone movements.



. **Figure 2:** Snake skull. Aspis viper. Photos.

It was noted that the square bone is mobile and has the form of a rod which is articulated at one end to the neuroskull and with the other one to the two jaws.

Pterygoids are long rod shaped and they join with the neouroskull by a mobile joint. The two halves, right and left of the mandible are independent and are linked only by an elastic ligament.

The maxillaries are mobile articulated to the base of the skull in nasal region and pterigoyds are mobile articulated to the square bone.

During mouth opening, square bone moves almost vertically and removes than the two jaws of the skull base, so that the mouth expands greatly.

The supratemporal bone is mobile articulated, with one end to the skull and with the other one to the square bone, together forming a mobile lever.

Upper jaw consists of premaxillas, maxillaries, palatine, ectopterygoids and pterygoids. All these bones, elongated like levers are mobile articulated between them and operate as a lever system.

When the mouth is closed, the jaws are directed less obliquely backwards and head back venomous teeth, are applied to the palatine vault.

The two jaws are parallel to the skull base and square bone as well, having its distal end pointed back.

When the mouth opens, the lever formed by the supratemporal and square is moving almost vertically and removes over from the skull base the two jaw joints.

When he uprights, the square bone pushes through lever system consisting of pterygoid, ectopterygoid, palatine and maxillary, so that the maxillary moves forward, causing venomous tooth projecting beyond.

Because of this system of levers, formed by the jaws bones and their mobile joints, vipers can open mouth widely, and the two jaws can close together a great angle.

4.THE STUDY OF A SNAKE HEAD BIOMECHANISM

It starts from the drawing of figure 1, which is enlarged and filled with the notation C, D, E, resulting in figure 3 (position "closed"-figure 3.A, position "open"-figure 3.B).

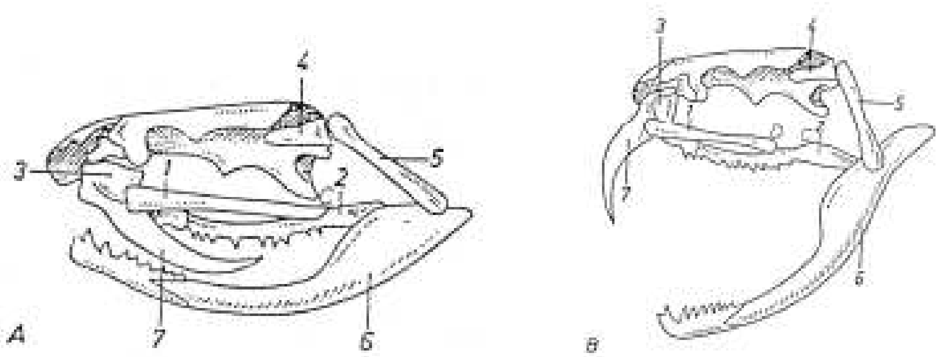


Figure 3: The snake skull biomechanism

To follow possible movements, they overlapped the two limit positions (fig. 4), with some adaptations, as drawings made by biologists are not strictly to scale.

From the analysis of possible movements can be concluded that:

-tooth 7 and bone 5 are articulated to the skull, considered the mechanism base;

-the 6 mandible consists of two pieces, in the Zoology work is shown that the teeth part moves, carrying prey to the inside (there are some ligaments, not shown in the drawing of figure 3);

-bone 1 takes two limit position, close to the neutral position; he rests (figure 3, A) on C 2 zone (similar to a ratchet), respectively in the D zone- as a ratchet too (figure 3, B);

-position A is characterized by maximum "wrapping" of the mechanism and the B position is characterized by maximum opening;

-the 2 bone has C and D areas for bone 1 block; thereby is ensured the mechanism locking in the two limit positions, through bones and not through muscular exertion;

-in intermediate positions, bone 1 moves on bone 2;

- it is also found the support-also of ratchet type- of tooth 7 in the E area.

Somewhat similar mechanisms are shown in some electrical appliances (with joints, curved bar and ratchets), being known as "free opening" mechanisms.

In figure 5 is given a kinematic scheme of the equivalent mechanism. There we see that element 1 acts only by locking in positions C and D. We also observe the propulsive slide on item 6, for the advancement of the prey inside. Since this movement is independent, occurring during the blocking of the rest of the mechanism in "open" position, below it will no longer be studied together with the mechanism movement.

To establish the directions of the movement and of the domains in which the elements move, they drew some of this, in extreme positions, in figure 6.

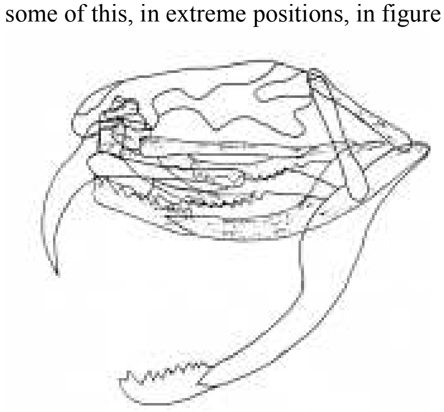


Figure 4: Biomechanism in limit positions

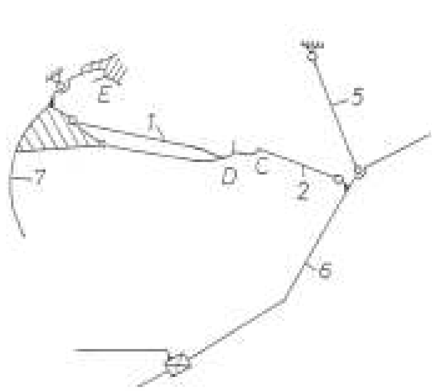


Figure 5: The kinematic scheme of the mechanism

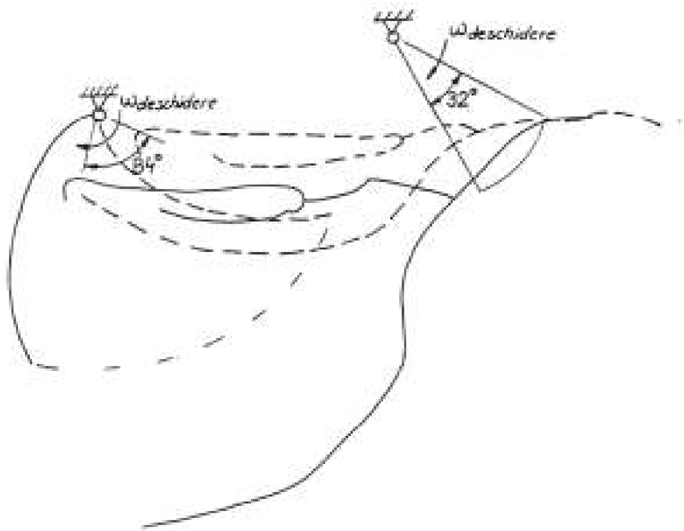


Figure 6: The mechanims with elements in extreme positions

5. CONCLUSIONS

- □ The masticatory apparatus of the snake is a prehensile biomechanism.
- □ The biomechanism provides a wide opening and a convenient packaging.
- □ Functional, this mechanism is similar to the free opening mechanisms from electrical devices.
- □ The equivalent mechanism which has been established is a prehensile mechanism.

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