than two tons of explosives could be carried, and this only at a low altitude. Naturally, other things being equal, the weight of the framework, etc., of a small airship is a larger proportion of the gross lift than the corresponding weight of a large airship.

In that type of airship in which the walls of the gas-container are themselves the "framework" of the displacement body (the "non-rigid" type), much weight is saved, but disadvantages come in that strains on the fabric affect its gas-tightness, which is also much affected by action of sun and other influences.

Again, the attachment of the car (containing the engines, etc.) by wire ropes to the container is worked out on the assumption that the gas-container will retain its shape. This end is attained in single gas-containers by having a bag of air (the "ballonet") inside the container, into which is pumped air under pressure, to maintain the full volume and shape of the envelope. If, however, compartments are to be used in the container, some means of equalising their pressures even if one be ruptured must be devised, otherwise the shape will be distorted. This is no easy task.

The non-rigid type has the great advantage of being quickly deflatable for transport packed up. Examples of this type are the Parseval and Astra-Torres, in which latter ship an ingenious system of suspension greatly strengthens the gas-container.

The "semi-rigid" type has some of the advantages and the disadvantages of both the other types. Examples are the Forlanini (Italian) and Astra XIII. (Russian).

The material of which gas-containers are usually constructed is made of layers of cotton fabric cemented to layers of rubber. In order to intercept the blue (actinic) rays of light that "rot" the rubber very quickly and make it porous to the gas, the fabric is coloured yellow. Goldbeater's skin makes a very gas-tight container, but untreated is affected by rain, which is absorbed, and by its weight decreases the net lift. This disadvantage applies to untreated fabrics, which are therefore usually varnished with an aluminium varnish, thus preventing water absorption and promoting gas-tightness. Fabric impregnated with gelatine, rendered flexible by added glycerine, and insoluble by formaldehyde, has given promising results. Oiled silk is very gas-tight but seams are troublesome. Very much research is still required into the question of fabrics.

Propulsion demands a power plant and means for obtaining a reaction from the air. The ratio of power installed to weight lifted has been steadily rising both in airships and aeroplanes. The first Zeppelin airship (1900) weighed 10,200 kilograms and the motors were two, totalling 32 horse-power. Zeppelin III. (1906) lifted 12,575 kg., and the motors (2) totalled 130 effective h.p. The "L1" (marine) of 1913 lifted about 28,000 kg., and the motors totalled 720 h.p. As an indication of the performances that may be expected from airships in years to come, we may note the proportion of power to weight lifted in the last vessel as one horse-power to every 80 lb. lifted. The speed attained is fifty miles an hour. In the case of an aeroplane doing ninety miles an hour or so, the weight lifted is only about 15 lb. per horse-power.

Screw propellers are universally used for airships, and are often of wood. They are usually placed at the sides of the gas-container in rigid vessels and below it in non-rigid vessels. Much research is needed as to the best position for propellers relatively to the body to which they are attached.

A strong reason for increasing the power of airships is that by so doing a large amount of lift can be obtained by the dynamic action of the large control surfaces, which, by directing the airship's nose up, are able to give it a very fast rate of rise, much quicker than that of aeroplanes.

The maximum height attained by airships is somewhat more than 10,000 feet (Zeppelin and Italian). Aeroplanes have ascended twice as high and ordinary balloons three times as high. To attain 10,000 feet high an airship must sacrifice much ballast and gas, so that it cannot voyage for its longest period at a great height. Zeppelins are claimed to be capable of holding the air for three days, but not at full speed or height. There is no advantage in going very high (except for military reasons), and under 3000 feet would be a usual zone in which to operate were it not for anti-aircraft measures. Some day, when the airship is better developed, it may pay to go to great heights in order to obtain the advantage of lessened resistance to advancement due to the tenuity of the air.

As regards steering and stability, it may be said at once that most airships steer clumsily and require large spaces in which to manœuvre. Our little non-rigid vessels have been specially developed for handiness in our much wooded country, but Zeppelins are craft for vast open spaces. The dynamic stability of an airship is a complicated matter to work out. Besides ordinary pitching and rolling there are added effects due to surging of the gas and distortion of the gas-container. Propellers also complicate the stability question. Large control surfaces are essential, sticking well out from the body, to avoid its "wash."

A REGIONAL SURVEY.[1]

A MODERN element in the fascination that islands undoubtedly exert is their biological interest. What are the island's inhabitants of high and low degree? How came they there and whence? How has the isolation affected them?

[1] "A Biological Survey of Clare Island in the County of Mayo, Ireland, and of the Adjoining District." Section I. (comprising Parts 1 to 16), Introduction, Archæology, Irish Names, Agriculture, Climatology, Geology, Botany. Section II. (comprising Parts 17 to 47). Zoology (Vertebrata, Mollusca, Arthropoda, Polychæta). Section III. (comprising Parts 48 to 68), Zoology (Oligochæta to Protozoa), Marine Ecology, Summary. (Dublin: Hodges, Figgis, and Co., Ltd.; London: Williams and Norgate, 1911-15.)

