tized mathematics construction can come in only secondarily as construction of examples, thus forming the bridge between pure theory and its applications. Sometimes there is only *one* example because the axioms, at least up to arbitrary isomorphisms, determine their object uniquely; then the demand for translating the axiomatic set-up into an explicit construction becomes especially imperative. Much more significant is the remark that an axiomatic system, although it refrains from constructing the mathematical *objects,* constructs the mathematical *propositions* by combined and iterated application of logical rules. Indeed, drawing conclusions from given premises proceeds by certain logical rules which since Aristotle's day one has tried to enumerate completely. Thus on the level of propositions, the axiomatic method is undiluted constructivism. David Hilbert has in our day pursued the axiomatic method to its bitter end where all mathematical propositions, including the axioms, are turned into formulas and the game of deduction proceeds from the axioms by rules which take no account of the meaning of the formulas. The mathematical game is played in silence, without words, like a game of chess. Only the rules have to be explained and communicated in words, and of course any arguing about the possibilities of the game, for instance about its consistency, goes on in the medium of words and appeals to evidence.

If carried so far, the issue between explicit construction and implicit definition by axioms ties up with the last foundations of mathematics. Evidence based on construction refuses to support the principles of Aristotelian logic when these are applied to existential and general propositions in infinite fields like the sequence of integers or a continuum of points. And if the logic of the infinite is taken into account, it seems impossible to axiomatize adequately even the most primitive process, the transition $n \rightarrow n'$ from an integer n to its follower n'. As K. Gödel has shown, there will always be constructively evident arithmetical propositions which can not be deduced from the axioms however you formulate them, while at the same time the axioms, riding roughshod over the subtleties of the constructive infinite, go far beyond what is justifiable by evidence. We are not surprised that a concrete chunk of nature, taken in its isolated phenomenal existence, challenges our analysis by its inexhaustibility and incompleteness; it is for the sake of completeness, as we have seen, that physics projects what is given onto the background of the possible. However, it is surprising that a construct created by mind itself, the sequence of integers, the simplest and most diaphanous thing for the constructive mind, assumes a similar aspect of obscurity and deficiency when viewed from the axiomatic angle. But such is the fact; which casts an uncertain light upon the relationship of evidence and mathematics. In spite, or because, of our deepened critical insight we are to-day less sure than at any previous time of the ultimate foundations on which mathematics rests.

My purpose in this address has not been to show how the inventive mathematical intellect works in its manifold manifestations, in calculus, geometry, algebra, physics, etc., although that would have made a much more attractive picture. Rather, I have attempted to make visible the sources from which all these manifestations spring. I know that in an hour's time I can have succeeded only to a slight degree. While in other fields brief allusions are met by ready understanding, this is unfortunately seldom the case with mathematical ideas. But I should have completely failed if you had not realized at least this much, that mathematics, in spite of its age, is not doomed to progressive sclerosis by its growing complexity, but is still intensely alive, drawing nourishment from its deep roots in mind and nature.

SCIENTIFIC EVENTS

ANIMALS AND AIR RAIDS

A SPECIAL correspondent of the London *Times* writes:

A certain amount of fresh facts as to the effect of air raids on animals has now come in as a result of the appeal for information made in these columns some three weeks ago. So far as the London Zoo is concerned there is little to report. It is difficult to observe the animals' behavior at night when things are really happening. After a bad night, and during such day raids as there have been, they seem unconcerned. Almost all the society's geese are at the moment at Whipsnade, so that it has not been possible to confirm the reports that geese are peculiarly alert sentinels for air raids.

However, some very interesting reports have come in from the Maidstone Zoo. In general, the experience there has been the same as in London—the animals show no reaction to the most violent air activity or anti-aircraft fire. On the other hand, the two chimpanzees, though they do not mind the guns, stamp and shriek at the sound of the siren. And of two emus, one is indifferent to noise, but the other gets so excited at the sound of the anti-aircraft guns and rushes about so violently that fears are entertained for its safety.

A cow elephant about twenty years old is so sagacious that she hurries to her house if the anti-aircraft barrage catches her in the open, but once there does not seem to mind. Finally, one lion, normally a quiet animal, after a shell fragment hit him in his cage (doing little hurt as it had ricocheted off the bars), has become con-

ditioned to the anti-aircraft guns, starting to rip his cage to bits every time they start firing.

