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Early Movements of the Opossum with Special Reference to the Walking Gait.*

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The specimens from which these records were made were of the first, fourth and seventh day, with an additional litter between the fourth day and the seventh, and one slightly older. In no case was the time of birth observed. The age according to days was determined simply by inspecting the females for the presence of young in the pouch each day about 8 A. M.

The young were forcibly taken from the pouch and immediately placed in an incubator designed for the purpose. It is closed on one side only with a curtain which hangs loosely enough to admit the observer's hands. The top, of plate glass, permits direct observation and the use of a reading glass 4 inches in diameter. The temperature in the incubator was permitted to vary from 80° to 100°F. The higher temperatures were accompanied by an unusual amount of activity. The young of the 7th day may live as long at room temperature (about 75°F) as in the incubator, but they are not nearly so active. One specimen of the 7th day was kept in the incubator from 9 till 10:30 A. M. at a temperature of 82° to 85° and then removed and placed in a glass dish on a table where it lived till 10:50 P. M., but it was constantly pale and cold to the touch, and very inactive, whereas a litter mate kept in the incubator was dead in 12 hours and 20 minutes, and another was living after 11 hours and 38 minutes. In the incubator the young were placed on pieces of outing flannel saturated with mineral oil to prevent desiccation of the skin.

During the first day in the pouch the young hold the feet closely appressed to the tail, which is bent forward closely on the ventral surface of the body. Of the hind leg only the foot extends beyond the contour of the body. The toes and claws are sufficiently strong so that one can hook a needle under them and drag the animal around. Spontaneous (endogenous) movements are almost constant when the young are kept warm. There is a great deal of individual movement of the fore limbs. The movements of the trunk begin in the head or neck region and progress caudad as an integrated system which effects alternate movements of the arms, with the head extended and moving from side to side. With ventral flexion

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(indicating a functional m. rectus abdominis) and extension, and squirming movements of the trunk, the hind legs do not move. No movement can be seen in them except that with a lens a very slight abduction is rarely perceptible when the body undergoes extreme ventro-flexion. This is probably due to lateral pressure of the viscera in the pelvis. The movements of the fore limbs may be characterized as grasping movements. They consist of extension of the fore limb, hand and fingers to full length and flexion of the fingers in initial phase of flexion of the limb. The result is a grasping of any suitable object, as the fur of the mother or the fibers of a rough cloth, with which they come in contact. The young take advantage of this and raise themselves to an upright position supported by the snout, rump and forelimbs, and crawl about by means of alternate movement of the fore limbs, extension of the head and pulling with the snout, aided by the anchorage provided by the claws of the hind feet. In this erect position they may lift the head high in the air and move it from side to side, while the claws cling to the cloth. Specimens placed between pieces of flannel crawled out and were found lying on the piece that had covered them. With lowered vitality as the young approached death there was a great deal of individual movement of the fore limbs.

In the 4th day the hind feet are held in the same position as in the first and do not move otherwise than in the first day. There are small bilateral movements of the arms. There is much ventroflexion of the rump only, indicating the action of the m. rectus abdominis alone. One specimen rolled and squirmed for 5 minutes, with very little if any progress, then definitely assumed the erect position and crawled its full length in 4½ minutes. After this it lay still, and I lifted the edge of the cloth on which it lay, progressively through various angles till it was in a horizontal position with the young suspended beneath by the claws of the fore and hind feet. I manipulated the cloth in various planes, and the young held fast. On the part of the hind feet this clinging must be passive inasmuch as the hind limbs do not move at this time. Afterward it crawled the distance of 2 cm. When I held the young in my fingers the head ventroflexed and the fore feet were brought up to the chin.

In a specimen that, judged by measurement, was slightly older there was still no movement of the hind legs. There were extensive grasping movements of the fore limbs at full length and abducted. In the typical resting position the hands are folded over the hind legs and the chin appressed to the chest or to the hind feet. In their movement the fore legs manipulate the hind legs a great deal.

The young of the seventh day still hold the feet closely appressed to the tail, which extends 1-2 mm in front of the feet. There is still a slight abduction of the hind legs on extreme ventro-flexion of the trunk, due presumably to pressure in the pelvis, and in addition there is very rarely an extension and flexion of the hind legs with movement of the trunk, but no movement in them without movement of the trunk. The 7 specimens of this age were under observation for a total of over 67 hours, during which time they were examined 35 times critically for movement of the legs with movement of the trunk. Of these trials 19 were negative, 4 were questionable and 12 were positive. These movements were so slight and rare that the 7th day may be regarded as marking the beginning of movement of the hind legs as a part of a total pattern of action.

In a litter of 6 young (measuring 22 mm c. r. length in 20% formalin) there was movement in knee and ankle joints with movement of the trunk, but no movement in the joints of the foot, and there was no movement of the hind leg unless the trunk and fore legs moved. When both fore legs moved both hind legs moved. When I took the head in one hand and the tail in the other and stretched the specimen out ventral side up there was rotation of the body from side to side and alternate movement of the fore legs with the hind legs moving mostly in harmony with the fore legs—when the fore leg on one side went forward the hind leg of the same side went backward—essentially the walking gait. The hind legs, however, do not always move alternately at this age, nor in harmony with the fore legs.

