Grama (*Bouteloua oligostachya*), gray.

Beard grass (*Aristida* sp.) light gray.

Tickle grass (*Panicum capillare*), silvery gray.

Low bunch grass (*Andropogon scoparius*); as indicated above, this may fade out to a dull gray.

Cottonwood twigs (*Populus deltoidea*), grayish-white.

I may close this paper with a couple of sections observed between Oxford and Minden, Nebraska.

In the one case (Figs. 1 and 2) a ravine, with moderately abrupt but regularly sloping sides, was observed to have a central band

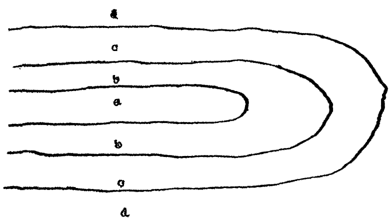

FIG. 1. Ground plan of ravine. *a*, yellow ; *b*, red ; *c*, gray ; *d*, red.

(*a*) of yellow (switch grass) which occupied the entire floor. On each side was a belt (*b*) of red (bunch grass) which occupied the lower and more sloping part of the side of the ravine. On the shoulder of the ravine, running down to the more precip-

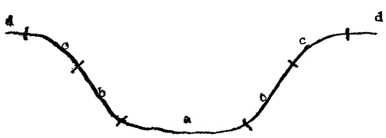

FIG. 2. Section of ravine ; *a*, yellow ; *b*, red ; *c*, gray; *d*, red.

itous part and back to the edge of the level ground was a broader belt (*c*) of gray (buffalo grass and grama), and back of this again came the red of the bunch grass (*d*) which colored the general surface of the plain.

In another case (Fig. 3) a gentle slope with somewhat terraced surface was observed with a peculiar distribution of color. There were three steps on the slope, each not more than twenty to thirty centimeters

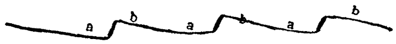

FIG. 3. Section of terraced slope ; *a*, *a*, *a*, red ; *b*, *b*, *b* gray.

in height, and a couple of meters apart, the surface sloping gently from step to step. On each terrace the upper edge near the step (*a*) was red with bunch grass, while the lower portion (*b*) was gray with Buffalo grass and grama. This was repeated exactly upon each terrace, giving the whole view a very singular appearance.

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RUDOLPH KOENIG.

ON the second day of October, 1901, Rudolph Koenig passed away at his home in Paris in his sixty-ninth year. He had been in failing health for several years.

Rudolph Koenig was born in Koenigsberg, Prussia, on the 26th of November, 1832. At his home he received nothing beyond the usual high school training given in the local gymnasium, in which his father was the teacher of mathematics and physics. He went to Paris at the age of nineteen years, and in the French metropolis he spent most of his manhood. Here he began life as an assistant in the manufactory of a celebrated violin maker, Vuillaume, where he manifested unusual aptitude both as a mechanician and as the possessor of an extraordinarily delicate and correct ear for music. Such leisure as he could command was devoted to the study of mechanics and physics.

Within a half-dozen years the young acoustician was enabled to undertake business on his own account, having already attracted the notice of men of science by his ingenuity, patience and accuracy. In 1859 he issued his first catalogue of acoustic apparatus. From that day to the present Koenig's instruments, and especially his tuning forks, have been generally recognized as standard.

Koenig was not satisfied to fill orders and maintain his reputation as a constructer of instruments. He early perceived the value of the graphic method for the study of harmonic motion, and to this he devoted much time and labor during the first few years after establishing himself independently. Wertheim and Duhamel had already used the tuning fork with style attachment for the registration of simple vibrations, as suggested a half century previously by Dr. Thomas Young in England. Koenig extended it to the study and registration of compound harmonic motion for both parallel and rectangular vibrations. The mathematical analysis of wave motion had been abundantly brought out in technical treatises, and Lissajous had but recently excited admiration by his optical method of presenting rectangular vibrations. Koenig devised the method of recording these directly from the sounding tuning fork. At an international exhibition held in London in 1862 he exhibited an album containing a large variety of such phonograms, recorded with apparatus of his own device, and accompanied with the tracings of the corresponding theoretical curves. This was the starting point for the use of the graphic method of self-registration which has since been so extensively employed in laboratories of physics, physiology and psychology.

