Generalizing, we may say that when we are dealing with a complicated chemical reaction in which a condition α goes into, or proceeds from, a condition β, and if we find that the specific reaction velocity is greater in the direction $\alpha \rightarrow \beta$ than in the direction $\beta \rightarrow \alpha$, it signifies that there are more elementary states comprised in the condition β than in the condition α.

By combining equations (1) and (2) we obtain a third law which is known as the equality of *a priori* probabilities and which, since it does not involve the element of time, we need discuss no further here. It is

$$p_a = p_b \qquad (3)$$

These three laws, of which, in fact, the first and third are both derivable from the second, are the fundamental laws of quantum kinetics and quantum statistics. They are at present the most important deductions from the law of the symmetry of time.

It is remarkable that so many positive conclusions result from the negative statement that physics requires no one-way time, but more important conclusions have been derived from the similar negative statements that we can not have a perpetual motion machine and that we can not determine absolute velocities. Whether the new law will be successful in leading to new and unexpected conclusions remains to be seen. At least, if accepted, it will warn us away from certain lines of thought which involve one-way time. There is at present in the study of quantum mechanics and in some interpretations of Heisenberg's uncertainty principle a tendency to introduce anew the idea of unidirectional causality. I feel convinced that this is a retrograde tendency which may introduce new errors into science.

OBITUARY

SHOSABURO WATASÉ

AMERICAN zoologists of the older generation well remember the young Japanese zoologist who came to America in 1886, became Bruce Fellow in Zoology at the Johns Hopkins University, where he took his Ph.D. degree in 1890, and was successively attached to Whitman's Department in Clark University (1890–1892) and the University of Chicago (1892–1899) before his return to Japan. He was also a well-known figure at Woods Hole where he spent most of his summers in America from 1888 on. Few of the many Japanese who have begun their scientific careers in America identified themselves more closely with the country of their residence, attained such sympathetic and thorough understanding of its history and spirit, so loved its literature and that of old England, or obtained such mastery of its spoken and written language as Sho Watasé. His friends had ceased to regard him as foreign, and thought of him as a permanent acquisition, so apparently domiciled was he in American social and academic life, until his sudden decision to return to Japan and accept the chair of zoology in the University of Tokyo in 1899.

This was a total loss to American zoology, for he resumed the old way of his life as completely as he had abandoned it for over twelve years, and his only visits to America thereafter were two brief ones on scientific missions. His return to Japan cut short a line of work in which he had already obtained marked distinction, and thereafter the needs of Tokyo and Japan claimed his undivided allegiance. This little sketch of his life will serve to fill out the picture for those who knew him, and to shadow forth a notable life to those who did not have this privilege.

Watasé was born in Tokyo, November, 1862, and there also he died March 8, 1929. He came first under the influence of American educational ideas when at the age of seventeen he entered Sapporo Agricultural College, an institution organized by William Smith Clark, President of the Massachusetts Agricultural College, under a special grant of the Japanese Government in 1875. Among the members of his class (1884) were the geographer Jugo Shiga, the journalist Gentei Zumoto and the statesman Tetsuji Hayakawa. From 1884 to 1886 he studied zoology at the University of Tokyo under Mitsukuri; from 1886 to 1890 he studied with William Keith Brooks at the Johns Hopkins University, held the Bruce Fellowship and received his Ph.D. degree there in 1890. Among his fellow students there were—E. G. Conklin, T. H. Morgan and E. A. Andrews. Then followed his years at Clark University, at Woods Hole and at the University of Chicago with C. O. Whitman, until his return to the University of Tokyo in 1899. From this institution he received the degree of D.Sc. in 1899, and succeeded Mitsukuri as head of the zoological department there in 1901.

He returned to America in 1907 as Japanese delegate to the International Zoological Congress held in Boston. On his return to Japan he took with him bullfrogs, which have become established in Japan and are very generally cultivated there as an article of food. Again on a trip to India in 1909–1910 he brought back the mongoose and established it in Japan on the Okinawa Islands, where it has almost exterminated venomous snakes which formerly caused serious loss of life. In 1922 on the occasion of another trip to the United States and Canada he inves-

tigated fox-breeding, and introduced the practice into Japan.