Such are the biological questions which, as Mr. Lloyd Praeger remarks, have led many naturalists to study islands. He recalls Alphonse de Candolle, Edward Forbes, Charles Darwin, Alfred Russel Wallace, and Sir J. D. Hooker; and many other names might be cited. The same old questions led a number of naturalists in 1909 to plan and inaugurate the survey of Clare Island, which has now been completed to the great credit of all concerned. The island was chosen because of its suitable size and position, because of its unusual elevation as compared with most of the islands lying off the west coast of Ireland, and for various practical reasons.

Clare Island lies across the entrance to Clew Bay, at about the middle of the great projecting buttress of ancient rocks which forms west Galway and west Mayo. It is almost cliff-bound, the cliffs varying from 50–100 ft. in the east and south to 1000 ft. in the north-west. The dominating feature is the high ridge of Croaghmore (1520 ft.) on the north-western shore. "On the inland (southern) side Croaghmore presents a steep heathery slope, and on the seaward face plunges down a magnificent precipice into the Atlantic." Its scarp is the home of a very interesting Alpine flora, and affords a sanctuary of wildness to many animals which could not survive the close grazing of other parts of the island. The adjoining islands of Inishturk and Inishbofin, which are included in the survey, are in a general way similar to Clare Island, but with no such lofty elevations.

The survey had two main objects in view:—(1) The study of the fauna and flora of this extreme verge of the European continent, and (2) the study of an insular area with reference to the special problems of island life and of the dispersal of organisms. As regards the first object, the results have far exceeded expectations, but as regards the second there was some disappointment.

A geological study of the area showed that it was not only probable, but almost certain, that a land-connection between the island and the mainland existed long after the Glacial period, which would have permitted of the immigration of much of the present fauna and flora after normal climatic conditions were resumed.

In short, the investigators soon found that they had to do with an assemblage of animals and plants that had *not* crossed even a few miles of sea.

As regards the fauna and flora in general, excluding winged animals and spore-plants, there is practical unanimity of opinion, resting on varied evidence from many different groups, that the narrow strait of sea which separates Clare Island from the mainland represents a very serious barrier to migration, and one across which the existing fauna and flora of the island, taken as a whole, could not have passed.

If the study of Clare Island as an island was rather negative, the other aim of the survey was realised in a manner positive enough to delight everyone, and some indication must be given of the number of additions made to the fauna and flora of Ireland and of the British Isles, and of the number of species discovered which were new to science. No fewer than 3219 plants were recorded, of which 585 were new to Ireland, fifty-five new to the British Isles, and eleven new to science. No fewer than 5269 animals were recorded, of which 1253 were new to Ireland, 343 new to the British Isles, and 109 new to science. This is a very gratifying result, and shows how many new forms of life still lie to be discovered not very far from our doors. It is pleasant to read that "almost the whole survey was carried out by volunteers, whose field-work had to be done in their own time, and, to a great extent, with their own money."

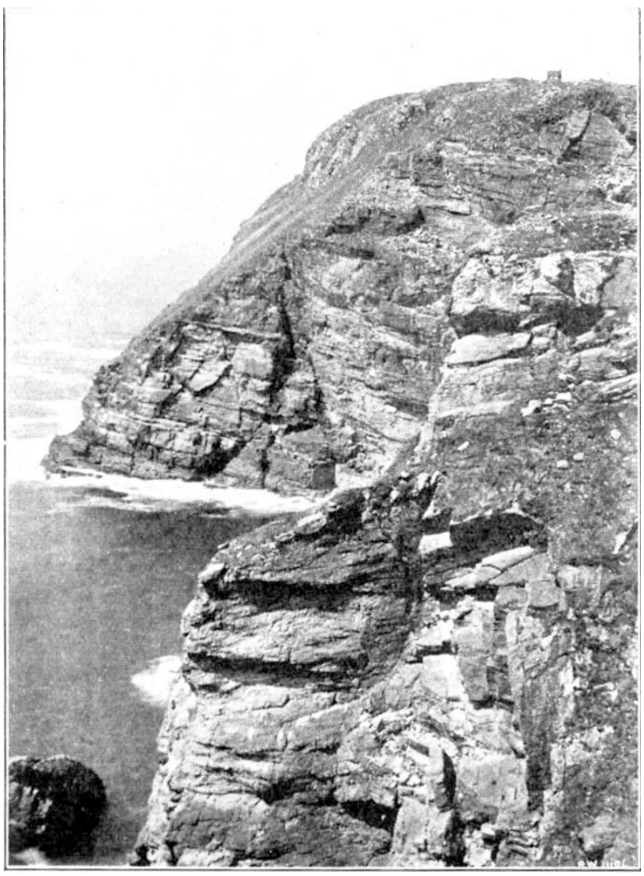

Photo.] [*R. Welch.*

FIG. 1.—Signal Tower Head, Clare Island. Silurian cliffs, 700 ft. high. Looking north. From "Clare Island Survey."

