pointed out[3] that, when crystal penetration is properly corrected for, the curve of atomic number versus square root of frequency is *almost* a straight line, their own values falling more nearly on a straight line than either those of Moseley or de Broglie. As a matter of fact it is manifest that the effective reflected ray for a crystal like calcite is along such a direction as to make the measured angle of reflection proportionately too large for the higher frequencies. In other words as the atomic number increases the measured frequency is proportionately greater than it should be. This possibly accounts for the fact that the curve in figure 3 of Blake and Duane's paper is convex downward toward the axis of atomic numbers. It would seem that a test of this reasoning could be made by repeating the work of Blake and Duane using a crystal with a cubic lattice but one whose faces are as good as those of calcite (rock salt is notoriously bad), care being used of course to correct for crystal penetration, or to eliminate the effect of such penetration by using a very narrow incident beam and having the ionization chamber slit very wide (the arrangement shown in figure 1, first used by Duane and Hunt[4]).

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[1] *Physic. Rev. Ithaca,* **10,** 1917, (624–637).
[2] *Proc. Roy. Soc.,* (A), **89,** 1914, (468).
[3] *Physic. Rev. Ithaca,* **10,** 1917, (703).
[4] *Ibid.,* August, 1915, p. 166.

THE MYODOME AND TRIGEMINO-FACIALIS CHAMBER OF FISHES AND THE CORRESPONDING CAVITIES IN HIGHER VERTEBRATES

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A functional myodome is found only in fishes, and even among them it is limited, in the specimens I have examined, to Amia and the non-siluroid Teleostei.

The myodome is always separated from the cavum cerebrale cranii by either membrane (dura mater), cartilage or bone, and the separating wall is in part spinal and in part prespinal in position. A depression in the prespinal portion lodges the hypophysis, or both the hypophysis and saccus vasculosus, and this part of the wall never undergoes either chondrification or ossification, a more or less developed pituitary sac always projecting into the myodome.

The myodome is found in its most complete form in the Teleostei, and there consists of dorsal and ventral compartments, which are usually separated from each other by membrane only, but that membrane, the horizontal myodomic membrane, is capable of either chondrification or ossification. The dorsal compartment lodges the hind ends of the musculi recti externi, and is always traversed by a cross-commissural venous vessel formed by the pituitary veins. The ventral compartment lodges the hind ends of the musculi recti interni, and is traversed by the internal carotid and efferent pseudobranchial arteries and the palatine branches of the nervi faciales.

The parasphenoid forms the floor of the ventral compartment of the myodome, and whenever the horizontal myodomic membrane undergoes ossification, the bone so formed forms part of the parasphenoid. This bone is thus certainly, in certain fishes, in part of axial origin, and not simply a dermal bone that has gradually sunk inward to its actual position.

In the Siluridae (Ameiurus) there is apparently a much reduced, but non-functional, dorsal myodomic compartment, but no ventral compartment, that portion of the parasphenoid that lies in the proötic region being developed in what corresponds to the horizontal myodomic membrane of others of the Teleostei.

In Amia the myodome corresponds to the dorsal compartment only of the teleostean myodome, and a strictly similar, but non-functional, myodomic cavity is found in Lepidosteus and Polypterus. The ventral compartment of the teleostean myodome is represented, in each of these three fishes, by a canal, on either side of the head, that is traversed by the internal carotid artery, and that corresponds to the canalis parabasalis of Gaupp's[1] descriptions of higher vertebrates.

The myodomic cavity is limited, in the Holostei and Crossopterygii, to the proötic region, and is there in part subspinal and in part prespinal and subpituitary in position. In the non-siluroid Teleostei examined, the dorsal compartment of the myodome is always more or less prolonged posteriorly into the basioccipital region, and the ventral compartment is frequently so prolonged.

The posterior part of the basioccipital portion of the myodome lies between ventro-lateral vertebral processes that are quite certainly the homologues of the haemal arches of the tail. In Hyodon, this part of the myodome is an open groove and lodges the anterior portion of the median dorsal aorta. In the Cyprinidae, part of this groove has become enclosed to form a short canal, which is traversed by the median dorsal aorta, the enclosing bone forming the pharyngeal process.

