

tion about the dependence of the fly upon blood. The further assumption was made that the fly cannot exist without game. Mr. Swynnerton has shown this to be untrue. In the Dar-es-Salaam district there is no game, but there are three kinds of fly known to exist. The fly apparently feeds upon human beings and animals indiscriminately.

Mr. Swynnerton proposes to exterminate the fly by bush burning, and he has already achieved a considerable measure of success in the Shinyanga district. There he was fortunate in obtaining the collaboration of a native chief of character and understanding and energy. Makweia, the chief in question, once convinced of the importance of fly extermination, called his people together and informed them that they were to take part in a campaign against a more insidious enemy than man, that they must discipline themselves and respond to instructions as if they were engaged in tribal warfare. With the assistance of fifteen thousand natives, Mr. Swynnerton was able to undertake bush clearings by means of burning and cutting on a vast scale, with the result that a large area of country will this year be under cultivation and a hitherto desolated district be re-populated and re-stocked.

In the neighbouring province of Uganda, Drs. Carpenter and Duke, and Mr. Fiske, are carrying out research of the greatest importance. Only a few years ago, owing to the death of more than two hundred thousand natives of sleeping-sickness, Sir Hesketh Bell removed the remaining population from the lake islands and the lake shores, an extremely costly undertaking and one which has been responsible since for much unrest among the detribalised natives. Mr. Fiske is carrying out single-handed an entomological survey of Uganda. Dr. Duke is at the moment engaged upon the important task of classifying human and animal trypanosomes and the connexion between human and animal trypanosomiasis. Dr. Lamborn, who has been working in Nyasaland, has for some time been engaged in the task of breeding parasites which attack the tsetse-fly with the object of exterminating tsetse by this measure.

It is clear, however, that unless all these territories

make a co-ordinated and combined effort to deal with the tsetse-fly menace, the achievements in one territory will be negated by the indifference in others. It will be useless, for example, to exterminate the fly in Uganda and Tanganyika portions of the Lake territory, if Kenya undertakes no similar campaign in the Kavirondo district. Sir Robert Coryndon, Governor of Kenya, has stated that "the leading experts who deal with the problems of sleeping-sickness and tsetse-fly control are servants of Uganda, and there is little organised or encouraged co-ordination or exchange of views between them and their technical colleagues in Kenya and Tanganyika Territory." In Kenya colony, as a matter of fact, there is practically no staff available for work in connexion with sleeping-sickness or animal trypanosomiasis.

There is every indication, however, of a changed attitude. In every territory the Governors impressed upon the members of the Parliamentary Commission the necessity for a co-ordinated plan of campaign in the interests of their territories. At the present time the Imperial Bureau of Entomology is engaged in formulating a plan of campaign of research into tsetse-fly problems. It is quite obvious that the problems are so vast as to be beyond the capacity of less than ten men to deal with them. As Dr. Andrew Balfour said in an address at the Anderson College of Medicine on October 14, 1924: "We are not yet certain as to whether *Trypanosoma gambiense* and *T. rhodesiense* are the same parasite or different species. We still quarrel over the vexed question of the big game, or perhaps one should say the wild animals, as reservoirs of infection. We know precious little about immunity to the disease; we are not at all sure as to the habits of Glossinæ, and we are still trying to discover which is the best drug and how we can best prevent this mysterious complaint." The matter is one of such great importance that it is to be hoped that Major Ormsby-Gore's suggestion, that a large working commission of experts be appointed to undertake the necessary research work in consultation with the men on the spot, will be acted upon. Such collaboration must form the basis of any heroic measures for tsetse-fly extermination.

Biographical Byways.¹

By Sir ARTHUR SCHUSTER, F.R.S.

5. LUDWIG BOLTZMANN (1844-1906).

I DID not know Boltzmann intimately, but can tell of some incidents in his life and quote from passages in little-known publications, which mark his impulsive and vigorous character, and illustrate some features of his personality that would be missed by any one acquainted only with his scientific writings. As a young man twenty-six years old, who had only published one or two minor papers, Boltzmann called on Königsberger, then professor of mathematics at Heidelberg, mentioning incidentally that he had discovered an error in one of Kirchhoff's mathematical papers. Königsberger told him that this was a good opportunity of becoming personally acquainted with one of the great men of the time. "Call on Kirchhoff," he advised.

¹ Continued from p. 127.

"Lead the conversation to the subject, and explain the nature of his error."

Boltzmann acted with characteristic impetuosity. Within an hour Kirchhoff, who always took a great pride in his accuracy, came rushing into Königsberger's room in a state of extreme agitation. "A most distressing thing has just happened to me," he exclaimed. "A young man, of whom I know nothing, enters my room, and before he has time to shut the door behind him, calls out: 'Herr Professor, Sie haben einen Fehler gemacht!'" I give the tale on Königsberger's authority.

