Abstracts of Proceedings

5TH MARCH, 1946

Annual Meeting

The Annual Meeting was held in the Society's Room, Tasmanian Museum. Professor V. V. Hickman, Vice-President, presided.

The following were elected Office-bearers and members of the Council for 1946:—Mr. L. Cerutty was elected Vice-President in the place of Professor V. V. Hickman, who retires under Rule 12; Professor V. V. Hickman and Mr. W. H. Hudspeth were elected in the places of Dr. J. B. Hamilton and Mr. G. C. Israel, who retire under Rule 21; Dr. H. D. Gordon was elected to take the place of Mr. L. Cerutty, who was elected Vice-President; Hon. Treasurer, Mr. S. Angel; Hon. Auditor, Mr. H. J. Exley; Hon. Secretary, Dr. J. Pearson; Assistant Hon. Secretary, Mr. D. C. Pearse.

Mr. M. Bower was elected a member of the Society.

Mr. W. H. Hudspeth delivered an illustrated lecture entitled 'The Stones of Hobart'.

2ND APRIL, 1946

A special meeting was held in the Society's Room. Mr. Henry Allport, Vice-President, presided.

Rule 44 was amended to read as follows:—

> Ordinary and life members shall have the right to vote for Office-bearers and Council, to attend all meetings of the Society, and to take part, subject to the control of the Chairman of such meeting, in the business of such meetings, to use the Library and books of the Society, subject to any rules which the Council may make regulating the Library and its use. Each Ordinary Member who, under Rule 33, is entitled to receive the Papers and Proceedings, shall receive one copy for every year during which his subscription has been duly paid.

The following new rules were passed:—

> 1. That all papers published in the Society's Papers and Proceedings should be deemed to be the property of the Society.
> 2. That in the case of all papers read before the Society but not printed in the Papers and Proceedings a copy of the manuscript should be placed in the Society's Library for permanent record.

2ND APRIL, 1946

A meeting was held in the Society's Room. Mr. Henry Allport, Vice-President presided.

The following were elected members of the Society:—Ordinary Members: Miss Joi Chapman, The Lord Bishop of Tasmania, Mr. J. C. Bennett, Mr. H. A. Buchdahl, Mr. D. A. Davie, Dr. R. W. Lawrence, Mr. W. N. Oats; Associate Member: Mr. W. B. Hitchcock.

Mr. L. W. Miller delivered an illustrated lecture entitled 'The Nutritional Requirements of Insects', of which the following is an abstract:—

Until recently the subject of insect nutrition had been a neglected branch of the science of entomology. The recent war and the importance of food storage necessitated intensive studies being made into the food habits and nutritional requirements of many of the pests of stored foods.

Because of the wide diversity of foods that are eaten by insects, one finds a high degree of specialisation in the food habits of the various species. Research has shown, however, that despite this superficial complexity, the fundamental nutritional requirements of the various species are surprisingly uniform. They may, however, be satisfied in different ways from widely differing sources.

Insects, like other living organisms, must somehow obtain energy, carbon and nitrogen, and the mineral elements necessary for the functioning of protoplasm. The sources of carbon and nitrogen must be as organic compounds as insects are quite incapable of satisfying their nutritional requirements with simple inorganic salts.

The importance of fats and the various mineral elements in insect nutrition is still imperfectly understood. In recent years it has been shown that vitamins are also essential in insect nutrition. The present knowledge of the vitamin requirements of insects suggests that they require only members of the "B Group" vitamins. Sometimes, however, the vitamin requirements of the insect may be satisfied by intra-cellular symbionts, which apparently have the power of synthesising some or all of the "B Group" vitamins.

7TH MAY, 1946

A meeting was held in the Society's Room. Mr. Henry Allport, Vice-President, presided.

The following were elected members of the Society:—Ordinary Members: Mrs. E. M. Cuthbert, Miss Katie Helms, Mrs. A. N. Lewis, Dr. Thomas Giblin, Mr. J. N. D. Harrison, Mr. M. L. Hughes, Mr. N. R. Laird, Major J. W. C. Wyett; Associate Members: Miss Margaret Hope, Mr. E. R. Taylor, Mr. Bernard B. Walker.

A paper entitled 'The Military History of Tasmania', prepared by Brigadier O. V. Hoad, was read by Mr. W. H. Hudspeth. The following is an abstract:—

Tasmania has associations with the British Army dating back for 142 years.

The army played an important part in building up the British Empire and a number of Imperial regiments served in Tasmania and other parts of Australasia.

Lt. John Hayes of the Royal Indian Navy brought an expedition to Tasmanian waters in April 1793, when he named the River Derwent and also gave the name Risdon to the place where the first settlement was established. Lt. John Bowen, R.N., arrived at Risdon on 12th September, 1803, to form the first settlement there. Lt. Colonel David Collins landed at Risdon on 16th February, 1804 and was received by a Guard of Honour formed by members of the New South Wales Corps under Lt. Moore, who was acting Commandant at the time, Lt. Bowden having gone to report to the Governor in Sydney. Lt. Edward Lord, R.M., built the first private house on or near the site where Macquarie House now stands in Macquarie St.

