has commenced publication of a series of brochures, of which two, dealing with computation services and industrial colloids and polymers respectively, appeared during 1956. A symposium on "Earth Satellites as Research Vehicles" was held on April 18 as part of a programme to promote the peaceful use of rockets; the full proceedings have since been published as Monograph No. 2.

Details are given in the report of the various meetings and scientific lectures held by the Institute during the year under review; the awards of the Franklin and other medals by the Committee on Science and the Arts; the activities of the Bartol Research Foundation and the Biochemical Research Foundation; the changes in the number of the staff, which increased by twenty to 556; and preliminary figures concerning the finances of the Institute. Separate sections of the report deal with the Museum and public relations. The Museum attendance showed a further increase, continuing the upward trend which commenced in 1951. About 40 per cent of the total of 336,000 visitors were in groups of school children, and for some of them the Museum's Education Division arranged special programmes designed to interest the young people in careers in science and engineering as part of the Institute's effort to help alleviate the shortage of trained people in those professions.

Several events in connexion with the celebration of the Benjamin Franklin anniversary took place at the Institute. A luncheon was held on Franklin's birthday (January 17), at which the City of Philadelphia's special Franklin Medal was presented to Mrs. Eleanor Roosevelt. The Institute has also been responsible for several series of radio and television programmes, including a weekly feature "Science, Servant of Man", which was broadcast from four separate stations. The anniversary celebrations and the broadcasts were all handled through the public relations department of the Institute.

THE WILDFOWL TRUST

READERS of the eighth report of the Wildfowl Trust, Slimbridge, Glos, will quickly detect the quiet pride and confidence which the editors, Peter Scott and Hugh Boyd, and the contributors have managed to convey. The visit of H.M. the Queen in 1956 set a seal on the Trust's first ten years of life and gave it a recognition so well deserved.

The Trust has three main lines of activity and the way in which each of these has expanded is clearly brought out in a report which covers a period of two years. As the results of its earlier work have become known, the Trust's research programme has received increasing outside recognition. Although much of the scientific work is paid for by the Trust itself, the Nature Conservancy has been able to offer increased assistance, while considerable help has been obtained from other, non-governmental, bodies.

In the educational field the value of the Trust's collection has been recognized by a spectacular increase in the number of schools and organized parties visiting Slimbridge. This number rose from 374 in 1953 to 464 in 1954 and 719 in 1955. The recreational value of Slimbridge was reflected in the growth of the number of visitors from 40,000 in 1954 to 90,000 in 1955 and more than 120,000 in 1956.

Although the numbers of wild geese seen at Slimbridge showed no striking increases during 1954–56, the ringing of geese and ducks, there and at other stations, expanded considerably. In 1954 the Trust assumed a large measure of administrative and financial responsibility for duck ringing in Britain. All the eight ringing stations are in the southern half of England and Wales and there is urgent need for ringing to be undertaken farther north and in Scotland and Ireland; this will be done as more money becomes available.

Although the population study of the pink-footed goose continues to be the main Trust investigation, studies were also made of comparatively small-scale ringing of greylags and white-fronted geese. These studies are particularly valuable for the indication they give of the general resemblances between the population dynamics of all three species despite the differences in their breeding places and migration routes and the extent to which they are pursued by man in Britain and other countries. An important parallel to the pinkfoot inquiry is provided by a study of the blue and lesser snow geese of North America by Graham Cooch, of the Canadian Wildlife Service. In his article, Cooch describes his technique for catching these geese during the flightless period of the moult; the method has been based on long-established Eskimo techniques.

Two complementary articles are concerned with wildfowl conservation in North America and in Europe. The first, by F. C. Bellrose and T. G. Scott, deals with conservation in North America since 1945. The second, by Hugh Boyd, shows how American experience has been used on the problems of re-stocking with hand-reared ducks in Britain; evidence collected by Boyd suggests that it is unlikely that hand-reared ducks can improve shooting on the foreshore.

Besides a wonderful collection of photographs and some black-and-white drawings which could have come only from the pen of the Director, the report contains all the financial information to show that the Trust is now well established; it must be congratulated on selling Christmas cards to the value of £1,341 in one year.

VARIATION IN THE NUMBER OF BUTTERCUP PETALS

FOR five successive years, girls of Westonbirt School have kept a record of the variation shown in the numbers of petals in buttercups. The species investigated was chiefly *Ranunculus acris* with some *R. bulbosus*, and no attempt was made to distinguish between the two in petal variation. The work was done by girls in the second year of a general science course, their average age being 12–13 years. It was carried out when they were first introduced to flower structure and function and could profitably be done by younger or older children. An account of the study has been given by E. A. Potter (*School Nature Study*, 52, No. 207; April 1957).