As regards wild birds, there is a good deal of evidence that many of the larger kinds are disturbed by the sound of bombs or anti-aircraft fire. With song-birds and other passerines, however, the chief reaction seems to be to aircraft. These are treated as if they were hawks, the birds scattering downwards and crouching to avoid detection. There are two curious exceptions to this: neither robins nor any member of the swallow tribe have been seen to pay the slightest attention to aircraft. The stories of gulls giving warning of the approach of hostile aircraft are presumably based on the same reaction: their keen senses—eyes more probably than ears—detect the aeroplanes a little before they are audible or visible to human beings.

Domestic animals vary individually. Some dogs have what may be called A.R.P. sense, and distinguish perfectly between the alert and the all-clear signals. One cat has been reported in this category; at the alert she comes indoors to take shelter, but when the raiders-passed signal is given she jumps up and scratches to be let out. She is indifferent to mere noise. Other dogs show no recognition of the difference between the sirens' signals. Again, some dogs do not mind the noise of guns and bombs, or even seem to like it, while others are miserably frightened and crawl under the furniture. Some parrots definitely dislike the noise, and scream loudly and hysterically.

EARTHQUAKES OF 1940[1]

FOUR strong distant earthquakes were registered at Kew Observatory during September. They were on September 12, 19, 21 and 22. The second of these was the greatest, having a ground amplitude at Kew of 47 μ, and being estimated at a distance of 17,400 km. The second was at a distance of 6,100 km with an estimated depth of focus of about 390 km, whilst the third, probably distant about 140°, had a depth of focus of approximately 500 km. News from other observatories is awaited before the epicenters and depths of focus can be given with precision.

On September 4, two local earthquakes were felt in Palestine each of which lasted about 10 seconds. No damage has been reported and the shocks were not registered at Kew. It is reported in the press that an earthquake was felt in Copenhagen early on September 28. No damage was reported. Earthquakes are rare in this district and the shock may have been caused by fault slipping in the Sound separating Denmark from Sweden.

The coast of Chile in the neighborhood of Iquique was shaken by a violent earthquake about 6 A.M. (local time) on October 4. Reports of damage and details of the shock are not yet to hand. Chile as a whole is very liable to earthquake shocks, and Iquique has been affected on a number of occasions in the past, notably on May 9, 1877, when there was widespread destruction due to large sea waves caused by the earthquake in addition to the extensive damage done by the earthquake itself, and on January 23, 1878.

During April, May, June, 1940, forty-seven earthquakes were registered at the Riverview College Observatory, New South Wales, as compared with fifty-six in the first quarter of the year. The observatory is equipped with two Wiechert horizontal 1,000 kgm instruments, one Wiechert vertical seismometer of 80 kgm, two Mainka 450 kgm seismometers and three Galitzin aperiodic seismometers with galvanometer registration, orientated north-south, east-west and vertical. The largest two shocks of the period appear to have been on April 1 when an amplitude of 23 mm was obtained and on May 28 when an amplitude of 22 mm was reached. The shock of April 18 was felt in the region of the Duke of York Islands, New Britain, etc. The shock of May 24 is reported to have had its epicenter in Peru, and the earthquakes of June 18 and June 22 were deep focus shocks. The instruments are occasionally affected by microseisms which are at times severe. The microseisms do not often preclude the accurate reading of the seismograms, details of which are given in the observatory report.

[1] From *Nature*.

FINANCES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IN the annual report of President Karl T. Compton, of the Massachusetts Institute of Technology, the finances of the institute are discussed. The institute closed the year with a modest surplus. Of the budgeted expenditure of $3,333,000, slightly more than 69.3 per cent. was for academic expenses, 26.4 per cent. for plant and administration, and 4.3 per cent. for miscellaneous expenses. The yield on all investments, based on market values as of June 30, was 4.32 per cent. as compared with 3.89 per cent. a year ago.

Financial aid to students during the year amounted to $434,966, which included undergraduate scholarships to the sum of $93,830, and graduate scholarships and fellowships reaching a total amount of $111,618. Loans to students amounted to $162,843, and $66,675 was earned through the student employment service.

Commenting upon the institute's placement service for alumni and the graduating classes, Dr. Compton reported that the class of 1940 was more than 90 per cent. placed on September 1, and that the men of this class found employment in thirty different states. A number of those not placed include graduates who are entering private consulting or architectural practice.

Among the urgent needs of the institute are a new building for the department of chemical engineering, the largest in the institute, which is now greatly overcrowded. Plans for such a building have already been