DISCUSSION

THE BREATHING MECHANISM OF TURTLES

THE commonly accepted statement that turtles breathe air in a manner essentially similar to frogs is in serious error. Most of the text-books that mention the breathing mechanism of the turtle have perpetuated the respected opinion of Louis Agassiz[1] and many others that the air is pumped into the lungs by throat action. Casual observation of any turtle will show that the hyoid apparatus does indeed produce movements like those in the Amphibians. It is not surprising, therefore, that such actions should be deemed the essential mechanism of breathing.

During the course of operative experiments upon the box turtle in which the body cavity was opened it became obvious that throat action was ineffective and probably had nothing to do with the case. Further experiments to test the efficacy of the hyoid apparatus and to ascertain what did cause the movements of inhalation and exhalation indicated that the whole action was performed by distinct respiratory muscles in the body and not by the throat. That turtles with broken imperfect jaws continue to breathe and live with an impossible and leaking mouth pump, that there are no valves in the nostrils of turtles, and that experimentally the mouth may be tied open indefinitely without affecting the animal's breathing should explode the notion of a mouth pump. Further, tracheotomy shows no air movements in the trachea during the expansion and contraction of the throat. The throat actions do result in aeration of the mouth, and in aquatic turtles where water is taken in and out of the mouth, it affords respiration through the lining of the mouth and pharynx. This has been shown by S. H. and S. P. Gage[2] in 1885.

In his excellent book "Turtles of the United States and Canada," Mr. Pope[3] puts no faith in throat action, but points out that it appears to be a rotation of the girdles which is responsible for the chief respiratory movements. This is an interesting view but somewhat obscure. It is doubtful whether the pelvic girdle should be considered in this regard, but it is true that the pectoral girdle does rotate during the respiratory movements.

The essence of the whole mechanism has been adequately described in a paper by S. Weir Mitchell and George R. Morehouse[4] published in 1863, and apparently forgotten by the subsequent generations of comparative anatomists. Briefly, inspiration is accomplished by two flank muscles which, acting like the mammalian diaphragm, enlarge the coelom and thus suck air into the lungs. The shoulder girdle passively rotates forward during inhalation. To accomplish expiration, the turtle uses an expiratory muscle consisting of two anterior and two posterior bellies connected by a tendinous band continuous across the mid-ventral line, and common to both sides of the animal. Air is forced out by the concerted action of the four parts of this muscle which compress the viscera against the lungs. This action may be aided by pulling in the legs and neck which thus further tend to decrease the body cavity. It has been clearly shown that girdle, leg or neck movements need not take place. The muscles mentioned are entirely adequate to the task. It follows then that an open body cavity will stop breathing. It is easy to demonstrate with the use of a manometer attached to the coelom that the pressure momentarily dips during inspiration and rises during expiration.

Dr. Simon H. Gage,[5] writing in 1883, says: "During the last twenty-five years the mechanism of respiration in the Chelonia has been investigated with considerable thoroughness both in this country and Europe; and at present the Chelonian form of respiration is considered to be comparable with that of the mammal rather than that of the frog, as formerly supposed." In spite of misleading text-books, the suspicion is strong that the turtles have not changed since.

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NICOTIANA RUSTICA CULTIVATED BY PUEBLO INDIANS

IN 1934, while engaged in an ethnologic study of the Indian Pueblo of Tamaya (commonly called by its Spanish name, Santa Ana, located on the Jemez river about 25 miles north of Albuquerque), I was told by an Indian informant that tobacco was cultivated by a certain individual at the pueblo's farms at Ranchitos (on the east bank of the Rio Grande, just north of Bernalillo, N. M.). Subsequently, I learned that this individual was a member of a society of medicine men and that the tobacco was grown for ceremonial use. I obtained a specimen of this tobacco. It has been identified as *Nicotiana rustica* by Mr. Volney H. Jones, ethnobotanist in the Museum of Anthropology, University of Michigan, to whom I am indebted for much assistance in the preparation of this paper. The specimen has been deposited in the Museum of Anthropology, University of Michigan (Cat. No. 14698). In

[1] Louis Agassiz, "Contributions to the Natural History of the United States," Vol. 1, p. 281, 1857.

[2] S. H. Gage and S. P. Gage, *Proceedings American Association Advancement Science,* Vol. 34, pp. 316–318, 1885.

[3] C. H. Pope, "The Turtles of the United States and Canada," 1939.

[4] S. Weir Mitchell and George R. Morehouse, *Smithsonian Contributions to Knowledge,* Vol. 13, No. 159, 1863.

[5] S. H. Gage, *Proceedings American Association Advancement of Science,* Vol. 32, pp. 316–318, 1883.