In the first lesson, each girl had a number of flowers, which she examined, noting and describing in the usual way the number and shape of the various parts. The number of sepals was found to be constant at five, and this result was anticipated for petals. Although the majority of flowers had five petals, there was considerable surprise when some with six,

seven and even eight were discovered. Further investigation showed that 'sixes' were very common and that there were 'sevens', 'eights', 'nines', and 'tens' in decreasing numbers. Later many more variants were found, the numbers of petals varying from four to twenty-five. These were tabulated statistically and supported by investigations during the following year. These showed that 'fours' are rare, and that flowers with thirty or more petals were occasionally found. Plants with these 'double' flowers were few in number, and all were growing in a small area within a few inches of each other. Some plants bore only one 'double' and many single flowers; others bore a few flowers, all 'double', though not necessarily with the same number of petals in each, and no single flowers. In counting the petals of 'double' flowers it was often difficult to distinguish them from stamens, the inner petals being abnormal in shape, much narrower, sometimes tubular at the base and almost staminoid. In all flowers with petals other than five, there was no variation from the normal five sepals.

There is much of value in a simple investigation of this kind. It stimulates the class to take an added interest in the buttercup, it introduces pupils at an early stage of their biology course to the use of statistical method, obviously of a simple type but yet quantitative, where so much of this branch of science is of necessity qualitative. It also encourages pupils not to accept statements such as "the buttercup has five petals", but to question and discover the truth for themselves.

MIDDAY CLOSURE OF STOMATA

Temperature Effects on the Minimum Intercellular Space Carbon Dioxide Concentration "Γ"

Loftfield[1] observed that the stomata of alfalfa, onion and many other plants sometimes closed partially or completely at about midday, reopening later in the afternoon, and Sayre[2] made similar observations for *Rumex patientia*; such closure was not generally accompanied by any obvious correlative changes in the starch contents of the stomatal guard cells in alfalfa or *R. patientia* (onion stomata do not contain starch). Both Sayre and Loftfield attributed midday closure to water-strain, but the large and rapid increases of stomatal starch that normally accompany wilting (for example, Iljin[3]) render this explanation implausible. Nutman[4] obtained evidence that the midday closure of *Coffea arabica* stomata was not due to water-strain and he concluded that high light intensity was the cause; the closure was accompanied by a fall in apparent assimilation rate, but in view of the control of stomatal aperture by the carbon dioxide concentration in the intercellular space system[5–8] a doubt exists as to which was cause and which effect. Heath[9] found that high temperature, above about 25° C., exerted a closing effect upon the stomata of the onion and interpreted this in terms of intercellular space and guard cell carbon dioxide contents. Like Parkin[10], he was under the misapprehension that onion stomata were free of chloroplasts[11–13], but he also directed attention to the unusually high ratio of non-chlorophyllous to green tissue in the onion leaf which might be expected to cause an especially pronounced increase in intercellular space carbon dioxide content with rising temperature. He suggested that the midday closure of onion stomata, and by implication that of *Coffea* stomata also, was a high-temperature effect operating *via* internal carbon dioxide content.

It was found by Miller and Burr[14] for whole plants and by Gabrielsen[15] and Heath[16–18] using detached leaves that photosynthesis by leaves illuminated with 1,000–2,500 f.c. could only reduce the carbon dioxide content of the air to about 100 p.p.m.; Heath[17,18] interpreted this as the minimum concentration at the surface of the assimilating mesophyll cells. Miller and Burr[14] claimed that this concentration, which will here be denoted by the symbol Γ, was independent of temperature, but Egle and Schenk[19] and the present authors (unpublished) later showed that Γ increased markedly with temperature. The more general aspects of this work will be published later, but a special investigation of temperature effects on Γ for onion, *C. arabica* and *Pelargonium zonale* leaves was made with reference to the problem of midday closure. Heath and co-workers[7,8] had found that wheat stomata (at 25° C.) showed a closing response to increasing carbon dioxide concentration, but only from 100 p.p.m. upwards; a survey experiment on

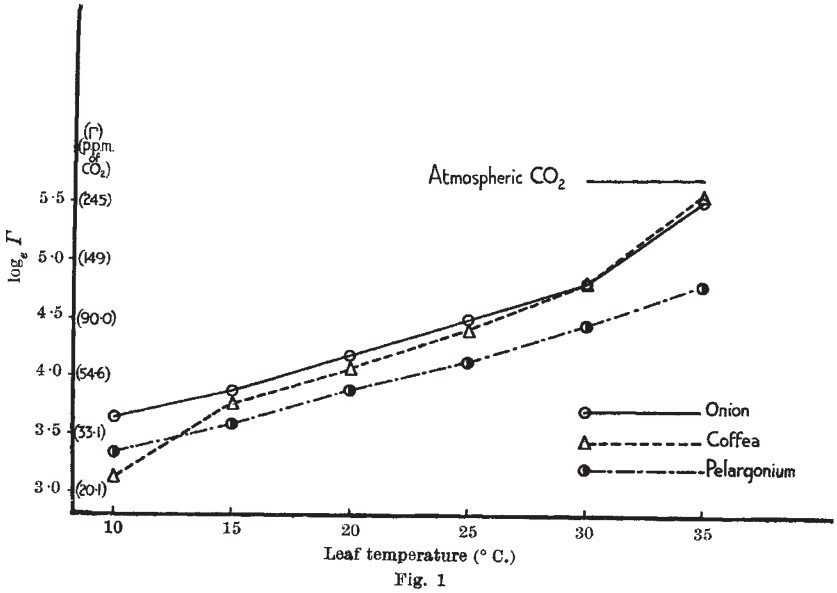

Fig. 1