In July 1804, the military garrison consisted of a Lt. Colonel, two first lieutenants, one second lieutenant, three sergeants, three corporals, two drummers and 37 privates. The first garrison in Northern Tasmania consisted of a detachment of the New South Wales Corps under Lt. Colonel William Paterson; they arrived at the Outer Cove near George Town in November 1804. Until 1812 this northern settlement and that at Hobart Town were administered as separate commands, each having a Lieut. Governor, who was also the senior military officer. An interesting fact relating to Lt. Colonel Collins' garrison is that it was responsible for the first wedding in Tasmania. This was the wedding of Corporal W. Gengell and Mrs. Anne Skilhorne, a widow at Government House, on 18th March, 1804.

The duties of the military forces in the early days were many and varied. They had to keep order, protect the inhabitants from aboriginals and bushrangers, hunt down escapees, guard prisoners and supervise road building and other public works. The opening up of new areas brought fresh responsibilities to the army. In 1824 there were 230 troopers in Tasmania, detachments being at George Town, Launceston, Macquarie Harbour, Jericho, New Norfolk, Ross and twenty-five men were held in reserve for the pursuit of bushrangers.

From 1870, when the last British regiment left Tasmania, until Federation, Volunteer regiments constituted the main military forces in the island.

The first Tasmanian contingent to go abroad was one company raised in October, 1899 with a strength of four officers, one W.O., five sergeants, four corporals, two buglers and sixty-four privates. Since then several Tasmanian contingents have seen service overseas, winning for themselves high praise, and many decorations.

A paper entitled 'Huts of Tasmanian Aborigines', prepared by Mr. J. F. Jones, was read by Mr. A. L. Meston. The following is an abstract:—

On that part of the west coast that lies between Mt. Cameron West and the Pieman River, circular artificial hollows about four feet deep and of varying diameters occur in small groups. Such hollows are found only on well-drained spots from which a good outlook can be obtained, and from the evidence gained by excavating them, they are all that remain of native huts such as were seen and described by Robinson, Jorgensen and others. If one of these circular depressions is dug there is first a foot or so of clean drift sand, then appears a layer of blackened sand mixed with charcoal, shells, bones, native flaked instruments and cores from which the flakes were struck. In addition there are usually a few long fire-blackened stones that evidently enclosed the fire. Lower still the sand again becomes clean and shows no sign of having been previously disturbed.

Of one hut that he saw Jorgensen writes, 'It was a complete piece of Gothic Architecture in the shape of a dome and presenting all the first rudiments of that science. It was made to contain 12 to 14 people with ease. The entrance was small and not above two feet high. The wood used for the principal supports had been steamed and bent by fire.'

When on a visit in 1945 to Bluff Hill Point, in close proximity to the site of the hut praised by Jorgensen, Mr. Jones noticed standing erect at the edge of one of the hut depressions a portion of a rib of a large whale. On pulling it out of the sand, he found it to be but a fragment two feet long, the upper portion from exposure to the air having decayed. The end that had been forced into the ground had been cut to a point on two sides by the chopper of a native. Near by he found a complete rib, from its size apparently of the same whale, but little decayed having probably been only recently uncovered.

Upon reflection he considered that in one at least of the huts a whale's ribs had been used for the supports, and he realised how Jorgensen's Gothic vault and dome were quite comprehensible. A number of ribs with one end buried in the sand at intervals around the hollow, and with their other ends gathered and fastened together over the middle of the hut, would, when completed with lighter material and thatched make a very perfect dome. Inside in the dim light, and blackened by smoke, the bones might easily be mistaken for wood, while their smoothness and the evenness of the curves would give the impression of timber that had been artificially shaped.

Good thatching material exists in the vicinity. Large tufts of coarse tough grass about six feet high with smooth flat blades an inch or more in width are very plentiful in sheltered spots among the bushes which it makes quite impenetrable.

Mr. Meston exhibited some knobbed implements made from trees by the Aborigines and sent by Mr. James, Head Teacher of the Marrawah State School.

4TH JUNE, 1946

A meeting was held in the Society's Room. The President, His Excellency the Governor, presided.

The following were elected members of the Society:—Ordinary Members: Mrs. G. Cox, Mr. R. F. Davidson, Mr. M. C. Neuburger; Associate Member: Miss P. W. Richardson.

Mr. J. M. Gilbert delivered an illustrated lecture entitled 'Forest Fire Control', of which the following is an abstract:—

Fire damage must be kept to a minimum if forest benefits are to be obtained in full and sustained amounts. Fires affect the growth and composition of stands and in a few cases can be used as a beneficial sylviculturne tool. Indiscriminate burning adversely affects watersheds and wild life.

Fire prevention activities include education, legislation and the removal of hazards. Pre-suppression work includes the erection of look-out towers, the provision of communications, access, transport, equipment and water storage and the training of fire crews.

There are three main principles to be observed in forest fire suppression:—

(1) Make a reconnaisance before the starting.
(2) Tackle the head fire as soon as possible.
(3) When the spread is checked, the fire should be mopped-up and patrolled.

Fire control planning includes investigation of fire causes and classes of people responsible, into the effectiveness of pre-suppression measures and fire-weather forecasting.

An annual suppression plan should be prepared for each district.

The question of the amount that can be afforded for forest fire protection has not been satisfactorily answered.

2ND JULY, 1946

A meeting was held in the Society's Room. Mr. L. Cerutty, Vice-President, presided.

The following were elected members of the Society:—Mrs. G. E. Perrin, Miss Ruth White, Mr. A. M. Olsen.

Dr. J. Pearson exhibited the following:—

(*a*) A sub-fossil tooth of the Sperm Whale *(Physeter catodon)*, from Flinders Island.

(*b*) Osteological remains of the False Killer Whale *(Pseudorca crassidens)*, found near Eddystone Lighthouse.

