the base line of the curve. Three inches of base line was chosen arbitrarily because it included all the elements of the curve. The side of this triangle was a line drawn at a right angle to the base line from the base line to the curve. The hypotenuse was the tonus tracing, in all instances irregular. The areas so delimited were measured with a planimeter, which gave readings in square inches. The planimeter readings were taken as an index of the amount of work done and may be called work values. Variations in the work values represent variations in the amount of work necessary to passively flex the arm; they represent variations in the amount of muscle tone. The accompanying table may serve as illustration of the variations in the work values in a few subjects, during repose, during laughter, and during frowning.

TABLE I.

Subject	Flexion of Right Arm. Work Value During		
	Repose	Laughter	Frowning
H. D.	2.33	1.45	2.48
H. C.	3.18	1.03	3.75
D. M.	4.17	2.96	6.34
H. H.	3.43	3.10	4.12
L. R.	4.30	4.07	5.06
C. H.	3.53	2.20	3.53
A. M.	2.13	1.81	2.88
E. R.	3.12	1.89	3.17
K. B.	1.93	1.12	2.85
R. K.	2.60	1.42	2.45

It was found that in 48 subjects, or 96%, there was a diminution of muscle tone during laughter, in 2 subjects, or 4%, there appeared to be an increase in muscle tone during laughter. In 39 subjects, or 78%, there was an increase of muscle tone during frowning; in 8 subjects, or 16%, there was a decrease and in 3 subjects, or 6%, there was no change during frowning.

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The Endodermal Origin of Middle Ear Cartilages of Rana.

H. N. VIOLETTE. (Introduced by A. W. Meyer.)

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In recent years a small, hitherto unknown cartilage has been described in the Amphibia. This develops at metamorphosis in the

interval between the facial nerve behind and the quadrate cartilage in front. Stadtmüller[1] described a cartilage lateral to the quadrato-mandibular articulation in *Bombinator pachypus* and termed it *"Cart. paraarticularis."* In the same position, in the members of the higher Anura, the *Annulus tympanicus* develops. In 2 urodeles (Litzelmann[2] on Triton and Stadtmüller[3] on Salamandra) a cartilage develops along the posterior border of the quadrate. Litzelmann shows that the tubo-tympanal rudiment of the first visceral pouch of the Triton embryo occurs in this position, but later becomes cut off from the pharynx and disappears. Litzelmann concluded that the cartilage which develops later in this position is the representative of the hyomandibular cartilage of fishes, long sought in the Amphibia.

The tubo-tympanal rudiment of Rana was shown by Spemann[4] to develop from the embryonic first visceral pouch. In the present study, the development of the tubo-tympanum during the transformation of the larva into the adult has been followed. During larval life a collection of mesenchymal cells appears about the distal end of the tubo-tympanal bud. These cells appear to be derived from the epithelium of the bud itself, inasmuch as cells from the latter appear to migrate out into the mesenchyma. The latter condenses, and at transformation, 2 cartilages differentiate in it. One becomes the *Annulus tympanicus,* the other the distal part of the *Columella auris.*

This was established by the following experiments upon a series of *Rana sphenocephala* embryos. A cut was made through the ectoderm along the hyomandibular groove, at a stage in which the external gills I and II each consisted in 2 simple branches. When the edges of the wound were reflected, the extremity of the tubo-tympanal bud was seen bending forward and outward around the hyoid mesoderm. The distal end of the bud was excised by means of glass needles. The individuals of the series were killed at various stages after the operation. At metamorphosis, the tympanic membrane failed to appear on the operated side. Dissection showed that the *Annulus tympanicus* and the distal end of the columella were absent on the operated side. This result bears on the finding of Helff[5] that the formation of the tympanic membrane is depen-

[1] Stadtmüller, F., *Z. f. Anat. u. Entw'gesch,* 1931, **94**, 792.

[2] Litzelmann, E., *Z. f. Anat. u. Entw'gesch.,* 1923, **67**, 457.

[3] Stadtmüller, F., *Z. f. Anat. u. Entw'gesch.,* 1924, **75**, 149.

[4] Spemann, H., *Zool. Jahrb. Abt. Anat. u. Ont.,* 1898, **11**, 389.

[5] Helff, O. M., *Phys. Zool.,* 1928, **1**, 463.

dent upon the cartilaginous *Annulus tympanicus.* The operation produced uniform results in the series. In the larval stages, no trace of the tubo-tympanum was to be seen on the operated side, and the chondroblastemata of the *Annulus tympanicus* and the distal part of the columella failed to appear. In the stages killed during metamorphosis, the tubo-tympanum, the *Annulus tympanicus* and the distal part of the columella were absent. No other abnormalities were evident on the operated side. The proximal part of the columella made its appearance in the *Fenestra vestibuli* as normally, and elongated anteriorly as far as the *Processus ascendens,* which joined the *Crista parotica* as on the unoperated side.

It appears that 2 cartilages in the middle ear of Rana (the *Annulus tympanicus* and the distal part of the columella), are formed from the endoderm of the first visceral pouch. The author wishes to suggest that possibly in urodeles and pelobatids the tubo-tympanal rudiment possesses the capacity to form cartilage, and that the cartilages described by Litzelmann and Stadtmüller are representatives of the chondroblastema in Rana, from which the *Annulus tympanicus* and the distal part of the columella arise.

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Glycogen Content of Fresh-Water Mussels.

DEA BAILEY CALVIN. (Introduced by Edgar Allen.)

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Determinations of the glycogen content of fresh-water mussels have been made, using a modification of the Pflüger method as described by Cori.[1] Separate determinations were made on the hepato-pancreas and foot muscle. The results are expressed in percentages of the wet and dry weights of the tissues analyzed.

Fourteen different species of fresh-water mussels were used in the work. Altogether, 51 mussels were analyzed. Many of them had been in the laboratory for some time. They were kept in tanks containing sand and a steady, slow stream of tap water was allowed to flow over them. No food was given them. Others were brought in for analysis from various sources.

[1] Cori, C. F., 1926, **70**, 559.