

This arrangement persists until hatching when the posterior serosal patch is cast off with the egg-shell.

Finally, I should not fail to point out that the occurrence of this phenomenon, *viz.*, the

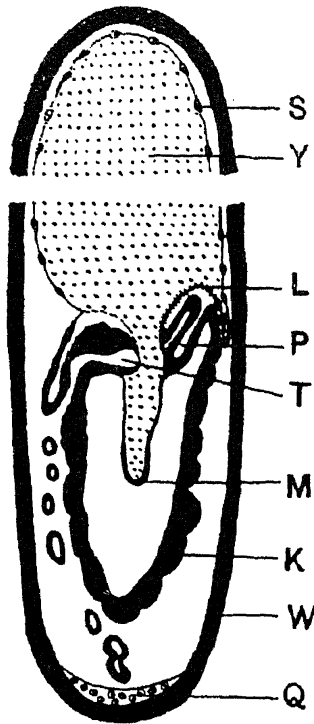


Fig. 1.

Longitudinal vertical section of an egg of *Locusta migratoria* during blastokinesis. Diagrammatic. $\times 22$.

K, embryo; *L*, amnion; *M*, splanchnic mesoderm and provisional dorsal closure; *P*, proctodæum; *Q*, posterior serosal patch; *S*, serosa; *T*, stomodæum; *W*, egg-wall; *Y*, yolk.

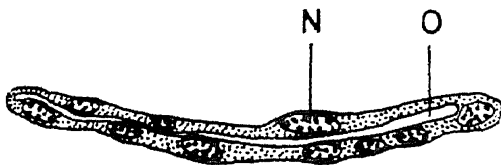


Fig. 2.

The posterior serosal patch from a longitudinal section of an egg of *Locusta migratoria* about two days after blastokinesis. Note the bi-layered arrangement of the nuclei with a cavity in between. $\times 240$.

N, nucleus; *O*, cavity.

persistence of the posterior serosal patch until hatching and the degeneration of the rest of the serosa long before hatching, provides us in the locust a very suitable material for the investigation of an interesting and important problem of Entwicklungsmechanik. Is the degeneration of the anterior portion of the serosa induced by its association with the yolk at the cephalic end

of the embryo? Two methods of attack are possible for the solution of this question. The small posterior serosal patch could be transplanted near the cephalic end of the embryo in the neighbourhood of the dorsal organ, and observations made as to whether it degenerates there or persists as in its original place. I have performed several such experiments without success. The difficulty lies in the fact that the locust egg invariably dies a few hours after it is experimented upon. In view of this difficulty for the solution of which I, at present, cannot see any way, the second method of attack, which I have not so far tried, appears to be much more hopeful. It would be interesting to know whether these two portions of the serosa which behave so differently in the living egg would do the same in *in vitro* cultures. Artificial culturing of insect tissues is extremely difficult because it is by no means easy to obtain sufficient quantities of a suitable culture medium. For this purpose I would refer to the papers of Goldschmidt⁷ and Frew⁸. Once a suitable culture medium is obtained, I have no doubt that the serosa would provide an exceptionally good material for *in vitro* cultures.

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¹ Imms, A. D., *A General Text-Book of Entomology* 1934, 3rd Ed., London.

² Wheeler, W. M., *J. Morph.*, 1893, 8.

³ Hagen, H. R., *J. Morph.*, 1917, 30.

⁴ Silvestri, F., *Boll. Lab. Zool. Portici.*, 1906, 1; 1921, 11.

⁵ Jackson, D. J., *Proc. Zool. Soc.*, London, 1928.

⁶ Jackson, D. J., *Nature*, 1935, 135.

⁷ Goldschmidt, R., *Biol. Centralbl.*, 1916, Bd. 36.

⁸ Frew, J. G. H., *Br. Jr. Exp. Biol.*, 1928, 6; 1929, 6.

The Respiratory Mechanism of the Frog.