The conditions in these fishes thus leads inevitably to the assumption that the entire dorsal myodomic cavity is a subvertebral canal similar to the haemal canal in the tail, and that the dorsal aorta has been excluded from it because of the formation of a circulus cephalicus. What the primary relations of the hypophysis and pituitary veins to this preëxisting canal were, is problematical, but they became lodged in its anterior portion and so gave rise to the conditions actually found in Lepidosteus and Polypterus. The musculi recti externi then secondarily invaded this space by traversing the foramina for the pituitary veins, the other recti muscles retaining their insertions on the external surface of the preclinoid wall, and so gave rise to the conditions found in Amia. The conditions found in the non-siluroid Teleostei then arose as a result of the resorption of the cartilage that, in Amia, forms the preclinoid wall, the pedicel of the alisphenoid, and those ventral portions of the b sicapsular commissures that form the lateral walls of the subpituitary portion of the myodome. Because of the resorption of the preclinoid wall, and its replacement by membrane, the musculi recti interni, which in Amia have their points of insertion on either lateral edge of that wall, have first sought firmer attachment on the dorsal surface of the parasphenoid, and have then later pushed posteriorly in the open ends of the persisting portions of the canales parabasales. The fusion of these two canals with each other then formed a ventral myodomic compartment, which is, in early embryos, separated from the dorsal and primary compartment by membrane only; but this membrane may undergo either partial chondrification (Hyodon), or ossification (Gasterosteus) the bone, in the latter case, forming a transverse and inclined ridge on the dorsal surface of the parasphenoid. The membranes resulting from the resorption of the preclinoid wall were then pressed together in the median line by the recti interni, and form a median vertical myodomic membrane, which encloses the internal carotid arteries in a membranous canal that is the homologue of the cartilaginous canals of Amia. The efferent pseudobranchial arteries, pressed downward by the recti interni, lost their connections with the internal carotids and acquired a cross-commissural connection with each other. The membrane resulting from the resorption of the anterior portions of the basicapsular commissures of either side ossified as part of the ascending process of the parasphenoid, and the tissues resulting from the resorption of the pedicel of the alisphenoid ossified, in certain fishes (Cottus, Gasterosteus), to form an anterior portion of that same process.

In the Selachii the myodomic cavities of the Holostei and Teleostei are represented either by canals in the basis cranii that are traversed by the pituitary veins and the internal carotid and efferent pseudobranchial arteries, or by a posterior and deeper portion of the large pituitary fossa of the chondrocranium that is shut off from the cavum cerebrale cranii by the dura mater, and is traversed by the pituitary veins and the internal carotid arteries.

In embryos of Ceratodus there is a subpituitary space, traversed by the pituitary veins, that corresponds to the dorsal compartment of the teleostean-myodome, and the internal carotid canals of Amia have been added to it. This fusion of these canals with the dorsal myodomic cavity is due either to the resorption of the cartilage that separates them in Amia, or to a shifting posteriorly of both the hypophysis and the internal carotides from a position between the hind ends of the trabeculae to one between the so-called anterior prolongations of the parachordals.

In the Amphibia the basis cranii apparently corresponds to the roof, and not the floor, of the dorsal myodomic cavity of Amia and the Teleostei. The fenestra hypophyseos of these animals is, then, the homologue of the pituitary opening of the brain case of fishes.

In the Reptilia and Mammalia a dorsal myodomic cavity is found that is similar to that in Ceratodus. In man it is represented in the cavernous and intercavernous sinuses, and the venous vessels that traverse those sinuses are the homologues of the pituitary veins of fishes.

The cartilago acrochordalis of Sonies's[2] and Noordenbos's[3] descriptions of birds and mammals, respectively, is the homologue of the cartilaginous prootic bridge of embryos of fishes. The open space between this cartilage, or bridge, and the anterior end of the parachordal plate is the fenestra basicranialis posterior properly so called. This fenestra is a perforation of the roof of the myodomic cavity, and hence is not the homologue of the so-called fenestra basicranialis posterior of embryos of fishes, which fenestra is a perforation of the floor of that cavity. This latter fenestra of embryos of fishes is the homologue of the fenestra hypophyseos of birds and mammals, the so-called anterior prolongations of the parachordals of fishes being the homologues of the polar cartilages of birds and mammals.

In certain of the Selachii there is an acustico-trigemino-facialis recess, and there may be certain canals in the cranial wall that are traversed by the vena jugularis and the external carotid artery.

In Amia the trigemino-facialis portion of this recess has fused with the canals for the vena jugularis and the external carotid artery to form a trigemino-facialis chamber, this chamber has become continuous ventrally with the myodome, and the large chamber so formed has been prolonged anteriorly by a space enclosed between the pedicel of the alisphenoid and the primitive side wall of the neurocranium. The foramina for the pituitary vein and the nervi oculomotorius and trochlearis open into this anterior prolongation of the chamber, and, through its orbital opening, into the orbit. The vena jugularis traverses this orbital opening to enter and traverse the trigemino-facialis chamber; the musculus rectus externus traverses it to enter the myodome; and the nervus profundus traverses it to join the ganglion or root of the nervus trigeminus. The nervus trigeminus and the external carotid artery issue from the trigemino-facialis chamber posterior to the pedicel of the alisphenoid and run forward lateral to it.

In the non-siluroid Teleostei the trigemino-facialis chamber is not continuous with the myodome, and it has been separated by a wall of bone into partes ganglionaris and jugularis that correspond, respectively, to the trigemino-facialis recess and the jugular and external carotid canals of the Selachii. The pedicel of the alisphenoid is incomplete, or wholly wanting, but it may be replaced by an anterior prolongation of the ascending process of the parasphenoid. In the latter case the nerves, arteries, veins and muscles all have the same relations to this process that they have to the pedicel of the alisphenoid of Amia. The lateral wall of the pars jugularis of the trigemino-facialis chamber is always less extensive than in Amia, and may be wholly wanting.