Boltzmann made his reputation during sixteen quiet years at Gratz, but it was a grief to him that his lectures did not attract a more numerous audience, and he was always looking out for a university where

budding mathematicians were as plentiful as chemists or lawyers. He went to Munich; next to Vienna, but still not being able to satisfy his ambition he was drawn again to Germany, the country towards which he had strong political leanings. He received an offer of a professorship at Berlin, and I was informed by one in a position to know, that the faculty of science at that University received a series of telegrams and letters, few of the latter being dated, some accepting, some refusing, and no one knew in what order they were dispatched. Ultimately, the negotiations were broken off, and Boltzmann went to Leipzig, but he soon longed to return to Vienna. That University would have welcomed his return, but the Emperor declined to call him back, on the ground that an Austrian subject who had accepted foreign service was disqualified from ever again finding employment in his dominion. Mr. von Hartel—who at the time was Austrian Minister of Public Instruction—told me how for a considerable time he stood helpless between two fires: on one side the insistence of the University which wanted Boltzmann, on the other the obstinacy of the Emperor who remained firm in his refusal. At last von Hartel decided to make a final effort, and asked the Emperor for permission to put a hypothetical question. This being granted, the question put was: "If your Majesty's favourite ballet dancer were to run away, and after a year's absence wanted to return, would you have her back?" The Emperor admitted that perhaps he might.

"I beg to submit," said the Minister, "Boltzmann is to the University what your favourite ballet dancer is to you."

Francis Joseph laughed and gave in.

I do not tell the story merely as an amusing episode, but because the image of Boltzmann's ungainly figure trying to practise ballet steps recalls to my mind the occasions—fortunately rare—when Boltzmann indulged in humorous writing. He had travelled much, visiting America, Constantinople, Athens, Smyrna, and Algiers, and in one of his writings tells us how he had always declined to publish an account of his experiences, but that after returning from a lecturing engagement at the Berkeley University in California, the temptation proved too strong, and an article appeared under the title of "Reise eines deutschen Professors in Eldorado." His jokes are driven into us with hammers. Eating and drinking, followed by drinking without eating, form a favourite subject, because to him—as he says—the most important consideration in travelling is to keep one's digestion right. But he might have spared us the gross and unrepeatable allusions to the poisonous effects of pure water and the boast that his otherwise good memory for figures fails when he tries to remember the number of glasses of beer he has imbibed! The astonishing part of his recital is, however, its want of accuracy. In an account of a dinner party given in his honour at the country seat of a wealthy lady near San Francisco, he tells us how it began with blackberries, which were followed by oatmeal: "an indescribable mixture of paste and oats, which might be used for fattening geese in Vienna were it not that the geese would refuse to eat it." The enumeration of subsequent dishes makes it clear that it was really dinner and not breakfast that was meant. On scientific

matters also he falls into error, as when he tells the reader that the moons of Mars were discovered at the Lick Observatory.

In great contrast with this heavy and vulgar joking, the other matter contained in the volume of popular writings shows us Boltzmann as a highly cultivated man, enthusiastic about poetry, fond of music, not averse from expressing an opinion on art, and with a leaning towards metaphysical speculations. An article on flying written in 1894 is specially interesting, and the following passage shows considerable foresight:

"It is scarcely doubtful that a dirigible air-ship would create an expansion of intercommunication compared with which that due to the introduction of railways and steamers is negligible. Our armies of to-day would be as helpless against the dynamite thrown down from flying machines as those of Rome would have been against breechloaders. The customs' regulations would either have to submit to unthought-of alterations or to be abolished altogether."

Astonishing, as coming from an Austrian, is the German chauvinism to which Boltzmann occasionally gives expression. It appears in his article on aviation, and in a passage in the description of his Californian journey. After criticising the Berlin Academy and expressing regret that, since the death of Helmholtz and other distinguished Germans, American students prefer to study in Cambridge and Paris rather than in Berlin, he adds that the United States, and with it the whole world, will suffer in consequence.

On scientific matters his judgment is nearly always fair and uninfluenced by national feeling; at any rate so far as Great Britain is concerned. Here is an example of his style of writing when he is carried away by his subject:

"A mathematician will at once recognise the authorship of the writings of Cauchy, Gauss, Jacobi or Helmholtz, just as musicians will distinguish between Mozart, Beethoven and Schubert on listening to the first few notes of a composition. Perfect elegance of construction, though occasionally supported by weak foundations, belongs to the French; the greatest dramatic vigour to the English—and above all to Maxwell. Who does not know his dynamical theory of gases? First the variations of velocities are deployed in majestic array; next enter from one side the mathematical conditions and from the other the equations of central motion. Higher and higher rises the chaotic flood of formulæ until suddenly four words resound: 'Let n be 5,' and the malignant demon V vanishes, just as in an orchestra a wild overpowering bass may suddenly be reduced to silence. By a magic wand, an apparently hopeless confusion is reduced to order. There is no time to explain why one or the other substitution is made; let him who does not feel it in his bones put away the book. Maxwell is not a conventional musician who has got to explain his notes; obediently his formulæ deliver torrential showers of results, until we reach the final surprise effect. The problem of the thermal equilibrium of a heavy gas is solved, and the curtain falls. I recollect Kirchhoff's

remark to me: 'This is the way to deal with gas theories!'