(*c*) Osteological remains of the Strap-toothed Whale *(Mesoplodon grayi)*, from Eaglehawk Neck.

Mr. G. T. J. Wilson delivered a lecture entitled 'Local Government and Democracy'.

6TH AUGUST, 1946

A meeting was held in the Society's Room. The President, His Excellency the Governor, presided.

Miss Ann Fraser and Mr. A. P. Findlay were elected members of the Society.

Dr. Joseph Pearson delivered an illustrated lecture entitled 'The Evolution of the Mammalian Placenta', of which the following is an abstract:—

The term *placenta* should be applied to those structures which assist in bringing about an intimate apposition or fusion of the trophoblast and associated parts of the foetus with the uterine wall for the purpose of carrying out physiological processes necessary for the well-being of the foetus.

The accompanying figure embodies all embryonic structures which take part in placental formation but which are not necessarily found in the same embryo at the same time.

The following foetal structures may become apposed to the uterine epithelium or uterine wall to form a placenta:—

1. *Chorion* (*Ch.*)

Consists of the extra-embryonic ectoderm or trophoblast (Tr.) and somatic mesoderm (S.M.). This is the simplest type and is non-vascular. The 'uterine milk' is absorbed through it. Probably functions in monotremes and for a short period in marsupials and eutherians. *(Chorionic Placenta.)*

2. *Bilaminar omphalopleure* (Bi. Om.)

Consists of the trophoblast and the yolk-sac endoderm (Ys.E.). Non-vascular. Present in many marsupials throughout the foetal period and probably functions for a brief stage in some eutherians. *(Bilaminar Vitelline Placenta,* or *Non-vascular Yolk-sac Placenta.)*

3. *Vascular omphalopleure* or *chorio-vitelline membrane* (V.Om.)

Consists of trophoblast, somatic mesoderm, splanchnic mesoderm (Sp.M.) and yolk-sac endoderm. Vascular. The functional placenta of most marsupials, and functional for a short time in the early stages of *Perameles* and many eutherians. *(Chorio-vitelline Placenta* or *Vascular Yolk-sac Placenta.)*

4. *Allantochorion* or *Chorio-allantoic membrane* (Al.Ch.)

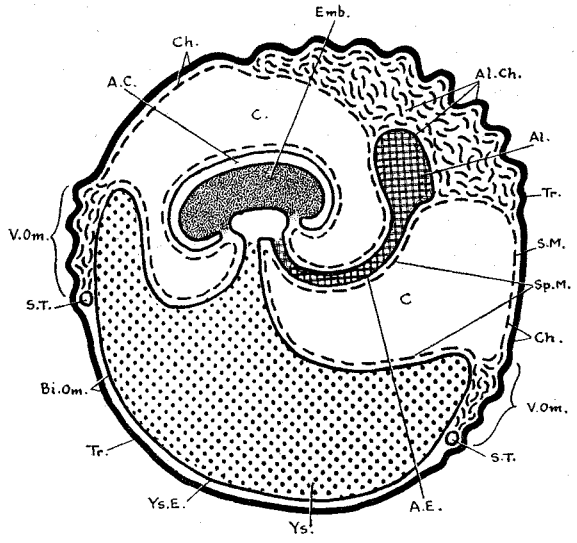
Formed normally when the allantoic endoderm (A.E.) with its investing layer of splanchnic mesoderm reaches the chorion. This is the 'true' or allantoic placenta, characteristic of *Perameles* and all eutherians. *(Chorio-allantoic Placenta.)*

In the most primitive type of chorio-allantoic placenta, the *epitheliochorial,* the two blood streams are separated by six sets of tissues:—

Foetal. Endothelium of the foetal blood vessels, mesoderm, and trophoblast.

Maternal. Uterine epithelium, connective tissue, and endothelium of the maternal blood vessels.

In the more modified types of placenta the trophoblast attacks first the uterine epithelium and later the other two maternal components until in the most highly specialized and efficient type, the *haemoendothelial*, the extravasated maternal blood surrounds the foetal blood vessels so that interchanges between maternal and foetal blood streams are effected across the simple membrane which constitutes the wall of each foetal blood vessel.



Embryonic structures which may contribute to Mammalian Placentation. (The maternal components of the placenta are not shown.)

A.C. amniotic cavity, *A.E.* allantoic endoderm, *Al.* allantois, *Al.Ch.* allanto-chorion, *Bi.Om.* bilaminar omphalopleure, *C.* extra-embryonic coelom (splanchnocoele), *Ch.* chorion, *Emb.* embryo, *S.M.* somatic mesoderm, *Sp.M.* splanchnic mesoderm, *S.T.* sinus terminalis, *Tr.* trophoblast, *V.Om.* vascular omphalopleure, *Ys.* yolk-sac, *Ys.E.* yolk-sac endoderm.

The fundamental embryonic elements in a vascular placenta are (1) the trophoblast with its phagocytic effect upon the uterine tissues and (2) the splanchnic mesoderm which bears the placental bloodvessels of the foetus.

In the Marsupialia the following placental conditions are found:—

Type 1

Allantois does not reach the chorion.

Bilaminar vitelline placenta sometimes functional.

Chorio-vitelline placenta generally well-developed (*Didelphis*, some phalangers, rat-kangaroos and kangaroos).

Type 2

Allantois reaches the chorion but does not form a placenta. Later retreats from the chorion and takes up a position as in Type 1.

Bilaminar vitelline placenta, probably nutritive.