In Ceratodus there is a trigemino-facialis chamber similar to that in Amia, and there is a bar of cartilage that corresponds to the pedicel of the alisphenoid of that fish.

In the Amphibia there is a trigemino-facialis recess, and the pars ascendens of the quadrate forms the lateral wall of a space that corresponds to the pars jugularis of the chamber of the Teleostei. The ascending process of the palatoquadrate is the homologue of the pedicel of the alisphenoid of fishes.

In the Reptilia there apparently is no trigemino-facialis recess, the lateral wall of the neurocranium being the primitive cranial wall. The pars ascendens of the quadrate forms the lateral wall of a trigemino-facialis chamber. The antipterygoid (columella) is the homologue of the pedicel of the alisphenoid of fishes, and the processus basipterygoideus the homologue of the floor of the orbital opening of the myodome of Amia.

In the Mammalia there is a trigemino-facialis recess formed by the cava epiptericum and supracochleare. The ala temporalis is peculiar to mammals, and is a bar of cartilage formed between the nervi maxillaris and mandibularis trigemini as they issue from the trigemino-facialis recess, the processus alaris corresponding to some part of the side wall of the prespinal portion of the myodome of Amia. The ala temporalis has been prolonged anteriorly so as to enclose a space that lies anterior to the trigemino-facialis recess, and the foras mina for the pituitary vein (sinus cavernous) and the nervi oculomotorius, trochlearis and profundus (first branch of trigeminus) open into this apace and from it into the orbit. The cavum tympanicum is the pars jugularis of the trigemino-facialis chamber, and the processus pterygoideus, the malleus, incus and stapes, and possibly also the annulus tympanicus, are quite certainly portions of the lateral wall of that part of the chamber. A diverticulum of the spiracular canal, or an independent evagination of the pharynx, has expanded into this part of the chamber and so formed the middle ear. The chorda tympani must, then, correspond to that communicating branch from the nervus facialis to the nervus trigeminus that, in fishes, traverses the trigemino-facialis chamber, and hence must be a prespiracular nerve.

The internal carotid artery enters the cranial cavity, in most vertebrates, by passing upward mesial to the related trabecula, or mesial to that posterior prolongation of the trabecula that is formed by the polar cartilage, but in Ameiurus it enters the cranial cavity through the foramen opticum, and hence would seem there to pass lateral and then dorsal to the trabecula. In embryos of the Mammalia ditremata also this artery is said to pass upward lateral to the trabecula, but it is probable that it here simply passes lateral to the infrapolar process of the polar cartilage, the latter cartilage itself not fusing directly with the parachordal plate, its direct relations to the artery thus being obscured.

[1] Gaupp, E., *Anat. Anz., Jena*, **27**, 1905, (273–310).

[2] Sonies, F., *Petrus Camper*, Deel. 4, Jena, 1907, (395–486), Taf. 7/10.

[3] Noordenbos, W., *Ibid.*, Deel. 3, Jena, 1905, (367–430), Taf. 6/8.

THE EFFECT OF INBREEDING AND CROSSBREEDING UPON DEVELOPMENT[1]

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The experiments dealing with the effects of inbreeding and crossbreeding in the naturally cross-pollinated corn plant, *Zea mays* L., carried on at the Connecticut Experiment Station have been reported on previously by East[2] and Hayes.[3] A continuation of these experiments shows that there is no appreciable reduction in vigor and productiveness, as indicated by the yield of grain and height of plant, after the eighth generation of self-fertilization as can be seen in table 1. The resulting inbred strains, now in the eleventh

TABLE 1

The Effect of Inbreeding on the Yield and Height of Maize

YEAR GROWN	NUMBER OF GENERATIONS SELFED	FOUR INBRED STRAINS DERIVED FROM A VARIETY OF LEAMING DENT CORN							
		1-6-1-3-etc.		1-7-1-1-etc.		1-7-1-2-etc.		1-9-1-2-etc.	
		Yield per acre	Height	Yield per acre	Height	Yield per acre	Height	Yield per acre	Height
		bushels	*inches*	*bushels*	*inches*	*bushels*	*inches*	*bushels*	*inches*
1916	0	74.7	117.3	74.7	117.3	74.7	117.3	74.7	117.3
1905	0	88.0		88.0		88.0		88.0	
1906	1	59.1		60.9		60.9		42.3	
1908	2	95.2		(1907) 59.3		(1907) 59.3		51.7	
1909	3	57.9		(1908) 46.0		(1908) 59.7		35.4	
1910	4	80.0		63.2		68.1		47.7	
1911	5	27.7	86.7	25.4	81.1	41.3	90.5	26.0	76.5
1912	6							(1913) 38.9	
1913	7	41.8		39.4				(1914) 45.4	85.0
1914	8	78.8	96.0	47.2	83.5	58.5	88.0	(1915) 21.6	
1915	9	25.5		24.8				(1916) 30.6	78.7
1916	10	32.8	97.7	32.7	84.9	19.2	86.9	(1917) 31.8	82.4
1917	11	46.2	103.7	42.3	78.6	37.6	83.8		