In the young of the first day a touch of a bristle on the snout may be followed by ventro-flexion of the trunk and flexion of the fore legs, or it may cause ventro-flexion of the rump only. Raking the bristle across the snout causes a slight ventro-flexion of the neck and trunk, extending to the rump. This response was repeated 8 times. Drawing the bristle down over the rump was followed by slight ventro-flexion of the rump only; sometimes the head moved in this response.

On the 4th day sometimes stimulation on the rump caused movement of the head and fore legs and sometimes ventro-flexion of the rump only. In a slightly older specimen (as judged by measurement) the prick of a needle in the rump caused first movement of the rump that continued farther headward and into the fore limbs, followed by about 3 minutes of general activity. At another time the same stimulus caused ventro-flexion of the rump, then movement of the fore limbs and head. Sometimes, however, a stab of the needle in the rump produces only slight ventro-flexion of the rump.

A prick of the needle on the forearm caused movement of the same fore limb and then other parts, or a touch on one fore limb caused extension of both fore limbs. Stimulation of the left fore foot with a brush caused flexion in both fore feet.

In specimens of 22 mm c. r. length (in 20% formalin) a prick of a needle on the rump was followed by a general movement, but the hind legs did not move independently. Repeated pricks of the needle in the hind foot and shank as far up as the knee gave no responses. I held the young in my fingers and spread the foot out on my thumb nail, and pricked the foot in several places, the ankle and shank but there was no response. This test was repeated with the same result. I then amputated the foot with iridectomy scissors and there was no response. In other cases I split the foot longitudinally as far up as the ankle joint, thinking it would have more freedom to move than with amputation, but there was no response.

Hartman[1] reported that he removed embryos of the opossum from the uterus at near term and that they crawled over the hair of the mother. Weed and Langworthy[2] placed the pouch-young on gauze, although the youngest animal they reported on was 23 days old with a length of 33 mm, and it grasped the cloth with the claws of the fore legs. Langworthy[3] reported that, when young of 10 days (22 mm) were placed on gauze, they "would seize the threads with the claws of the fore legs" and pull themselves along. In a later paper[4] he says of opossums of 7 days (27 mm), when placed on gauze, "the claws of the fore legs seized the threads and the young pulled itself along by alternate progressive beats of the fore legs," and "the hind legs did not participate in these grasping movements, but remained for the most part in a flexed position." He found there was no righting reflex in specimens of 36 days, but that it was beginning to develop at 41 days, and is "not yet very active" at 46 days.

My opossums of the first day in the pouch rolled over from one side to the other ventral side down, and took the erect position by clinging to the flannel with the fore legs, and crawled in that position. This was purely thigmotactic, for we know from the observations of Larsell, McCrady, Jr., and Zimmerman[5] that the vestibular apparatus is not functional at that time. This thigmotactic righting

1 Hartman, C. G., *Anat. Record*, 1920, **19**, 251.

2 Weed, L. H., and Langworthy, O. R., *Am. J. Physiol.*, 1925, **72**, 8.

3 Langworthy, O. R., *Contributions of Embryology, Carnegie Inst. Wash.*, 1927, **19**, 149.

4 Langworthy, O. R., *J. Comp. Neurol.*, 1928, **46**, 201.

5 Larsell, Olof, McCrady, Edward, Jr., and Zimmerman, Arnold Albert, *J. Comp. Neur.*, 1935, **63**, 95.

reaction may be a transitory function characterizing the period from immediately before till a few days after birth, serving the animals, under normal conditions, only for gaining access to the pouch and the nipple (Hartman[1]). I did not observe it in specimens of 28 mm c. r. length, but I did not examine them critically for this feature.

With regard to coördination of the hind legs with the fore legs, Langworthy[4] says that there was very little contraction of hind leg musculature "at an estimated age of 7 days" (27 mm), and scarcely any coördination "at 36 days" (49 mm). Possibly his failure to find it earlier may be due to an interference of local fields of stimulation with the mechanism of the total pattern action (Coghill[6]). The position in which I held the animal might be favorable for the free action of the limbs.

Conclusions. From my observations it is clear that, in the opossum of the first day in the pouch, there are functional commissural relations at the level of the brachial plexus, a descending (motor) path as far caudad as the lower thoracic level (for stimulation of the m. rectus abdominis) and an ascending pathway from the lumbosacral region to the upper cervical segments or the brain; also that the hind legs become motile on the 7th day in the pouch, and at a more advanced stage they become integrated with the fore legs so as to execute the walking gait before they are capable of reflex action. In the development of walking, therefore, in the opossum as in amblystoma (Coghill[7]), the gait is essentially a total pattern of action while reflexes serve for orientation and adjustment to surfaces.

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Excretion of Sex Hormones in Urine of Adult Male Monkeys.*

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The concentration of androgenic activity found in the urine of human males has been shown to be high in comparison to that found

[6] Coghill, G. E., *Psychiatrische en Menrologische Bladen*, 1934, No. 3 and 4, 122.

[7] Coghill, G. E., PROC. SOC. EXP. BIOL. AND MED., 1929, **27**, 74.

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