not seem to give much significance to this fact. They are sure there are combinational tones.

Hazel[3] shows that both sides were right, experimentally, and that both sides were wrong, in that they did not recognize that there is an underlying fundamental principle of wave motion in the experiments.

Koenig tried to add two sine waves and found nothing but the two parent waves. Helmholtz modulated one wave or frequency with a second wave and found combination tones. In Koenig's work the equation is, $A_1 \sin \omega_1 t + A_2 \sin \omega_2 t = ?$ Mathematically and experimentally, the only frequencies or waves found are the two original frequencies. In Helmholtz's work we may assume that the output is affected by the air pressure in the common air chamber or that the output is proportional to P sin ωt. When two orifices in the siren are open, the pressure at orifice No. 2, say, is $P_0 + P_1 \sin \omega_1 t$ (the pressure varies in unison with the frequency of orifice No. 1). Then the output is, $(P_0 + P_1 \sin \omega_1 t) \sin \omega_2 t$. Thus we have a "product term." The "product term" is shown by mathematics to be two frequencies, the difference and the sum of the two parent frequencies.

Hazel has shown that in every case when the "product term" is present we find combinational frequencies. These combinational tones or frequencies or waves are real waves which can be detected by tuned apparatus.

With the simple addition of waves these combinational waves are not present, and in the case of sound we have beat notes in our ears. However, if the two frequencies or waves are added through non-linear apparatus we have a "product term," and the combinational waves are found. In the case of sound, since we hear beat notes, the logical conclusion is that our ears are non-linear.

Hazel's work clears up the prevailing hazy conceptions of addition and modulation of waves and shows that the two operations are not the same and that they are fundamentally different.

The case of beat notes is somewhat the reverse of the physiological question: "If a tree falls in the center of a vast forest where there is no animal life, is there any sound?" Physicists will agree that there are waves in the air. There are waves but no ears. With beat notes there are ears but no waves—no air waves whose frequencies are the frequencies of the beat tones heard.

R. R. RAMSEY

INDIANA UNIVERSITY

GONADECTOMY AND A NEW SECONDARY SEXUAL CHARACTER IN FROGS

AN extraordinary and entirely new secondary sexual character in tailless amphibians has recently been described by Dr. C. C. Liu, of Soochow University.[1] This structure, the morphological relationships of which are fully described by its discoverer in a recently published paper,[2] consists of a band of connective tissue extending the entire length of each layer of the Obliquus muscle, at both their dorsal and ventral borders. In certain species at least, the ventral bands are continued inward toward the midline at certain of the inscriptiones tendinae. These bands have been named the *Lineae Masculinae*. As with many other sex-limited modifications in Amphibia, the functional significance of these structures is not immediately apparent. The most obvious assumption—that they are concerned with the mechanics of voice production—is rendered doubtful by their complete absence in many species that are excellent singers. They are found, among other species, in sexually mature males of the common American and European ranids, but are lacking in the bufonids of these regions, and are not found in females of any species. Parker[3] has erroneously stated that they are confined to the two species of *Kaloula, borealis* and *manchuriensis*. Liu has been able to show that they occur in a great many species of the frogs and toads of the world.

It is curious that the presence of a structure as sharply defined as this should have escaped observation until now, particularly in an animal that has been subjected to the minute and continuous scrutiny that has been applied to the frog. Once seen, the lineae masculinae are immediately apparent when a male frog has been skinned. Thousands of students must have observed them unconsciously in American and European laboratories. That they should have escaped the searching eyes of the German anatomists of the last century is still more remarkable. Only the chance combination of a transparent skin and almost complete lack of sexual dimorphism in the Chinese frog *Kaloula borealis* revealed them to Liu. From this starting point he has traced them through the Salientia of the world.

The restriction of the lineae masculinae to one sex suggests a correlation of some kind between them and the gonadal hormones. Their absence in sexually immature animals and an apparent lack of seasonal variation are also significant. As a rule, sexual dimorphism in frogs and toads is not great. The most obvious sex-limited characters are the growths, asperities and glandular accretions which have achieved

[3] *Phil. Mag.*, p. 103, January, 1935.

[1] C. C. Liu, "Secondary Sex Characters of Chinese Salientia." Thesis, Cornell University, 1934 (abstract, 6 p.).

[2] C. C. Liu, "The 'Linea Masculina,' a New Secondary Sex Character in Salientia." *Jour. Morph. Physiol.*, 57: 131–145, 1935.