Chorio-vitelline placenta probably respiratory. *(Dasyurus.)*

Type 3

Allantois reaches the chorion and remains there but is not placental, probably respiratory.

Both types of vitelline placenta function, probably nutritive. *(Phascolarctos, Halmaturus.)*

Type 4

Allantois reaches the chorion and forms a functional chorio-allantoic placenta.

Chorio-vitelline placenta functional in early stages. *(Perameles.)*

It is usually considered that Type 4 is the most primitive and that gradual retrogression from a functional chorio-allantoic placenta is shown in Types 3, 2 and 1, with Type 1 exhibiting the greatest degree of degeneration. It is also widely accepted that the common ancestors of the marsupials (Methatheria) and 'placental mammals' (Eutheria) had a chorio-allantoic placenta

and that all marsupials except the perameloids have lost their true placenta and have fallen back upon the inefficient vitelline placenta. One of the purposes of the present lecture was to call in question these accepted views and to show cause why the sequence as given above, with *Perameles* as the last and most specialized of the series, probably depicts more correctly the course of placental evolution in the marsupials.

It was claimed that a good case could be presented for considering the common ancestors of the Metatheria and Eutheria as having lacked a chorio-allantoic placenta, and that the perameloid type of placenta had arisen by convergence. The absence of a chorio-allantoic placenta in nearly all recent marsupials might be due to their having arisen from non-placental stock.

The various types of placentation in eutherian mammals were then considered. It was shown that in the early stages of foetal development of all viviparous mammals the yolk-sac is relatively large and may for some time have placental functions. In marsupials the yolk-sac retains its importance and has placental functions and the allantois is small and usually non-placental. It was suggested, therefore, that the Proplacentalia possessed a vitelline placenta and that when the marsupials and eutherians diverged from this common stock the former retained the ancestral characteristic, while in the latter group the yolk-sac gradually lost its importance and was ultimately superseded as a placental organ by the allantois.

Some investigators claim that the placenta provides a reliable criterion of mammalian inter-relationships, but this view is open to question. It was pointed out that recent researches in reptilian placentation have revealed that in this group at any rate the type of placentation did not necessarily give an indication of affinity.

3RD SEPTEMBER, 1946

A meeting was held in the Society's Room. Mr. H. Allport, Vice-President, presided.

The following were elected members of the Society:—Mr. Gollan Lewis, Mr. R. A. McInnes.

The Assistant Honorary Secretary drew the attention of members to the Geographical Journal, Vol. CVI, Nos. 5, 6: Nov.-Dec. 1945, in which there is a paper dealing with the sailing of Sir John Franklin with the 'Erebus' and 'Terror'.

Mr. W. T. Dowsett delivered a lecture entitled '"Ordinary People" in the First Settlements' of which the following is an abstract:—

The purpose of the paper was to demonstrate the use of the atomistic method of historical study as a supplement to the usual approaches through the development of States resting upon Austinian monism or by the pluralist examination of the interplay between movements and institutions. That is to say, the paper was concerned only with the views of historical events seen through the eyes of ordinary people of the times.

Two justifications of the method were given, the first based upon a normative historical philosophy. It suggested that any social science is concerned with the interplay between man and environment, the selected norm being capacity for survival. History regarded thus is concerned with institutional environment and its effects upon man; and since generally speaking, history is made by movements and influenced by great men, but suffered by little men, the little man's reactions to his times are of vital importance.

The method is justified, even for those who do not accept the normative approach, because it can be used to reinforce other studies of positive pluralist history. The source material for research into past movements and associations is largely composed of the writings of those who played leading parts in determining them; it may therefore be coloured by their philosophy. A correction to this is the study of the lives of ordinary people who endured more or less passively the influence of those associations.

One of the few well-known examples of this method is 'Mediaeval People', by the late Professor Eileen Power. The paper presented three similar studies, taken from early Australian history, given principally by the Historical Records of Australia. The life of Edwin Dodd, one-time valet to Phillip and manager of the Parramatta community farm, illustrates conditions during the few years of autocratic communism at the beginning of Port Jackson. Richard Clark, soldier and stonemason, experienced the difficulties of settlement in the first days of Van Diemen's Land. Finally, the story of Edward Eagar, emancipist, casts light not only on the changing balance of social classes in New South Wales during the second decade of the nineteenth century, but also on the rise and growth of such institutions of the growing capitalism in the State as Macquarie's Bank and the forms of internal and foreign trade.

1st October, 1946

A meeting was held in the Society's Room. Mr. H. Allport, Vice-President, presided.

The attention of members was drawn to the new Panel Heating system in the Royal Society's Room.

The following were elected members of the Society:—Mr. R. W. Hortle, Mr. C. W. Kent, Rev. L. O. C. White.

Mr. L. Cerutty delivered a lecture entitled 'Robert Boyle, Chemist, and His Times'.

The Reverend Walter Walters exhibited a book written by Robert Boyle on 'The Usefulness of Natural Philosophy', which has been in the Bothwell Public Library since 1839.

5th November, 1946

A meeting was held in the Society's Room on the occasion of the R. M. Johnston Memorial Lecture. It was advertised as a public meeting and invitations were also extended to members of the member Societies of the Tasmanian Association of Scientific Societies.

Approximately 200 people were present.

Mr. L. Cerutty, Vice-President, presided.

The following were elected members of the Society:—Mr. H. K. Aves, Mr. W. F. Walker, Mr. G. H. Willing.

