

viously director of operational research to the Admiralty, who was appointed to fill the new post of deputy director of the Laboratory, is expected to be of considerable assistance in connexion with the extension of the impact of the work and policy of the Laboratory on industry. Dr. J. A. Pople took up his post as superintendent of the Basic Physics Division on October 1; work on the application of magnetic resonance to the study of the structure and properties of materials, on the physics of high polymers, and on the study of free radicals, is to be commenced in that Division.

During 1958, sixteen scientific officers and twenty-three experimental officers were newly appointed, but although these represent record numbers there was no net gain in the total staff. The hope is expressed in the annual report that foreign scientists will be attracted to come and work at the Laboratory for a few years as Research Fellows, and that more firms will second staff for periods of work at the Laboratory. Contact with the universities was maintained, but no details of any extra-mural contracts with universities are given in the report. Six members of university staffs were appointed as vacation consultants during the summer months, and nineteen vacation students worked at the Laboratory.

Two open days were again held, and of the 7,900 people invited, 3,250 attended. Two international symposia were held during the year. The ninth in the series, which took place during June 4-6, dealt with the physical chemistry of metallic solutions and intermetallic compounds, and the tenth, on "The Mechanization of Thought Processes", during November 24-27, evoked such considerable interest that the attendance had to be limited to the two hundred who could be accommodated. The proceedings of the symposium on visual problems of colour, held in September 1957; No. 19 in the series of Notes on Applied Science entitled "Signal Generators, Attenuators, Voltmeters and Ammeters at Radio-Fre-

quencies"; and a second volume, "Tables of Everett Interpolation Coefficients", in the series of NPL-Mathematical Tables, were published during the year. In addition to a full programme of lectures, talks and discussions, in which the staff have participated, there have been several sound and television programmes based on work and tests carried out at the Laboratory. A transportable NPL caesium atomic-clock was included in the exhibition "Pendulum to Atom", organized by the British Horological Institute, and the Laboratory provided items for display at the Physical Society Exhibition, the Gauge and Tool Exhibition, the Royal Society soirée, and an exhibition for freshmen at St. John's College, Oxford.

The Lord President of the Council, Lord Hailsham, visited the Laboratory on June 5, and the chairman of the Council for Scientific and Industrial Research, Sir Harry Jephcott, on July 17. On February 26, a sub-committee of the Select Committee on Estimates inspected the Laboratory and appeared generally satisfied with the work being done, but expressed concern at the possibility of overlap of work and facilities between the Ship Division of the Laboratory and the Admiralty in relation to research on hull and propeller design. There is formal liaison between the two establishments through the Froude Ship-Research Sub-committee, and informal liaison between the superintendent of the Division and senior officials in the Admiralty.

A building plan for the long-term development of the Laboratory site is being considered in consultation with the Ministry of Works, and a centre, with lecture, conference and restaurant facilities, has at long last been authorized. A new physics building and a building properly equipped for the mechanical working of difficult materials have been included in the 1959-64 proposals. Reference is also made to the Ship Hydrodynamics Laboratory at Feltham [which was opened by the Duke of Edinburgh on October 19, see p. 926 of this issue of *Nature*].

YELLOWSTONE PARK EARTHQUAKE

ON August 18 an earthquake occurred at 06h. 37m. 13s. G.M.T. from an epicentre near the western boundaries of Yellowstone National Park (epicentre lat. $44\frac{1}{2}^{\circ}$ N., long. 111° W.). The earthquake had a magnitude of 7.1 or rather greater on the Richter Scale. The shock appears to have had a normal depth of focus. Most damage appears to have been caused by the earthquake near the Hebgen dam in south-western Montana. The dam is built at an altitude of 6,000 ft. and holds up a lake some 37 miles long in a narrow canyon, through which flows the Madison River. The dam is 87 ft. high and 718 ft. long. In addition to cracking parts of the base of the floor of the lake and producing minor cracks in the earth and rock section of the dam, the earthquake started a huge wave in the lake, which threatened further damage. Fortunately, the wall held fast. The surge of water in the lake and canyon is reported to have caused an air blast which stripped the clothing from one person.

Some seven miles below the dam, landslides from an 8,000 ft. high mountain blocked the road and the river. The road and the surrounding countryside

were severely fissured. Roads leading into the western side of Yellowstone Park were closed. Perhaps two hundred people, including ranchers, campers, fishermen and tourists in about fifty cars, were trapped between the landslide and the lake. Ten people are reported to have been killed and sixty injured. Telephones and electric power installations were out of action. Buildings shifted on their foundations, chimneys fell and fuel pumps toppled over.

The elastic waves of the earthquake were recorded by seismographs at observatories throughout the world. At Kew Observatory the provisional readings are:

<i>eP</i>	06 hr. 48 min.	11 sec.	G.M.T.
<i>iS</i>	06 hr. 57 min.	13 sec.	G.M.T.
<i>MH</i>	07 hr. 18 min.	00 sec.	G.M.T. amplitude 570 μ
<i>F</i>	12 hr. 00 min.	00 sec.	G.M.T.

In the past the regions most affected seismically in this part of the United States have been east of Helena, Montana (lat. 46° N., long. 111.2° W.), and north-east of the centre of Helena (46.6° N., 112° W.).