[3] H. W. Parker, "A Monograph of the Frogs of the Family Microhylidae," London: British Museum, 1934.

such an extraordinary diversity among these animals.[4] In addition, as might be expected, those species which have been intensively studied have been found to show more or less minute sex-correlated differences in nearly every detail of their anatomy. Experimental work on salientian secondary sexual characters has been for the most part confined to those found in easily obtained American and European species of the genera *Rana* and *Bufo,* and the characters which have been available for experimental analysis are singularly uniform and conservative when compared with the bizarre developments seen in many exotic species. With the exception of the vocal sacs, which Champy believes are self-differentiating,[5] and the accessory reproductive apparatus (Müllerian ducts, seminal vesicles), which have long been known to be under the control of the hormones in their post-pubertal development, the characters which have been available for study are seen to be integumentary modifications. Numerous experiments have definitely established that these structures depend upon the sexual hormones, not only for their initial development, but also for their conservation. Occasionally museum collections yield specimens among exotic species that are undergoing sex-reversal, and the condition of the secondary sexual characters in these individuals indicates that the mechanism governing integumentary modifications is uniform throughout the Salientia. While it is impossible to forecast the nature of the supposed correlation between the linea masculina and the gonads, it is immediately apparent that its morphological expression is basically different from the relatively superficial structures represented by nuptial pads and other modifications of the integument. The potential importance, from the sexual standpoint, of the discovery of this sharply defined structure in a standard laboratory type is evident. Scarcely less interest attaches to its functional significance and its curious absence in bufonids and other groups.

In an attempt to determine the nature of the supposed relationship between the linea masculina and the gonads, a number of leopard frogs (*Rana pipiens* Schreber) were gonadectomied during the months of April and May, 1934. An additional series maintained under identical conditions served as controls. The gonads were removed surgically through the customary single abdominal incision, which was sutured with a couple of stitches to prevent prolapse of the viscera. Recovery was rapid and complete, except in those animals that were heavily parasitized or were subjected to undue operative shock. The frogs were maintained in excellent condition by regular feedings of cubed beef liver about every third day. The importance of maintaining experimental animals in a healthy condition, as well as of making a careful examination for regenerated testicular fragments, has been strongly emphasized by Champy (*loc. cit.*). Eight completely castrated males survived operative shock and parasitization. They were killed for observation, along with controls, at irregular intervals between 30 and 163 days. In each case a careful examination was made for indications of regenerated testicular tissue, suspected fragments being subjected to histological examination. Although there was some regeneration of minute nodules of fat, in only one case was a fragment of testis found. Two specimens were retained for 152 and 163 days, respectively, before they were killed. At this time the autopsy revealed that the bands were still fully developed in both operated animals and controls. Histological examination, which shows that the bands are composed of dense white fibrous connective tissue, likewise failed to show any castration effects. Results were also negative in males that had been retained for shorter intervals before they were killed; and the linea failed to develop in a small series of females from which both ovaries had been removed.

The negative nature of these results is not surprising, since the linea masculina obviously forms a part of the basic supporting structure of the body, and experimental work on other vertebrates has shown that many deeply seated somatic differences are not dependant on the sexual hormones for their conservation, once they are fully established. They are of considerable interest in showing the relation between this new secondary sexual character and those sexual characters in frogs that have already been studied so intensively. Two conclusions may be drawn from the results outlined above: (a) Although the testicular hormone may be necessary for the initial development of the linea masculina, it is not necessary for its conservation; and (b) the linea masculina is not potentially present in both sexes in the adult stage, as Zahl and Davis found to be true of the caudal ocellus in *Amia.*[6] Several other possibilities remain. The bands may possibly attain somatic expression entirely independently of the gonadal secretions, as Champy found to be true of the vocal sacs, although this hardly seems likely in view of the apparent time correlation between their appearance and the onset of the testicular hormone. The true nature of the relationship may be revealed by additional castration experiments or by

[4] G. K. Noble, "Biology of the Amphibia," Chap. V, 1931.

[5] C. Champy, "Les caractères sexuels considérés comme phénomènes de développement et dans leurs rapports avec l'hormone sexuelle," Paris, 1924, p. 107.

[6] P. A. Zahl and D. D. Davis, "Effects of Gonadectomy on the Secondary Sexual Characters in the Ganoid Fish *Amia calva* Linnaeus," *Jour. Exper. Zool.*, 63: 291–307, 1932.

heterosexual gonad transplants. Further experiments along these lines are being conducted.