The following papers which had been submitted for publication in the Society's Journal were tabled, and it was agreed to submit them to the Standing Committee:—

Note on a new Cestode from the Tasmanian 'Electric Ray' (*Narcine tasmaniensis* Richardson). By P. W. Crowcroft. (See page 1.)

Some digenetic Trematodes from Fishes of Shallow Tasmanian Waters. By P. W. Crowcroft. (See page 5.)

The female urogenital system of the Bandicoots *(Peramelidae)*. By Joseph Pearson.

The development of the urogenital system in the Marsupialia. By Joseph Pearson.

The Chairman presented the R. M. Johnston Memorial Medal to Professor L. H. Martin, who then delivered an illustrated lecture on 'Radar', as follows:—

Introduction

Two outstanding contributions were made by the physicists of the United States during the War—*Radar* and the *Atomic Bomb*. It may be that History will confirm the opinion expressed by Professor Blackett that the atomic bomb did little to win the war and has since served only to bedevil the Peace, but of Radar there can be no division of opinion. In its many modifications and adaptations Radar did more than any single technical device to bring defeat to the enemy.

The story of Radar mirrors in a striking fashion the development of the struggle against the forces of Germany by the British Empire. In its original conception as a defensive weapon, it played a decisive part in winning the Battle for Britain. Later, coupled with the mounting air strength of the United Nations it evolved into an offensive weapon which slowly drained the vitality of German industrial power. Radar brought defeat to the U-boat in the Battle for London, and paved the way for success on D-day by assuring precision bombing of German defences through solid overcast. As a measure of the military significance of Radar, it might be mentioned that by July 1945 nearly $3,000,000,000 worth of equipment had been delivered to the U.S. Forces and no doubt a like sum had been expended by Britain.

Basic Principles of Radar

Officially the term Radar is said to derive from the descriptive phrase 'radio-detection and ranging'. This definition omits a third aspect of the technique which is equally important, namely 'direction finding'. In this regard the original British term 'Radiolocation' was more satisfactory.

The principles upon which Radar operates are not new; they were demonstrated by Hertz in 1886 when he discovered that radio waves possess the optical properties of visible light.

1. *Radio-Detection*

If a beam of radio waves is directed towards a solid body, a small fraction of the energy will be scattered or reflected back towards the transmitter and may be detected with a sensitive radio receiver. Usually the receiver is operated at the limit of its sensitivity; for example, in detecting a medium bomber at 150 miles the power entering the receiver is less than $1/10^{18}$ of the power radiated by the transmitter.

Radio detection is analogous to the detection of a plane with a searchlight but possesses essential advantages. The range of Radar is greater than that of the eye, and its ability to detect the target is relatively unaffected by night, fog, smoke, or rain. One of the most potent factors in warfare is surprise, but the element of surprise formerly afforded by darkness, fog, cloud or artificial smoke or simply the glare of the rising sun does not exist in a Radar war. At one time naval battles were described by the factor of who happened to be 'up-sun' from the enemy. The successful action at Cape Matapan by the Mediterranean Fleet took place in pitch darkness at ranges so great that the Italian Fleet had no idea that our ships were in the vicinity. The Scharnhorst was crippled by our heavy guns long before she was in sight.

2. *Ranging*

Ranging by radio makes use of the fact that radio waves travel with the velocity of light, 186,000 miles a second. The technique of 'pulse-ranging' was first used in 1925 by Breit and Tuve of the Carnegie Institute of Washington for measuring the altitude of the ionosphere. A transmitter and receiver are located at the same place, usually sharing a common aerial, and the transmitter is designed to radiate energy in very intense bursts of short duration called 'pulses'. The duration of each pulse may be one-millionth of a second, and each pulse is separated by an interval of a few thousands of a second. During those periods in which the transmitter is silent the receiver detects the echoes of the transmitted pulse scattered back from the target. The time interval between the transmission of a pulse and the reception of its echo is a measure of the distance of the target from the receiver for in this interval the pulse travels with the speed of light to the target and back. Thus if the target is one mile away, the pulse makes the double journey of two miles taking 10·7 microseconds. In spite of the technical difficulties, methods for measuring short intervals of the order of microseconds have been so far improved during the war that the range accuracy in gun laying is now 5 to 10 yards, which corresponds to about 1/30 of a microsecond. Time intervals in Radar are measured with a cathode ray oscillograph. A stream of electrons is made to fall on a screen of fluorescent material such as zinc sulphide and at the point of impact produces a bright spot. This can be swept across the screen with a uniform speed by applying across the X axis plates a uniformly changing potential such as can be obtained by charging or discharging a condenser through a pentode valve. These electrical elements can be chosen to give an appropriate range scale, for example with a long range early-warning Radar the scale may be marked off into divisions of 107 microseconds each of which represents 10 miles of range. For equipment designed to give more accurate ranges at close quarters the scale may be graduated into divisions of 6·1 microseconds, each of which represents 1000 yds of range. The number of journeys of the spot per second is equal to the number of pulses per second and may vary between 100 and 1000. Owing to the persistence of vision the observer sees a bright line on the screen interrupted by a 'blip' corresponding to the range of the target.

