noted. There appears an increased extensor postural sensitivity in the neck muscles but a conspicuous opisthotonos fails to appear unless the "released" neck muscles are further reflexly stimulated (see below).

II. *The vestibular (lingula) anterior lobe.* (4) Following pure lesions of the lingula the signs are such as to suggest "release" of the labyrinthine tonic influences. Though disequilibration is profound, local and segmental postural reflexes in the extremities are entirely normal provided support is afforded the animal's head. The labyrinthine tonic effects upon the extremities are, however, abnormally increased. The syndrome fails to appear after preliminary labyrinthectomy.

(5) Results of combinations of these discrete ablations indicate that opisthotonos appears only when the neck extensors are released and, in addition, a tonic influence upon them is also increased above normal. Thus, the prime requisite is that the anterior centralis be removed; then, either the labyrinthine tonic influences must be released by lingular ablation (resulting, compositely, in an extreme opisthotonos), or the foreleg extensor influence upon the neck be released by posterior centralis removal (resulting, compositely, in a mild opisthotonos).

Summary. Ablation studies in the dog, cat and monkey reveal a functional type of localization within the anterior cerebellar lobe. This localization is so precise that functional units in single extremities, the neck and the labyrinths are discretely represented in isolated anterior cerebellar subdivisions.

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Developmental Rate of Hybrids between *Rana pipiens* and *Rana sphenocephala.*

JOHN A. MOORE. (Introduced by L. G. Barth.)

From the Department of Biology, Brooklyn College, Brooklyn, N.Y.

This forms the second report on developmental rate in hybrid frogs. The purpose of these experiments, in hybridizing species that differ in rate of development, is to determine the earliest effect of the sperm on this particular character. Previously such a study has been made on hybrids between *Rana pipiens* and *Rana palustris.*[1]

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[1] Moore, *J. Exp. Zool.*, 1941, **86**, 405.

Both hybrids, *pipiens* ♀ X *palustris* ♂ and *palustris* ♀ X *pipiens* ♂ developed at the maternal rate during early stages. The first unmistakable deviation from the maternal rate appeared in the neural plate stage in both hybrids. Additional evidence on these points is derived from the following crosses.

The material used in these experiments is from the following sources: *Rana pipiens* Schreber from dealers in the Lake Champlain area of Vermont and *Rana sphenocephala* (Cope) from dealers in southern Florida. Although listed as separate species by many taxonomists the two are closely related and are thought best included under one name by Kellogg.[2] Regardless of their true taxonomic status the two frogs form viable hybrids and differ in rate of growth to such an extent that it is possible to analyze the developmental rate of their hybrids. At 15°C the rate of both species is identical. At higher temperatures *sphenocephala* develops more rapidly and below 15° less rapidly than *pipiens*. The egg diameter in the *sphenocephala* used in these experiments averaged 1.3 mm and in the *pipiens* 1.8 mm. Whereas the upper limit for normal development in *pipiens* is 28° or 29°, the Florida species can tolerate temperatures as high as 34.5°.

The first experiment was begun Jan. 20, 1939. Gametes of both male and female *pipiens* and *sphenocephala* were used, the eggs being secured by pituitary injections and sperm by cutting the testes in 0.1 amphibian Ringer's. One hour before first cleavage the 2 groups of control eggs (*pip.* ♀ X *pip.* ♂ and *sph.* ♀ X *sph.* ♂) and the 2 groups of hybrids (*pip.* ♀ X *sph.* ♂ and *sph.* ♀ X *pip.* ♂) were placed in an incubator which maintained water temperature at 19.6 ± 0.1°C. Because of the difference in size between the eggs of the 2 species it was possible to keep both the *sphenocephala* and *pipiens* controls in one bowl and the *pip.* ♀ X *sph.* ♂ and *sph.* ♀ X *pip.* ♂ hybrids together in another. This reduced the error of measuring rate of development due to temperature variations.

The interval between cleavages was not measured in this experiment. The *sphenocephala* controls and *sph.* ♀ X *pip.* ♂ began gastrulation (stage 10[3]) 17½ hours after first cleavage (Table I). At 20 hours the *sphenocephala* controls were in stage 11. In the *sph.* ♀ X *pip.* ♂ gastrulation seemed not to have progressed quite so far. At 24 hours the *pipiens* controls and *pip.* ♀ X *sph.* ♂ had begun gastrulation. By this time the *sphenocephala* controls had a complete blastopore (stage 12). The *sph.* ♀ X *pip.* ♂ appeared somewhat

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[2] Kellogg, *Bull. U. S. National Museum*, 1932, 160.