D. DWIGHT DAVIS
FIELD MUSEUM OF NATURAL HISTORY
CHARLES R. LAW
NORTH CENTRAL COLLEGE

A CHAT

I HALTED to peruse a piece of modern commercial advertising and was excited by it. It was a neat pamphlet, entitled "———— News Chats," which is periodically published and circulated by one of our huge concerns whose business is the sale of scientific laboratory supplies. It announces itself as being "A bulletin of newsy information to those who know us well and an introduction to those who do not, who we hope will become our friends and customers."

Allow me to reproduce the titles found on some of the articles in the last issue—October, 1934—of this genial monthly visitor from the land of trade to the desks and minds of us lords of American science:

Thar's Sillimanite in Them Thar Hills
A Field Trip in the Classroom
A Hole in a Black Derby Hat
Fitting Trees to the Soil
Black Light from Sunshine
Now Liquids Are Polished
Lots of Agitation for a Little Money
Keeps Storage Batteries Healthy
On the Lookout for J. Pluvius

Furthermore, grant me liberty to quote, with briefest comment, several sentences from these articles—so cleverly and intimately, not to say adroitly, named!

Just being out-of-doors in the bright sunshine is stimulating, but the most excitement comes in searching out interesting insects and animals to see how they *build their homes and raise their children.*

"'Chose qui piait est a demi vendu,' runs the French saying; a thing that pleases is half sold—a truth we all must admit."—To be sure.

"Stranger, that 40 over yonder is the finest hardwood soil you ever want to see."—Yessiree!

"Light, the intangible something that enables us to see things and promotes the growth of plant and animal life, was so much a mystery to ancient mankind as to be deified in some form in almost all of the earlier religions."—Startling information!

"The value lies in the 'eye appeal' which leads prospective buyers to choose one in preference to the other."—I see.

"Only a *healthy,* active storage battery gives its owner a normal period of service."—Honestly?

However, if blame there be for this infantilism in these high places, do not suspect that I lay it upon the publisher. He has a business, and must chat accordingly. This must be a proper approach—effective and profitable—to his audience, else, having tried it, he would not continue it. The great analyzers themselves are analyzed. The business sense has an instinctive power of psychological insight that amounts to wizardry. We are to believe that the "———— News Chats" is a shrewd, welcome and successful adaptation, in the tough realm of competitive trade. Why not?

The average scientist, even the super scientist, of the present day does likewise, as his turn comes to sell, so to speak, his products to his customers—the public and the world. It is the vogue. He cleverly composes his material; cites the business man or else Lewis Carroll as his justification, and then goes out talking folk-lore, even baby dialect, quite naturally and congenially. He acquits himself most adorably before "The Boy Scouts," "The Ladies Better-Fed Club," "The Tradesmen's League Against the Spinning Wheel" and other advanced organizations whose members are simply spoiling for enlightenment in the black magic of all the sciences. Yes, let a second and living Jacques Casanova call to-day upon a second and living Voltaire, and the latter mention some popular modern scientist—as he mentioned on that past day the name of Count Algarotti, the prominent Venetian scientist—and Casanova would be obliged to repeat his famous comment: "That is how he made his name. He constituted himself an admirer of Newton, and made it possible for the ladies to talk learnedly about light."

Though long neglected and out of use, the amazing pedagogical potency of "chat" or the "chatter" method has been rediscovered and re-employed. I am informed that scientific causerie is again very prevalent, even in the erotic wit of the best social circles. They say it is not unusual there, in these days, to hear sweet and burning passion vent itself and forward its cause in language such as the following: "In compound ratio of your affection," "In inverse ratio of my languor," "The mass multiplied by the velocity of my attendance equals the momentum of your passion," "The squares of the times of my hope are as the cubes of the distance of your consent" and so forth—quotations from a French work on Italy, in the second half of the eighteenth century. Sciencized gallantry—what can't science achieve, once it dismounts from its high-horse!

And so, to chat. Just folks, all around; just one big chatting family. Shan't we just sit down now, all together, and enjoy a little chat over a "true black body" or, what amounts to the same, "a hole in a black derby hat hung from a hook on a surface covered with black felt"?

JOHN W. CRIST
MICHIGAN STATE COLLEGE
EAST LANSING