Sir D'Arcy Wentworth Thompson, C.B., F.R.S. (1860–1948)

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SIR D'ARCY WENTWORTH THOMPSON, one of the greatest academic figures in biological science, was a true naturalist with a wide range of intellectual interests and attainments. A Greek scholar, he possessed a unique sense of the classics, which he brought into his interpretations of contemporary scientific thought.

Biologists of past generations mastered much of the knowledge of their times in all known fields of the natural sciences. With the passage of time each of these fields has been so greatly developed that specialization has been the inevitable result, and biologists, along with other scientists, have become largely specialists. Sir D'Arcy belonged to neither category, encyclopedist or specialist. His strength lay in his attention to broad, simple principles developed through extensive knowledge of ancient and modern philosophical thought. His was an integrated outlook, based on broad understanding of these principles and appreciation of mathematics with its precision, and nature with its greatly varied phenomena.

Thompson, born in Edinburgh, Scotland, May 2, 1860, was the grandson of a shipmaster of Maryport, Cumberland, England. His father, also D'Arcy Wentworth, was born at sea off the coast of Van Dieman's Land, attended Pembroke College, Cambridge, and became classical master at the Edinburgh Academy and afterwards professor of Greek at Queen's College, Dundee. The father was alive to social and educational problems of the day. His liberal ideas are expressed in his books, written in a whimsical and fascinating style: *Daydreams of a schoolmaster* (1864), and *Wayside thoughts: being a series of desultory essays on education* (1868). The latter covers the subject matter of his twelve Lowell Institute Lectures, delivered in Boston during the season of 1867–68. In these lectures he also paid tribute to the New World for having done so much for women's rights.

His mother, Fanny Gamgee, belonged to a family distinguished in science and in medicine. Privileged in having such a background, the son in addition showed an intense love of nature from his early boyhood throughout his life. His preliminary studies were at Edinburgh Academy, a school long famous for the brilliant scholars it turned out. At the age of 17 he matriculated as a medical student at the University of Edinburgh. There he came under the influence of Sir Wyville Thompson, who had lately returned from the Challenger Expedition. At the age of 19 D'Arcy Thompson published a couple of papers on hydroid taxonomy and on a Pleistocene fossil seal. After two years in Edinburgh he obtained a classical scholarship which took him to Trinity College, Cambridge. There his inclinations towards zoology were furthered by his contacts with F. M. Balfour and Michael Foster, who were then laying the foundations of the modern Cambridge School of Biology. For a year he served as demonstrator in Michael Foster's laboratory of physiology. While at Cambridge he translated H. Muller's work on the fertilization of flowers, which was published with an introduction by Darwin. Concerning this D'Arcy Thompson wrote: "Charles Darwin's preface, full of suggestion, full of kindly appreciative feeling, is of peculiar interest as one of the very last of his writings." In 1884, at the early age of 24, he was appointed professor of biology in the recently founded University College in Dundee. In 1897 the College was united with the University of St. Andrews and he became a member of the Senate. Later, he was appointed to the senior chair of natural history in the United College of St. Salvator and St. Leonard, St. Andrews, Scotland. His tenure of the chairs at Dundee and at St. Andrews had extended for 64 years when he died at the age of 88.

In 1896 and 1897 Sir D'Arcy went to the Bering Sea as a member of the British-American inquiry into the fur seal fishery, and represented Britain in the international conference on the subject at Washington. For these services he received the title of Companion of the Bath in 1898. He was one of the British representatives on the International Council for the Study of the Sea from its beginning in 1902, and he edited and contributed largely to the Scottish section of its reports. He also wrote many papers on fishery statistics and oceanography in the Scientific Investigations of the Scottish Fishery Board from 1913 to 1931.

In 1908 he published a short paper in *Nature* on "The Shapes of Eggs and the Causes which Determine Them." This was the first published intimation of a line of inquiry that had long engaged his thought and on which he had accumulated masses of notes.