It is not perhaps fair to examine this passage too closely, as a certain amount of poetic license must be forgiven—but Maxwell did not write, "Let n be 5"; he wrote, "It will be shown that we have reasons from experiment to believe that $n=5$." Sixteen words instead of four; but scientific accuracy has no chance when rhetorical effect is in danger, as the late Lord

Rayleigh remarked to me when I criticised a statement of a distinguished relative of his.

Shortly after his final return to Vienna, Boltzmann committed suicide. With him passed away a man of great intellectual power and a fascinating personality. His predilection for Schiller's poetry indicates a strain of morbid sentimentality, and if his humour was somewhat primitive and his technique crude, he paid dearly for his disappointments in life.

The Talking Film.

By Dr. E. E. FOURNIER D'ALBE.

THE demonstration of the De Forest phonofilm at the Royal Society of Arts on November 26, 1924, and its recent exhibition at the Royal College of Science during the Physical and Optical Societies' Exhibition, showed that the old problem of producing a motion picture endowed with its original sound effects has been brought within hail of a perfect solution.

As Mr. C. F. Elwell remarked in the course of the demonstrations, the De Forest phonofilm was preceded by many partial solutions of the same problem.

The first "talking picture" was known as the "cameraphone"—the method employed being to make the motion picture while a stock wax cylinder type of record was played. The actors sang, or pretended to sing, and the camera photographed the lip motion. The novelty of this method made it popular for a time.

The "kinetophone" of Thomas A. Edison was the next step in advance. Better results were obtained for the reason that the phonograph record was made simultaneously with the making of the motion picture negative. The synchronisation of the sounds with the lip motion was good, but the reproduction of this synchronisation was difficult, as so much depended upon the skill of the operator, who generally had another man to start the phonograph record. If mechanical or electrical means were supplied it was difficult to keep the phonograph record and the film exactly in step. If a portion of the film became mutilated the difficulties became greater. Notwithstanding these objections the "kinetophone" enjoyed quite a large measure of popularity. But this popularity waned, and finally no more was heard of this method.

It became evident that no solution would be practically workable until a perfect synchronism between sound and movement could be automatically established. It was, therefore, necessary to look for other methods of reproducing sound. Among these the most promising was Ernst Ruhmer's "photographophone" of 1907, in which a "speaking arc" projected light through a slit on to a moving photographic film. The audio-frequency fluctuations of the arc were thus recorded as a series of lines stretching across the film in a direction normal to its displacement, and Ruhmer succeeded in reproducing the original sound by transmitting a beam of light through this record to a selenium cell.

It was a modification of this method which Dr. Lee de Forest used for his talking motion picture. In common with Berglund and other experimenters, he

confined the photographophone record to a narrow portion of the standard one-inch film as used in cinema theatres. But his method of producing the record has many original features. He uses a double-button ("push-pull") microphone with a duralumin diaphragm between the two buttons. Such a microphone is capable of carrying 20 milliamperes. It is placed

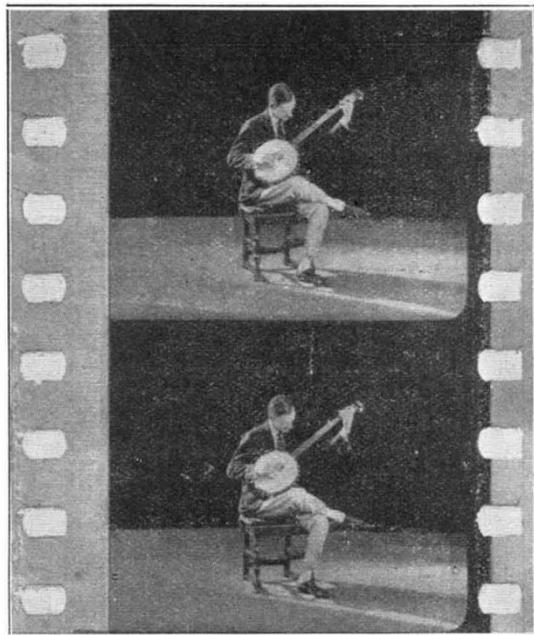


FIG. 1.—Enlarged photo of piece of film showing a banjoist performing. The cloudy strip at the left of the photograph is the music record.

about 5 feet from the speaker, and responds to all frequencies from 30 to 7000 per second.

An even better device is a condenser microphone with a capacity of 4 milli-microfarads, which is found capable of a range of 25 to 8000 vibrations per second.

The distortionless amplification of the electrical pulses yielded by the microphone is nowadays a comparatively easy matter, thanks largely to Dr. Lee de Forest's own previous inventions.

The next stage is the conversion of the electric pulses into fluctuations of actinic light. This conversion is neatly accomplished by means of a vacuum tube in which an electrode covered with barium dioxide discharges a current of some 5 milliamperes under a pressure of 150 volts through helium at 100 mm. pressure. This vacuum tube is called a "photion." It responds instantaneously to the variations of the