[3] Pollister and Moore, *Anat. Rec.*, 1937, **68**, 489.

retarded at this time, as they were at 20 hours. However, this difference was slight and may not have been of significance. At 28½ hours after first cleavage an unmistakable retardation in rate was noticed in the *sph.* ♀ X *pip.* ♂. The *sphenocephala* controls at this time were in stage 13 (neural plate) whereas the hybrids in question were still in stage 12. The reciprocal hybrids showed the first unmistakable deviation from the maternal rate at about the same morphological stage. Forty-five and one-half hours after fertilization when the *pipiens* controls were in stage 14 (neural folds) the *pip.* ♀ X *sph.* ♂ were still in stage 13. Previous to this time it was not possible to detect any difference in rate between these hybrids and the maternal controls.

When examined at later times it was found that both groups of hybrids continued to be slower in development than their respective controls. The *sph.* ♀ X *pip.* ♂ were the most retarded group and exhibited a rather constant morphological deviation, the heads of these tadpoles being very small. In the reciprocal cross, *pip.* ♀ X *sph.* ♂ the heads seemed to be much too large.

Some of these animals together with others from a similar experiment were placed in tanks and many hybrids of both types were raised to large tadpoles and young frogs. In early stages when the different groups were examined carefully no difference in mortality could be noticed. In all groups about 95% gave rise to normal tadpoles.

Further experiments were undertaken in the 1940 season to study the rate of cleavage in the hybrids and to pay special attention to the stage at which hybrids deviated from the maternal rate of develop-

TABLE I.
Development of *Rana pipiens*, *Rana sphenocephala*, and their hybrids at 19.6 ± 0.1°C.

	Stage of development			
Hrs. after 1st cleavage	*sphenocephala* controls	*sph.* ♀ X *pip.* ♂ hybrids	*pip.* ♀ X *sph.* ♂ hybrids	*pipiens* controls
17½	10	10	9	9
20	11	10	9	9
24	12	12 (early)	10	10
26	12	12	10	10
28½	13	12	11	11
31	13	13	12	12
37	14	13	12	12
45½	14	14	13	14
48½	16	15	14	14
54½	16	16	14	16
67	17	17	16	17
76½	18	18	17	18
89	20	18	18	18
102½	20	19	19	20

ment. In these experiments the only hybrids studied were *pip.* ♀ X *sph.* ♂.

No deviation from the maternal rate of cleavage was noticed. At 23.8 ± 0.1°C the *pipiens* controls reached first cleavage in 112 minutes after fertilization. The time for the *pip.* ♀ X *sph.* ♂ was 113 minutes. The interval between first and second cleavage was 40 minutes for both groups of eggs. The *pipiens* controls required 39 minutes between second and third cleavage and the *pip.* ♀ X *sph.* ♂ 40 minutes.

Three experiments were carried out at 23.8 ± 0.1°C to detect the first deviation of the *pip.* ♀ X *sph.* ♂ hybrids from the maternal rate. In the first the hybrids were possibly retarded at 20 hours after first cleavage (stage 12). In the second experiment a definite retardation was noticed at 23¾ hours (stage 12). In the third experiment the hybrids and controls were identical at 18 and 21 hours (stage 12). In all cases the retardation was unmistakable during neural plate stages. Experiments at 27.5°, 18.5°, and 15.5° gave similar results. In all experiments there seemed some indication that the retardation in rate of development began near the close of gastrulation. This retardation was invariably evident in neural plate stages.

In contrast with the regular development of the hybrids in the 1939 season the mortality and percentage of abnormal tadpoles during 1940 was extremely high. The most obvious external abnormality of the *pip.* ♀ X *sph.* ♂ hybrids was in the functioning of the circulatory system. Gill circulation was abnormal or lacking in most embryos. The gill filaments were usually bulbous at the end and the presence of a large bleb at the base of the gills seemed characteristic. In many the heart was not beating. Over 95% of these embryos died as young tadpoles.

At the present no explanation of the difference in results obtained the two seasons is offered. The collector who supplied the animals states that during 1940 lack of rain and cold had been very hard on the frogs and they were not "in breeding condition." The cause of these abnormalities, interesting in itself, is apart from the main purpose of the experiments. In all the observations on hybrid rate of development are consistent. The developmental rate of the hybrids is maternal until late in gastrulation. Possibly towards the end of gastrulation and certainly in the neural plate stage the sperm exerts an effect on the rate of development. This is precisely the stage at which the first unmistakable effect of the sperm was noticed in the *pipiens* X *palustris* cross mentioned before.[1]