Table 1. AFTERSHOCKS OF THE YELLOWSTONE PARK EARTHQUAKE OF AUGUST 18 (ALL DURING AUGUST)

Initial day and time (G.M.T.)				Epicentre		Magnitude Richter Scale
Day	Hour	Minute	Second	Lat. (° N.)	Long. (° W.)	M
18	07	54	32	45	111	—
18	15	26	06	44½	111	6½
19	04	04	03	45	111½	6
19	19	06	29	45	111·4	—
19	19	43	45·7	45	110½	—
19	21	45	57	45	111½	—
20	10	59	11	45	111	—
20	19	11	27	45	111	—

From the first of these epicentres earthquakes on June 27, 1925, reached intensity 10 on the Rossi-Forel Scale and caused greatest damage at Man-

hattan, Logan, Three Forks and Lombard. From the second location shocks in October and November, 1935, attained maximum intensity 9 on the Rossi-Forel Scale. However, minor shocks of intensity 4-5 (R.F. Scale) from an epicentre in Yellowstone National Park, Wyoming (44° N., 111° W.), occurred at various times from August 24 to December 22, 1930. In 1947 (November 23) at 09h. 46m. 05s. G.M.T. a shallow focus earthquake from an epicentre 44¾° N., 111¼° W. reached a magnitude 6½ on the Richter Scale. Earthquakes are always liable to recur at or near old epicentres.

Aftershocks of the earthquake of August 1959 so far listed by the United States Coast and Geodetic Survey are given in Table 1, although smaller shocks are said to have occurred at intermediate times.

E. TILLOTSON

A THEORY OF AGEING

THE theory of ageing put forward by Szilard¹ refers explicitly to mammals. It is the purpose of the present communication to point out that this theory cannot explain ageing in *Drosophila*, since it is inconsistent with two experimental observations. This of course does not prove that it cannot explain ageing in mammals; but reasons will be given for doubting that it does so.

Szilard postulates the random occurrence of 'hits', each hit rendering ineffective the genes of a whole chromosome, or perhaps of a large segment of a chromosome. A cell becomes ineffective either when two homologous chromosomes have each suffered a hit, or when one of a pair of homologues has suffered a hit, and the other carries an inherited 'fault'. By a fault is meant a recessive gene which in homozygous condition renders the cell inviable, or incapable of performing a necessary function in the adult organism. Death occurs when some predetermined fraction of the cells initially present is in this way rendered ineffective; Szilard suggests that this fraction is of the order of 2/3 to 11/12.

It is a direct consequence of this theory that, in the author's words: "The main reason why some adults live shorter lives and others live longer is the difference in the number of faults they have inherited". This is the first consequence of the theory which is contradicted by observations on *Drosophila*. In so far as differences in adult longevity are genetically determined, by far the largest differences are those between inbred and outbred individuals^{2,3}. F_1 hybrids between inbred lines live for longer than do the parental lines (sometimes for twice as long). Outbred and genetically variable wild populations have approximately the same expectation of life as do F_1 hybrids. Now inbreeding increases the proportion of loci at which individuals are homozygous. An individual which survives for an appreciable time as an adult cannot, by definition, be homozygous for a fault. Therefore inbred individuals which survive to become adults, and which do not die immediately after emergence, are not homozygous for faults at any loci, and would be expected to be heterozygous for faults at fewer loci than are members of outbred wild populations. If two inbred lines are crossed, the F_1 hybrids would be expected to carry a load of faults intermediate between the loads carried by the parental lines. Thus according to Szilard's

theory, inbred lines should have a higher expectation of life than wild populations, and F_1 hybrids between inbred lines should be intermediate between their parents. Neither of these predictions is in fact true.

Further, since males have only a single X chromosome, any hit on that chromosome in a male would render the cell inviable, whereas in a female not heterozygous for a sex-linked fault both X chromosomes must be hit before a cell becomes inviable. Therefore females should live longer than males. This again is not the case in *D. subobscura*. In some strains females do live longer than males, but in other strains, both inbred and outbred, the reverse is true. This point is particularly telling since in *Drosophila* the sex chromosomes account for about one-fifth of the total chromosome material.

The other group of facts which are inconsistent with the theory concern the rate of ageing at different temperatures⁴. Female *D. subobscura* of a particular strain have an expectation of life of about 56 days at 20° C. and of 18 days at 30·5° C. The changes responsible for death at 30·5° C. are not repaired or reversed in individuals kept for a time at 20° C. Consequently the changes responsible for death at both temperatures can properly be regarded as ageing processes. If these processes were, at each temperature, those postulated by Szilard, differing only in the rate at which hits occur, it follows that individuals kept for an appreciable time at 30·5° C. should have, when returned to 20° C., an expectation of life at that temperature lower than that of individuals of the same chronological age not previously exposed to 30·5° C. In fact, exposure to 30·5° C. for periods of the order of half the expectation of life at that temperature does not alter the further expectation of life at 20° C. of males, and significantly increases that of females.

Hence, if, despite the genetic evidence to the contrary, we assume that ageing at 20° C. is due to random hits on chromosomes, then ageing at 30·5° C. cannot be explained by the same process proceeding at a higher rate. In other words, either at 20° C. or at 30·5° C. ageing must be due to a process different from that postulated by Szilard; it is possible, and in my view likely, that such a process is not primarily responsible for ageing at either temperature.

It is perhaps unreasonable to criticize a theory intended to explain ageing in mammals by quoting