It was at the same exhibition that Koenig made known a wholly new method of causing the effects of sonorous vibration to become visible by utilizing the delicate sensitiveness of flame to variations of atmospheric pressure. The suggestion had come from America, where Le Conte had published, in 1858, his observations on the effect of sound waves upon naked gas flames. Koenig devised the manometric capsule, and resorted to Wheatstone's application of the revolving mirror for spreading the flame images. The last improvements on this method have been made by the application of instantaneous photography to perpetuate the images, some of the best of this work having been done within the last few years by Hallock in New York and Merritt in Ithaca. The manometric flame is not equal to the tuning fork curve as a means of studying the composition of vibration, but the novelty and attractiveness of the method quickly made its author famous. He received a number of medals, and in 1868 the honorary degree of doctor of philosophy was conferred upon him by the university of his native city, Koenigsberg, in acknowledgment of his meritorious original work in science.

Prior to 1882 Koenig had published about sixteen scientific papers, some in the *Comptes Rendus*, but most of them in the *Annalen* of Poggendorff and Wiedemann. These were gathered into a volume entitled, 'Quelques expériences d'acoustique.' Since that time he has published a number of contributions to *Wiedemann's Annalen*, the last of which appeared in the summer of 1899. Failing health had already put a check upon his activity, but his passion for experimental research continued long after the time when most men lose their enthusiasm for abstract investigation. All his research work was the outcome of the love of science without the promise of pecuniary reward. It was done, moreover, with full knowledge that as a branch of pure science acoustics had been forced to the background by such subjects as heat, and more especially electricity, in which the field has become widened almost without limit during the last two or three decades.

In the absence of systematic university training in early manhood Koenig as an investigator in physics was compelled always to work at some disadvantage. He had an abiding faith in experiment, and was not afraid to proclaim the results of his careful, painstaking work, even if it seemed to contravene the conclusions of those whose theoretic preparation was better than his. The subject of musical quality was one which he attacked with characteristic patience. With the mathematical theory of combination tones, as brought out by Helmholtz, and the two subdivisions of difference tones and summation tones, Koenig was not prepared to grapple. With his naturally acute and highly trained ear he sought in vain to perceive the summation tones for which theory provided, and he reached the conclusion that they had no objective existence. Difference tones, or beat tones, as he called them, are easily perceived, and he spent much time in the investigation of such tones due to the interference of upper partials. It was in furtherance of this investigation that he invented the wave siren; and as a result of experiment with it he concluded, in opposition to the view of Helmholtz, that musical quality is determined not only by the number, the orders and the relative intensities of the upper partials which accompany a given fundamental tone, but also by their mode of phase combination. To test this the wave siren was certainly better than the apparatus employed by Helmholtz; but the perception of the result requires an experienced ear. The experiment is more psychological than physical. Upon the present writer, while cooperating with Koenig in his laboratory, and upon others also, the decided impression was that Koenig's conclusion was correct. But the subject is still one for investigation.

A monumental piece of mechanical work accomplished by Koenig was his great tonometer, consisting of hundreds of accurately adjusted and properly labeled tuning forks arranged in a series, each making a definite and small number of beats with the preceding and following ones, so that the frequency of any source of sound approximately simple can be at once ascertained by direct comparison. The range extends through all the tones ordinarily employed in music. To have access to this tonometer the late Professor A. M. Mayer spent the summer of 1892 in Paris, where he secured the cooperation of Koenig in his research on the variation of the modulus of elasticity of different metals with change of temperature, as indicated by the pitch obtained by transverse vibration of bars. Koenig's keen ear was applied also in Mayer's investigation regarding the duration of the residual auditory sensation when beats are produced by neighboring tones in different parts of the musical scale. The author's conclusion was that, between the limits of 100 and 4,000 vibrations per second, there was closer accordance between the results of calculation and observation than in the case of any other physiological law for which the attempt had been made to express sensation mathematically. So well trained was Koenig's ear that in the tuning of the standard forks issued from his laboratory there was little need for any better guide than his own auditory sensation. After the pitch had been provisionally attained in this way it was corrected by other and more exact methods, but the correction was always very small.