3. *Direction-finding*

In most Radar applications directional antennae are used to determine the azimuth and elevation of the target and to concentrate the energy in the desired direction. Accuracy in direction-finding is determined in large measure by the beam width which is given by the formula $W^\circ = 2{\cdot}1 \left(\frac{\lambda \text{ cm}}{D \text{ ft}}\right)$ where λ is the wavelength of the radio waves and D is the effective width of the antenna. In the early days of the war λ was usually 150 cm. and D of the order of 20 ft., in the closing days, λ was 1·5 cm. and D approximately 2 ft., giving a ten-fold improvement in resolution. It is interesting to compare the performance of sound detectors used in the 1914-18 War and the early days of the last War with direction-finding Radar. Consider an aeroplane 10 miles away which is approaching at 300 miles an hour—it will have travelled 4 miles in the

time taken for the sound to reach the observer. The time taken for a radio pulse to reach the plane and return to the receiver is 107 microseconds—in this time the plane will have moved about one-half of one inch. The advantage of Radar to the anti-aircraft gunner is obvious.

Radar in Operations

During the winter of 1934-35 the British Air Ministry set up a Committee for the Scientific Survey of Air Defence with Sir Henry Tizard as chairman. Sir Robert Watson-Watt, then the head of the National Physical Laboratory Radio Department, suggested the pulse method of Breit and Tuve for the detection of aircraft, and the first experimental system was set up in the late spring of 1935 at Baudsey near the east coast. It is reported that Churchill, on witnessing the first successful tests exclaimed 'England is once again an island'. Work began in 1936 toward setting up five early warning stations about 25 miles apart to protect the Thames estuary. By March 1938 all these stations—the nucleus of the great chain which ultimately stretched along the east coats—were complete and operating under R.A.F. personnel. These early warning sets were mounted on huge masts, and ultimately had a warning range of nearly 200 miles. The structures supporting the aerials afforded an unmistakable target, but in the critical early days for some reason were never attacked by the Germans, neither did they attempt to avoid the radio beam by flying in low. The assaults on England by the Luftwaffe began on 8 August 1940 and were initially directed at R.A.F. and Navy bases, but a month later mass raids on London began. Despite a critical shortage of first line fighter planes and pilots (the number of planes has been given as 500), Radar early warning enabled the British to spot each incoming raid in time to throw fighters against it. Under favourable conditions Radar actually disclosed German planes assembling on the French coast prior to a raid. During August the total loss of German planes was 957 and in the great September battles the Nazis lost nearly 200 of every 500 planes which attacked. By the beginning of November the Germans replaced day raids by night attacks.

The British had foreseen the danger of indiscriminate night raiding and had striven to develop methods to combat them. As far back as 1938 experimental equipment had been developed for use by night fighters to enable them to detect hostile aircraft (Aerial Interception equipment). The night fighters were also given considerable assistance from the ground by S.L.C. ('Elsie', searchlight control) which searched for and found the enemy plane by Radar before the arc was switched on. Experience showed that the target was illuminated 9 times out of 10. In spite of successes a serious situation was not really brought under control until a technique of fighter direction from the ground was built up. This was called G.C.I.—ground controlled interception. A controller on the ground watched the air situation on the screen of a Radar set which could be rotated to cover the visible horizon. He chose a specific target and gave instructions through a V.H.F. communications system to the fighter under his control and manouevred the fighter to a position 1 to 3 miles behind the target, just below and on the same course. He then instructed the fighter to 'flash his weapon' and the A.I. on the plane took over. This was operated by a special Radar operator in the plane who had no other duties than to direct the pilot up to the moment when they were able to see the enemy plane against the night sky. From this time on the pilot completed the attack.

It will be remembered that the width of the Radar searching beam is given by the expression $W = 2{\cdot}1\ (\lambda/D)$. The shortcomings of early airborne sets was due to the fact that with the shortest wavelength available (1·5 m.) and an aerial of the maximum dimensions which could be mounted on a plane the width of the beam was still too great to give precise direction-finding. Accordingly a research group at the University of Birmingham under the direction of Professor Oliphant was given the task of inventing a valve which would generate radio waves some centimetres in length with adequate power. This was achieved by Randall & Boot with their invention of the 'cavity' magnetron, a device which revolutionised the performance of Radar and placed the Radar techniques of the United Nations far ahead of those of the enemy.

Centimetre Radar

One of the first applications of the 10 cm. magnetron was the development by ADRDE at Malvern of an accurate gun laying equipment for anti-aircraft fire. The tiny dipole was mounted at the focus of a 6 ft. paraboloid and this gave a sufficiently narrow beam (4°) to obtain an average accuracy of 6 min. in angle measurements.

The British G.L.III equipment was robust and accurate. In service trials over rough ground the gun carriage of the A.A. gun was cracked but the G.L.III was operating within a few minutes. Radar-controlled A.A. scored its most striking victory against the V1 buzz bombs. There was a great balloon barrage across the Downs which entangled some of the V1's in its web of steel cables. Radar plotted the paths of the bombs and disclosed many of the launching sites to Allied bombers. G.C.I. controlled jet planes also accounted for vast numbers, but it was clear from the first cloudy day that if buzz bombs were to be dealt with it was A.A. fire which would have to solve the problem. This A.A., coupled with the proximity fuse, did in large

measure. On a Sunday late in August 105 V1's crossed the British coast headed for London—only 3 of them arrived. Some teams brought down one buzz bomb for every 40 rounds fired. At the end the A.A. was shooting down the great bulk of the bombs and doing just as well on cloudy as on clear days.

For coastal batteries both 3 and 10 cm. waves have been used. It is possible to follow on the screen the path of the shell on its way to the target and if a miss is scored the correction to aim can be made by observing on the screen the distance between the target and the splash. Similar systems are used on ships for gun laying. Ship defence against air attack is interesting. Radar equipped gun directors are trained on the incoming planes. They feed range, altitude, and bearing, into predictors which take into account the target speed, the ship's motion, &c., and position the guns correctly to hurl their shells into the exact spot where the plane will be when the shells arrive. In this way guns of different calibre form screens at different distances corresponding to their range.