His book *On growth and form* appeared in 1917. This immediately attracted attention both because of its novel approach and because of its mass of illustrative material gathered from ancient and modern writers. In his own words: "The road of physicomathematical or dynamical investigation in morphology has found few to follow it; but the pathway is old. The way of

the old Ionian physicians, of Anaxagoras, of Empedocles and his disciples in the days before Aristotle, lay just by that highway side. It was Galileo's and Borelli's way; and Harvey's way, when he discovered the circulation of the blood. It was little trodden for long afterwards, but once in a while Swammerdam and Reaumur passed thereby. And of later years Moseley and Meyer, Berthold, Errera and Roux have been among the little band of travelers. We need not wonder if the way be hard to follow, and if these wayfarers have yet gathered little. A harvest has been reaped by others, and the gleaning of the grapes is slow. . . . Morphology is not only a study of material things, but has its dynamical aspect, under which we deal with the interpretation, in terms of force, of the operations of Energy. And here it is well worth while to remark that, in dealing with the facts of embryology or the phenomena of inheritance, the common language of the books seems to deal too much with the *material* elements concerned, as the causes of development, of variation or of hereditary transmission. Matter as such produces nothing, changes nothing, does nothing; and however convenient it may afterwards be to abbreviate our nomenclature and our descriptions, we must most carefully realise in the outset that the spermatozoon, the nucleus, the chromosomes or the germ-plasma can never *act* as matter alone, but only as seats of energy and as centres of force."

The central theme of the book is an enquiry into how far the form and structure of living things can be interpreted in terms of physical forces acting within the lifetime of an organism. This method of approach of causal morphology is to be distinguished from the historical morphology which was the almost exclusive study of the preceding period.

At the insistence of many friends he published in 1942 his second much enlarged edition (1116 pp. Cambridge University Press and the Macmillan Company) in which he emphasizes "the twofold problem of accumulated inheritance and of perfect structural adaptation [which] confronts us and passes all understanding." Dorothy Wrinch, who knew D'Arcy Thompson well, says, in her review of the book in *Isis*:[1] "One experiences, page by page, the feelings of a guest at a banquet of learning and insight, of knowledge and feeling. Those who wish to add to our fundamental understanding of biological structures must arm themselves with weapons from other sciences, yet at the same time develop to its highest pitch a proper feeling for biological materials. As we feed ourselves at this table groaning with good things, we see that one biologist at least accomplishes this."

A striking testimony to the influence of this book is given in a volume of "Essays on Growth and Form presented to D'Arcy Wentworth Thompson" edited by W. E. LeGros Clark and P. B. Medawar, published by the Clarendon Press in 1945. In this volume is included his bibliography.

Sir D'Arcy's classic leanings are expressed in his studies on the natural history of the ancient world. His *Glossary of Greek birds* appeared in 1895 and a second edition in 1936; his translation of Aristotle's *Historia animalium* was published in 1910 and his *Glossary of Greek fishes* in 1945. One of his invaluable services was as a member of a staff for the revision of Liddell and Scott's Greek-English Lexicon (Clarendon Press).

Concerning his glossaries Sir D'Arcy states: "Many old bird names and fish names are recorded by Italian scholars from the rich dialects of Italy, and new light is thrown thereby on obscure Greek and Latin; but the dialects of Modern Greece are still all but unknown. Some day, scholars will explore, to our great advantage, the common speech and folk-lore of the bird-market of Athens and the fish-market of the Piraeus, and of all the islands and all the provinces of Greece.

"Many a Greek word or hero name was foreign to Aryan speech. The merchant and mariner had brought strange words home from overseas; and many a beast and bird and hill and river had kept its pre-Hellenic name, harking back it might be to the nameless and forgotten language which was spoken by the Gods."

A brilliant essay is his "Science and the Classics," delivered as his presidential address to the Classical Association, Cardiff, and published in *Nature*, May 25, 1929. Its allusions open up a wealth of beauty and appreciation by showing the significance of the terms used for objects of nature in their relations to stories in prose and poetry of the ancient writers.

His quest was not so much a thirst for knowledge as for the thrill of revealing beauty. The following is quoted from the last paragraph of his address: "Whether we be taught science or the classics in our boyhood is not the last word of all. But whichever of the twain it be, let us so learn it as to live it, and so love it that we may love it to the end. Science and the classics—both alike continually enlarge our curiosity, and multiply our inlets to happiness."