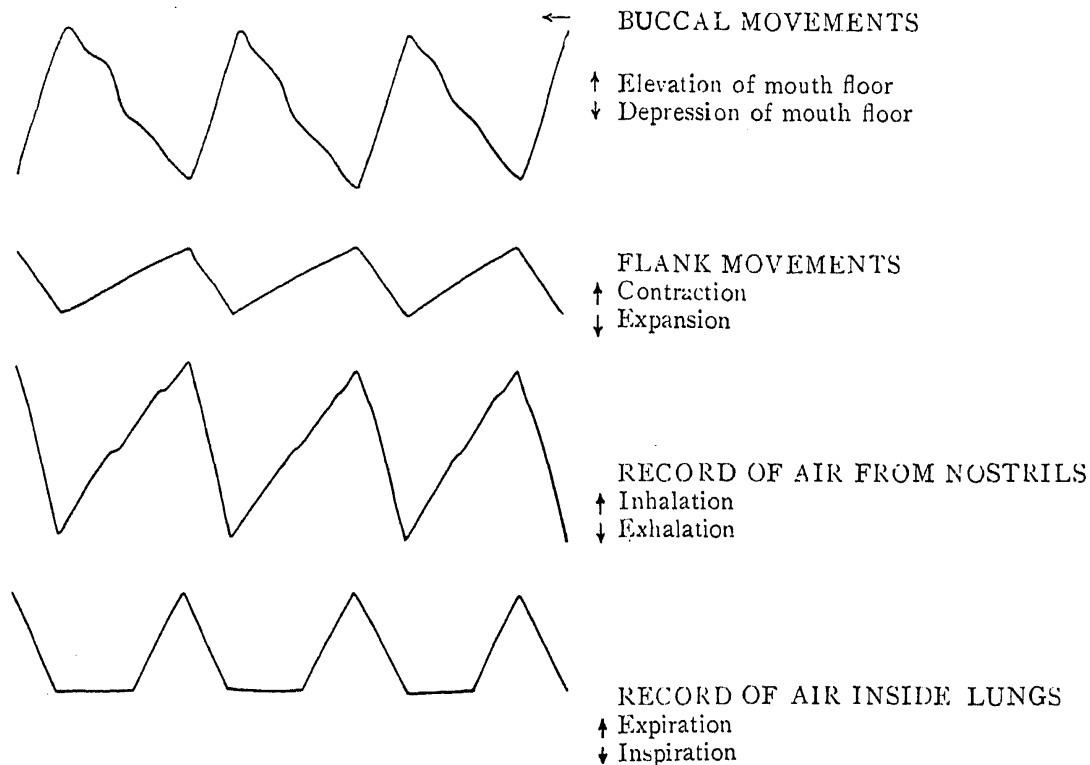
EXCEPT Wedenski and Willem (1918), all others, Gaupp (1900), Baglioni (1901), Bruner (1914), Goppert (1903) and Heine-mann (1884), appear to have made no experimental observation; and of the former two, Willem alone has used the graphical method. According to Gaupp, the two processes—expiration and inspiration of air into the lungs—are preceded by a third process—aspiration of air into the mouth. This account does not explain the exit of air

from the mouth. Others, principally Willem, therefore describe two phases (buccal ventilation and pulmonary ventilation) taking place alternately. Almost all accounts state or imply that the lungs and the mouth are ventilated one after the other. Experiments show that they are ventilated simultaneously and that the breathing mechanism is much simpler than has been described hitherto.

The movements of the flanks were recorded on smoked paper and it was found (*a*) that they were uninterrupted, continuous and regular; (*b*) that they are of uniform magnitude. The buccal movements when similarly recorded on smoked paper showed that they were also continuous and uniform. A simultaneous record of both the buccal

taking this record of air along with the movements of the buccal floor, it was found that when the mouth floor was raised, the air was exhaled and was inhaled when the mouth floor was lowered. The hyoid apparatus and associated muscles are capable of raising the buccal floor.¹ The air currents were also recorded with the movements of the flanks and the graphs showed that when the air goes out of the nostrils (exhalation), the flanks dilate (inspiration) and when the flanks collapse (expiration), the air enters the nostrils (inhalation). The closing and opening of the glottis was observed by anaesthetising a frog and introducing a slender tube into each lung and leading the air in the lungs into a tambour and thus

Scheme of records to illustrate the synchronism of various movements concerned in the respiration of frog.



floor and the flanks showed that when the mouth-floor is raised, the flanks distend and when the flanks contract the mouth-floor is lowered. It is inferred from this that when the buccal floor is elevated, the mouth cavity is reduced and the air is pumped into the lungs and that when the body wall contracts, the air is pressed out of the lungs into the mouth.

The opening and closing of both the nostrils as well as the glottis was observed by graphical records of the air currents. The air going in and out of the nares was led into a tambour by a mask applied to the snout and was recorded—the graph showed uninterrupted inhalations and exhalations. By

recording the entrance and exit of air from the lungs. This graph also showed regular and uniform expirations and inspirations.

Putting together the tracings of the buccal movements, flank movements, air currents from nostrils and from lungs the interpretation of the respiratory mechanism would be as follows: When the buccal floor is lowered, outside air is inhaled through the nostrils into the mouth cavity while the air inside the lungs is sucked (and also squeezed by the body wall) through the glottis into the buccal cavity. Thus the fresh and the impure air mix in the mouth chamber. When the buccal floor is elevated, this mixed air rushes out of the nostrils as

well as into the lungs. The graphs of the air currents make it clear that neither the nares nor the glottis are completely closed for any long interval. They constrict in such a way that the buccal floor oscillations increase or decrease the pressure in the mouth chamber.