From the beginning of the war, the Germans had decided to put a major effort into the destruction of allied shipping by concentrated U-boat warfare, knowing that a German victory depended ultimately on their achieving control of the seas. More than other phases of the conflict the Battle of the Atlantic was a technical conflict, and it did not look always as if the submarine would be beaten. During 1942 Allied shipping was being sunk at the rate of 16,000 tons a day. There were three basic methods of fighting the U-boats:—

1. To attack by bombing the factories which make submarines and the repair shops which maintain the submarines between voyages. The Germans beat this attack by thick layers of concrete;
2. To watch continually the lanes of egress and the areas of operation of the submarines and to search for surfaced submarines; and
3. By employing the convoy system.

In the last war the submarine proceeded submerged during the day and came to the surface at night to charge its batteries. This was no longer possible with Radar-equipped planes which could detect a surfaced submarine tens of miles away.

The Germans ultimately suspected Radar, and this was confirmed in the spring of 1942 when they captured intact one of the A.S.V. Radar sets used by Coastal Command. The Germans countered by equipping each submarine with a receiver which covered the wavelength range used by the A.S.V. Radar. This receiver gave a signal whenever the beam from the airborne Radar swept over the submarine and sufficiently early to permit the U-boat to submerge and escape attack. By the end of summer it was clear to the Allies what was going on. While the number of visual sightings changed very little, the number of Radar sightings declined steadily and the number of blips which disappeared while the plane approached the target told the story.

The British were ready with their next weapon—centimetre A.S.V. The U-boat activities increased markedly during the winter of 1942-43 but by spring a number of 10 cm. A.S.V. sets were in operational use. During May, June and July of 1943 nearly 100 confirmed submarine kills were made, two-thirds of them by aircraft. The German technicians redesigned their receiver several times, painted the U-boats with a special paint in case the Allies were using infra-red detection devices, but still the losses mounted. Two scientific expeditions put to sea in U-boats fully equipped to search for the mysterious radiation used by Coastal Command to detect submarines. Civilian experts were carried with complete and modern apparatus. The first boat put to sea from St. Nazaire on Feb. 5 1944 and lived 13 days. The second left Lorient on April 27 and lasted 9 days. It was not until autumn of 1944 that the Germans found a counter by installing an air-tube they called Schnorkel which enabled a U-boat to breathe and to run its Diesels while still remaining submerged. An extraordinary aspect of the whole story is that the German Army had early captured a British air-borne set which revealed the fact that we were using 10 cm. Radar, but the Army had failed to inform the German Navy.

When the R.A.F. Bomber Command undertook the systematic bombing of the industrial centres of Germany they decided to commit their heavy bombers to night operations entirely. In providing navigational aids for their aircraft the British were at a severe disadvantage in comparison with the Germans. While the latter could erect the aerials of their radio-navigational aids on the Channel coast and in the Low Countries only a couple of hundred miles from London, the British were aiming at targets in the heart of Germany 500 to 700 miles away round the curve of the earth. The British radio-navigational methods, known as GEE and OBOE operated from stations far apart on the East coast of England and proved sufficiently accurate for raids on the Ruhr. To guide the pathfinders as far as Berlin, however, a method had to be devised which was not restricted by the curve of the earth. A Radar method was developed known as H_2S—a designation said to have been inherited from an unsuccessful demonstration in its experimental form.

A shovel-shaped reflector confines the radio pulses into a narrow cone which for navigation is rotated about a vertical axis. The aerial is mounted below the plane directed downwards and as it rotates a circular area of the terrain is swept over by the beam. Energy scattered back from

each pulse enters the aerial, is amplified and made to control the brightness of the cathode ray spot. The presentation of the radio echoes on the screen differs from that previously described. In H_2S the trace revolves about a central point about twenty times a minute in synchronism with the rotating aerial. The fluorescent screen is a thin layer of a phosphor which glows for some time after the cathode ray spot has passed. The surface of more or less level ground sends back echoes of moderate strength so that when an aeroplane is passing over it the screen glows faintly all over. The radio rays are reflected from water like light from a mirror and so scatter practically nothing back to the receiver aerial. The concrete buildings of built-up areas, and ships return much stronger echoes and give rise to bright patches on the screen. Circles at various distances from the centre are inscribed on the screen and these show the pilot how far he is from various features of the terrain and the target. The shape of a town and disposition of its main thoroughfares are so clearly painted on the screen that a town can be recognised by comparing it with the shape in a large scale map. The Germans went in for camouflage wholeheartedly, even going to the extent of covering up lakes and rivers with floating disguises and to construct dummy towns realistic enough to deceive the human eye. These flimsy structures did not deceive H_2S however, as the reflections from them bear no resemblance whatever to reinforced concrete and brick.

Counter Measures

Successful radio detection devices were developed independently in America, Britain, France and Germany during the 1930's. It is likely that Germany, realising that Radar was essentially a defensive method found no place for it in her blitzkrieg plans. Certainly she made no great use of the technique until she herself was under air assault. Germany devised an efficient early warning system on the western approaches to Europe and also developed an effective A.A. control but she was always behind the United Nations in novelty of Radar applications.