It seems scarcely probable that Koenig will have any successor. For a man now to devote his whole life to the science of acoustics would be a piece of specialization for which but little reward can be expected. The progress of science has its phases of relative importance and that of acoustics seems now to be past. Koenig is dead, and his friends will remember him with affection and respect. His devotion to acoustic science was unique. His life was that of the recluse bachelor, and his later years brought anxiety and privation because his science had lost its value as a means of support. He will not soon be forgotten; but likewise no one will aspire to take his place. W. LE CONTE STEVENS.

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SCIENTIFIC BOOKS.

1. *Hygiene and Public Health.* By LOUIS PARKES, M.D., D.P.H., London University, and HENRY KENWOOD, M.B., D.P.H., F.O.S. Sixth edition, 1901. Philadelphia, Pa., P. Blakiston's Son & Co., publishers. With numerous illustrations. Pp. 732. Price, $2.50.
2. *The Theory and Practice of Military Hygiene.* By EDWARD L. MUNSON, A.M., M.D., Captain, Medical Department, U. S. Army. First edition, 1901. New York, Wm. Wood & Company, publishers. Illustrated by eight plates and nearly four hundred engravings. Pp. 971. Price, extra muslin, $8.00; leather, $8.75.
3. *A Manual of Practical Hygiene*, for students, physicians and medical officers. By CHARLES HARRINGTON, M.D., Assistant Professor of Hygiene, Medical School of Harvard University. First edition, 1901. Philadelphia and New York, Lea Brothers & Co., publishers. Illustrated with twelve plates and one hundred and five engravings. Pp. 729. Cloth, $4.25 net.
4. *The Principles of Hygiene;* a practical manual for students, physicians and health officers. By D. H. BERGEY, A.M., M.D., First Assistant, Laboratory of Hygiene, University of Pennsylvania. Philadelphia, W. B. Saunders & Co., publishers. Pp. 495. Price, cloth, $3.00 net.
5. *School Hygiene.* By EDWARD R. SHAW, Professor of the Institute of Pedagogy, New York University. First edition, 1901. New York and London, The Macmillan Company, publishers. Pp. 260. Price, cloth, $1.00.

In view of the fact that hygiene is not an independent science, but a correlation of the teachings of physiology, chemistry, physics, meteorology, pathology, epidemiology, bacteriology and sociology, it is not surprising that the progress of this branch has been phenomenal. Over twenty text-books have been issued during the last ten years, and all but Parkes's in the above list are products of the present year. Indeed, this science was scarcely taught in any of our medical schools twenty years ago, and has received such an impetus during the past two decades that many regard it of modern origin. Such, however, is not the case, for on turning to early history, we almost invariably find that the health of the population has been made the subject of legislation. Hygiene was practiced by the Egyptians, the old Indians and Hebrews, and a study of the habits of the primitive peoples shows that a desire to prevent disease is innate to all men. The Greeks and Romans paid special attention to the physical culture of their youth, public water supplies and baths, and Athens and Rome were provided with sewers at an early period of their history. During the Middle Ages sanitation received a decided check; ignorance and brutal prejudices appear to have been the ruling spirits, and for many reasons it was the most unsanitary era in history. About this time most of the towns in Europe were built in a compact form, surrounded with walls; the streets were narrow and often winding for defensive purposes, shutting out light and air from the houses. The accumulation of filth was simply frightful. Stables and houses were close neighbors, human filth was thrown on the streets or manure heap. The dead were buried within the church-yards. Sewers and aqueducts having been permitted to fall into disuse, the inhabitants were compelled to resort to wells with polluted subsoil water. All the conditions were favorable for the spread of infectious diseases, and in the fourteenth century alone the oriental or bubonic plague, according to Hecker, carried off one-fourth of the population of Europe. The mortality in towns was greater than their birth rate, and the city population until the close of the eighteenth century had to be recruited continually from the country. The repeated invasion of pestilential diseases, however, compelled everywhere some sanitary efforts in the way of