His interest in the domestication of wild animals was joined to an interest in their preservation in his native country, together with a life-long interest in the preservation of natural monuments in Japan. He was largely influential in the passage of laws and in the organization of a society relating to the preservation of the natural and historic monuments of Japan (1911 and 1919). Under the latter law he was put in charge of a committee on preservation of wild animal life, and worked on this subject for the remainder of his life, making a survey of some thirty-four animal species to be specially protected, including various birds, mammals, reptiles and rare marine species.

Watasé's doctoral dissertation was on "The Morphology of the Compound Eyes of Arthropods" based on a study of the structure and development of the compound eyes of Limulus with a comparison of many other representative arthropods. It was an epoch-making work in its field, and several of the artistically executed figures have long been standard illustrations of the subject. He then came under the influence of Whitman at Woods Hole and his next published work bears the marks of this influence. It deals with the cleavage of the ovum of the squid (Loligo) and was intended as the first of a series of studies on cephalopods. However, it served to introduce him to the field of cytology, and the proposed cephalopod studies were laid aside. During the remainder of his stay in America, until 1899, he devoted himself exclusively to cytological work. He had the great advantage during this time of being a member of Whitman's staff at Clark University (1890–1892), at the University of Chicago (1892–1899) and at Woods Hole. This insured him freedom for research, a situation that exactly suited his scholarly temperament. Although his activity was incessant, he did not publish much, being content to present the results of his work and thinking from time to time in the form of lectures or brief articles.

His publication on the cleavage of the egg of Loligo was a contribution of permanent significance, especially his observations on the bilaterality of the ovum and his ideas on its promorphology. The material proved excellent for the study of karyokinesis and led him into studies of the centrosome, and finally the nature of cell organization. A lecture on this subject published in the Woods Hole Biological Lectures 1893, presents the idea that the relation between the cytoplasm and nucleus of the cell is a kind of symbiosis, similar to that exhibited in the organization of a lichen. This idea, consistently and thoughtfully developed, as it is, has in it much for the fruitful consideration of modern cytologists.

In 1895 in a lecture on "The Physical Basis of Animal Phosphorescence" Watasé quotes the poet Fletcher (1637)

> You gaudy glow-worms, carrying seeming fire,
> Yet have no heat within ye!

and continues with observations from Robert Boyle (1667–1668), Faraday (1814) and others, in a way that shows his remarkable acquaintance with English literature, before proceeding with an interesting analysis of the subject in hand. This was one that satisfied both his scientific and his artistic nature, and was carried by him during the remainder of his stay in America; afterwards in Japan the subject of luminous organisms remained a favorite interest, as evidenced by his popular work in the Japanese language on this subject (1902).

In addition to the interests that he carried on in Japan already cited, he was an assiduous collector of animals and a student of ecology, which subject he studied on numerous trips to every corner of the islands of Japan; this interest led him to establish with the aid of students and friends a society for the study of the ecology of animal life of Eastern Asia.

Under a grave and serious manner Watasé was very warm hearted; he was considerate of other people and courteous in his attitude. To his students he was kindly, but never familiar; he corrected their dissertations with care and insisted on a good style of presentation.

Throughout his life Watasé was a man of many interests. During his stay in America he was one of the best read of his associates here in general literature and science; he had a lively interest in world politics, and was regarded as a special authority on Japanese art. He employed much of his leisure time in America in studying Japanese prints and paintings in various museums and libraries throughout the United States. On his return to Japan he became a member of the newly organized Institute for Japanese Arts and was a regular attendant at the monthly meetings where artists assembled to discuss and criticize Japanese paintings. He also maintained and enlarged his interest in European and American literature.

Watasé was twice married, in 1901 to Miss Yoshi, daughter of Viscount Arata Hamas, President of Tokyo Imperial University. She died in 1905, and three years later Watasé married again, the sister of one of his colleagues of the Imperial University. His home life was peaceful and happy. One of his two daughters by his first marriage and two sons by his second marriage survive him. His second wife died suddenly in August, 1928; in September of the same year Watasé himself was taken ill, but lingered on until March.

F. R. LILLIE
SHIGEO YAMANOUCHI