Nevertheless our losses in massed raids over Berlin became so great that the R.A.F. had to resort to counter-measures. Cover for large raids was given by airborne jammers and for a diversion a mock raid could be simulated by a single aircraft fitted with a spurious echo generator. This was called, appropriately enough, Moonshine. 'Window' was also used to confuse the German A.A. gunners. Dropped from aeroplanes in various forms, usually in the guise of aluminium strips one half wavelength long it gave innumerable strong echoes which cluttered up the screens of enemy cathode ray screens. Ultimately the Germans used Window against us but the British A.I. planes were by then fitted with centimetre Radar which managed to see through Window.

The Germans also developed counter-measures against our Radar. The Scharnhorst escaped while the C.D. (coast defence) stations along the east coast were jammed, but she was detected by a single 10 cm. experimental set which, using a much shorter wavelength, was immune. In the Atlantic struggle too she used a variety of devices such as scattering dummy targets over a wide area of the ocean to confuse the ASV aircraft.

Radar in Peace-Time

Radar protected the cities of Britain and our convoys. It was instrumental in bringing down innumerable enemy planes and sinking many ships. An aspect sometimes lost sight of was the value of the navigational aids it provided in bringing home and safely landing planes in all kinds of weather after operational flights above Germany. It has been reported that in the early years of the war the Germans lost as many planes landing on temporary fields of France at night as were shot down over England.

Navigational aids and aircraft control will probably be the greatest peace-time applications of Radar. For example:—

Large ships: Modifications of H_2S.
Small ships: Land-based beacons triggered from ship.
Aircraft: Varieties of triggered beacons, in larger craft possibly H_2S blind-landing devices.

The fundamental advantage of Radar is that it provides information to the pilot through cloud, fog or falling snow. Meteorological applications of Radar are possible using very short wavelengths. At 10 cm. a moderate rain will scatter back sufficient radiation to give a pattern of the extent of the rain, while at 3 cm. very light rain can be detected. However, even with 1·25 cm. fog particles which make up ordinary cumulus clouds cannot be seen—drops large enough to be considered rain rather than a heavy fog are necessary to give an echo. In the tropics turbulent centres of thunderstorms give a large echo and the possibility exists of guiding planes through gaps in bad weather when the presence of dangerous local storms would make it unsafe to fly unaided.

The biggest influence Radar will have in peace is indirect. Thousands of man-years have gone into the improvement of component design and construction which will accelerate revolutionary technical advances of many kinds, especially radio communication.

Radar techniques are finding their way into atomic physics. Pulse modulation of the cyclotron is used in producing homogeneous beams of neutrons with known velocity. Two hundred 10 cm. Radar machines are being built into a quarter mile long atom smasher which will produce atomic particles with energies of 10^9ev, probably sufficient to disintegrate the fundamental nucleons themselves. The technical potentialities of Radar seem to be limitless but whatever the future of Radar holds it will play no greater role than its part in the saving of Britain. It gave the peoples of the world a second chance for a lasting peace.

Acknowledgment

Many facts quoted are taken from a 'Report on Science at War' issued by the U.S. Office of S.R.O., the War Department and the Navy Department.

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Following the decision to restrict the number of lectures given during the session, there were two very successful gatherings, the first on the occasion of Mr. W. H. Hudspeth's talk on 15 October, 1946, and the second, Mr. A. L. Meston's talk on 26 November, 1946. Both meetings were held at the Museum.

Mr. W. H. Hudspeth delivered a public lecture entitled 'Some Leaves from the Diary of a Van Diemen's Land Official'. His material was based on the diaries of Mr. G. T. W. B. Boyes, Colonial Auditor from 1826-1853. These diaries were the personal comments of Mr. Boyes on the Governors under whom he served, namely Arthur, Franklin, Eardley Wilmot and Denison; and on the people and events of the period. The diaries, hitherto unpublished and unknown, form a valuable commentary on many aspects of the political life of the Colony and contain much new material. The lecture was illustrated by lantern slides.

The Governor, Sir Hugh Binney, presided over the November meeting, which was the first time a meeting of the Branch had been attended by a President of the Society. Mr. A. L. Meston delivered an illustrated lecture on 'The Tasmanians and their Culture'. He dealt first with the history of the contact of the aboriginal with the white man. The aboriginal was then described and related to a negroid stock (unlike the Australian) and his habits and customs, his tools, weapons and utensils described, all aspects of his life and culture being discussed. Mr. Meston drew attention to the many primitive characters shown by the Tasmanian; thus he found their boat to be of a type found very early in the history of man and still to be seen in Abyssinia, on Lake Chad and on Lake Titicaca. The lecture was illustrated by lantern slides.

In addition to these meetings, members of the Branch interested themselves in problems relating to Northern Tasmania, groups being organized to study local history and botany. In the latter case much collecting was carried out, particularly in the Tamar Valley, it being arranged to make the specimens available to Dr. H. D. Gordon for study in connection with his revision of Rodway's 'Tasmanian Flora'.

As a result of the renewed activity of the Branch during the year, eleven new members joined the Society and four members became Life Members.

Officers of the Branch and their terms of office are:—

Chairman: F. Smithies, 1947.
Vice-Chairman: J. E. Heritage, LL.B., 1947, 1948.
Council: C. Craig, M.D., M.S., F.R.A.C.S., 1947, 1948; T. Doe, B.Sc., 1947; J. R. Forward, 1947; Gilbert C. McKinlay, 1947, 1948.
Hon. Secretary-Treasurer: N. J. B. Plomley, M.Sc.