His writings and speeches are rich with literary allusions and their volume attests to his fertile mind and breadth of knowledge. John L. Myers once asked him concerning the Homeric description of the death struggle of Nestor's chariot horse which Jupiter caused to be struck through the forehead by the arrow of a thunderbolt. The reply was immediate: "The arrow had grazed the cerebellum and the convulsive

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[1] Dorothy Wrinch, *Isis*, 1942–43, **34**, 232. See also G. Evelyn Hutchinson, *American Scientist*, 1948, **36**, 577; Frederick S. Hammett, *J. Hered.*, 1943, **34**, 85.

vanoscope. If the two drops represent solutions of different osmotic pressures, evaporation from the drops will differ. That having the lower osmotic pressure will evaporate more rapidly and thus become cooler than the other. The difference in the temperatures will generate a thermoelectric force which will register on the galvanoscope. By these measurements we then find the two successive standard solutions between which the vapor pressure of the test solution lies, and, with the aid of the registration values, we can by interpolation calculate the sodium chloride concentration that gives the same vapor pressure as the test solution. From this concentration, by employing the relation between sodium chloride concentration and freezing point depression (see Fig. 1) previously described (*6*), we can find the freezing point depression which the particular solution would give. The uncertainty in this determination is about ± 5%.

From the sodium salts of the pencillins we prepared aqueous solutions with 6.25–36.0 mg/ml solution.

In Fig. 2 the results found experimentally and converted to freezing point depressions are plotted as small circles. The continuous curves in the figure are drawn by transferring point by point the straight lines connecting the circles in a double logarithmic coordinate system to the arciform curves seen in the arithmetic system employed in Fig. 2. The relation between the concentration and the molar freezing point depression, calculated by Raoult's law, is shown in stippled curves.

The osmotic coefficients for 0.05 molar solutions of sodium penicillins F, G, K and X are as follows: F, 0.98; G, 0.94; K, 0.88; and X, 0.97. It will be seen that the osmotic coefficients for pencillins F, G, and X amount to 0.94–0.98, which corresponds to that for a 0.05 molar solution of sodium chloride. In a 0.05 molar aqueous solution of sodium penicillin K the osmotic coefficient is lower, 0.88, corresponding to the osmotic coefficient in a 0.05 molar solution of lobeline-hydrochloride. The low osmotic coefficient shown by the K penicillin is possibly due to the long heptyl chain in this molecule.

Not only the high value found for the osmotic coefficient, but also the fact that the osmotic coefficients of the sodium penicillins are of the same order as other dissociated electrolytes of the 1:1 valence type in similar concentrations, shows that these are true solutions.

References

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(*Continued from page 139.*)

movements of the limbs, causing the horse to roll over and over, were precisely those which are to be observed in the death struggle of a rabbit shot through the cerebellum."

D'Arcy Thompson was made Companion of the Bath in 1898 during Queen Victoria's reign, elected to the Royal Society in 1916, created knight in 1937. He received the degrees of D.Litt. (Cambridge), Hon. D.Sc. (Dublin and Witwaterstrand) and LL.D. (Aberdeen and Edinburgh). He was vice president (1931–38) and president (1934–39) of the Royal Society of Edinburgh. He was awarded the Darwin Medal in 1946. He was foreign correspondent and honorary member of a number of learned societies.

One spring morning in Paris, walking on the crowded boulevard, I heard my name called and saw a towering figure with massive sculptured head and long flowing beard, dart out from the tables of a sidewalk cafe. He greeted my wife, seized our hands, and pushed us into chairs. Seated opposite us, Sir D'Arcy, with no further ceremony, began to read to us a funeral oration that he was working on!

His last visit to this country was in 1936 on the occasion of his delivering six Lowell Institute Lectures in Boston, 79 years after his father had been invited to the same Institute. The subject matter of Sir D'Arcy's lectures is included in his book on Growth and Form. On his leaving New York for Scotland I went to see him off and found him on board with Leo Hendrik Baekeland, of Columbia University, the inventor of Bakelite. During the conversation, Professor Baekeland, who was 74 years of age at the time and only 3 years younger than Sir D'Arcy, remarked on my callow youthfulness in the presence of two septuagenarians. Sir D'Arcy, gazing at the magnificent panorama of New York from the Jersey shore said: "My hope is that I shall die young!"

Happily, he maintained his "youth" and at the age of 86 accepted an invitation to be one of four delegates to the Indian Scientific Congress in Delhi. He had been extremely well and was full of enthusiasm at the thought of ten days in Egypt before flying to India. But on his return the wear and tear of the journey had so depleted his strength that he was unable to recuperate from a protracted siege of pneumonia. He died June 21, 1948.

Sir D'Arcy was a man of the world, at home everywhere and with all conditions of people. He was a man of deep conservatism but with a quality of delightfully disarming revolt against the conventions. He had an inexhaustible sense of humor with touches of the oratorical, and was always an interesting companion and a solid friend.