The rôle played by the body wall and the elasticity of the lungs in this mechanism can be demonstrated by preventing the mouth of a frog from closing and thus throwing the buccal floor out of action. Graphical records of the flanks show a series of expirations followed by no inspiration—until the expirations become extremely feeble. Thereafter each weak expiration is followed by a feeble passive inspiration and the frog continues to breathe in this way. This co-operation of the buccal floor and the body wall serves to lead up to the reptiles the more primitive members of which employ the buccal floor as well as the ribs to ventilate the lungs.²

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October 28, 1935.

¹ *Rec. Ind. Museum*, June 1933, Anatomy of the tongue of *Rana hexadactyla*.

² *Curr. Sci.*, Oct 1933.

The Sub-central Foramina of the Squamata.

SINCE writing a note¹ on the presence of paired apertures on the ventral aspect of the vertebral centra in the common house-gecko, *Hemidactylus flaviviridis* Rüppel, I have been on the look-out for previous references to them in zoological literature. A consultation of such standard text-books of zoology as Sedgwick², Wiedersheim and Parker³, Hertwig and Kingsley⁴, Kingsley⁵, Reynolds⁶, Parker and Haswell⁷, Hyman⁸, Goodrich⁹ and de Beer¹⁰, shows that these apertures have somehow escaped the general observation of many eminent zoologists. As pointed out by Ramanujam and Ramaswami¹¹, however, Owen¹² recorded them for the Ophidia long before Mookerjee and Das¹³. More recently, Camp¹⁴ has studied and sketched the vertebræ of 22 species of lizards for this feature. He says:

"The size of the intervertebral canals, large in the Geckonidæ and Xantusiidæ, undergoes reduction in the more advanced groups. The paired sub-central foramina, present in geckos, pygopodids and amphibænians.... appears less frequently among the Scinco-

morpha and are absent in the higher anguimorphs and in the chamæleons."¹⁵

This statement seems to imply that the presence and size of these apertures is a primitive feature in lizards, and that it, therefore, adds to the "Paleotelic Weight"¹⁶ of the animals in which it is found. If this notion is right, it is a significant fact that these apertures in *Hemidactylus* are larger in size relatively to the size of the whole centrum than in the vertebræ of the four species of Geckonidæ, figured by Camp, viz., in *Thecadactylus rapicauda*, *Tarentola cubana*, *Sphaerodactylus macrolepis* and *Coleonyx variegatus*.

Goodrich¹⁷, although he makes no mention of the presence of sub-central foramina in this work, gives an instructive diagram about the "relations of sclerotomes and development of vertebral column in Amniota", which seems to suggest that these apertures are really intersegmental in position and represent the sclerotomic segmentation of the earlier stages in the case of the adult. The position of the intersegmental artery in his diagram (Fig. 1) coincides very well with the

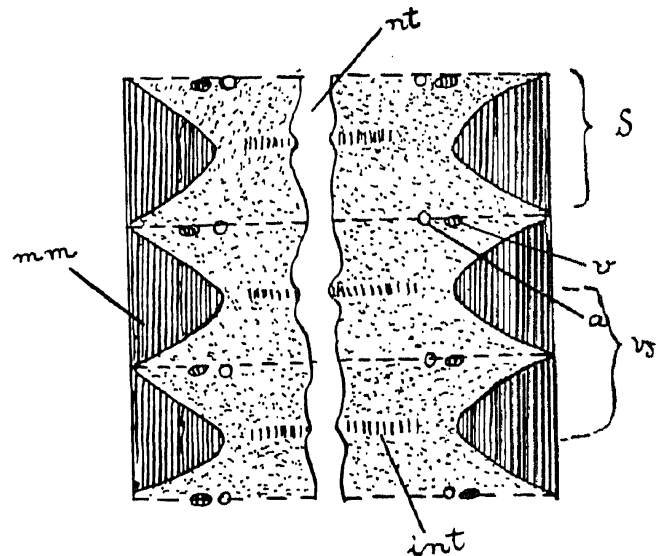


Fig. 1.

Diagram illustrating relations of sclerotomes and development of vertebral column in Amniota (simplified from Goodrich).

a, intersegmental artery; int, intervertebral ligament; mm, myomere; nt, notochord; S, region between two transverse broken lines occupied by one body segment; v, intersegmental vein; vs, region occupied by one vertebral segment composed of a half-sclerotome from each of two consecutive segments.

position of the sub-central foramina in *Hemidactylus* (Fig. 2) and other Squamata. Thus these apertures are probably reminiscent of a former condition and may be regarded as primitive features.

Granting the intersegmental position and the primitive nature of these foramina, it