There are sixty-eight reports altogether, so that it would take considerable space even to mention subjects and authors. We are tempted to remark on the Foraminifera dealt with by Messrs. Heron-Allen and Earland (recording 287 species, thirteen new); on the Rhizopods by Messrs. Wailes and Penard (recording 129 species, five new); on the Flagellates and Ciliates dealt with by Mr. Dunkerly (recording ninety-eight species, many of them very interesting forms); on the marine sponges described by Miss Stephens (sixty-five species, including the new and interesting *Leucandra cliarensis,* with dermal monaxon spicules visible to the naked eye and giving the sponge a characteristic silvery-white appearance; on the Turbellarians reported on by Mr. Southern (forty-five from the sea and five from fresh water); on the Polychætes tackled by the same energetic worker (249 species, sixteen new—by far the largest list as yet recorded from any limited area); on the new genus Grania discovered by Mr. Southern, the first Oligochæt found beyond low-water mark and occurring down as far as twenty-four fathoms; on the spiders recorded by Mr. Denis R. Pack-Beresford (108 species and ten Phalangids besides); on the fresh-water mites dealt with by Mr. Halbert (eighty species, four new)—but it is obvious that we must not continue. It is needless to pick and choose where all the workmanship is good. Some of the studies—notably on Marine Algæ, Phanerogams, Polychæts, and Foraminifera—are much more complete than others, and this, it should be noted, is in part due to the simple fact that some of the specialists were able to visit the island oftener than others. This readily intelligible inequality was, of course, to some extent counteracted by co-operation in collecting.

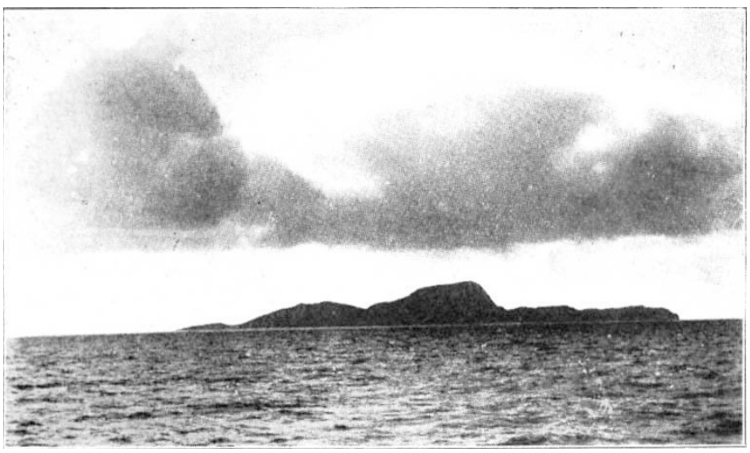

Photo.] [*G. P. Farran.*

FIG. 2.—Clare Island from E.N.E. Croaghmore in the centre. Lighthouse on extreme right. Harbour on extreme left. From "Clare Island Survey."

Looking into the novelties more analytically, we find fifteen new genera—one among Fungi, three among Mites, three among Chætopods, and eight among Nematodes. As to the last, it must be borne in mind that our knowledge of British free-living Nematodes has been of the scantiest, and we are not surprised that Mr. Southern should speak of one of the gatherings as furnishing "an apparently inexhaustible source of new and interesting species." It was among the Lower Invertebrates and Lower Cryptogams that the biggest hauls of new records and new species were obtained. Thus there were thirty-three water-bears recorded, all new to Ireland (for there had been no water-bear list before), eleven new to the British Isles, and five new to science. One of the most interesting results is the demonstration of the rich micro-fauna of the "Polygordius ground"—a sub-littoral habitat with gravel, sand, and broken shells lying in about twenty-five fathoms of water. It abounds in the primitive Annelid Polygordius, and yielded six new genera and twenty-eight new species of small fry.

We should like to have been able to refer to the discussion of marine ecology by Mr. Southern, to the admirable introduction, narrative, and summary by Mr. Lloyd Praeger, and to the reports on history and archæology, place names and family names, Gaelic names for plants and animals, agriculture, climate, geology, tree-growth (rather a negative quantity), and non-flowering plants; for this model regional survey has been as comprehensive in its scope as it has been thorough in its treatment. The survey has been completed in six years, which means hard work and loyal co-operation. We heartily congratulate those who have contributed to an achievement to be proud of, and most of all the secretary and editor, Mr. Lloyd Praeger.

PROF. BARNARD'S ASTRONOMICAL PHOTOGRAPHS.[1]

THE name of Barnard is not only familiar to all astronomers, but also very generally to those who have from time to time perused illustrated astronomical books. The photographic recording of celestial objects has been carried by him to a very high state of perfection, and thereby not only has his own fame and that of the Lick Observatory been considerably enhanced, but our knowledge of the visible and invisible universe has been greatly extended. Unfortunately, it is an extremely difficult matter to reproduce, with complete accuracy, such photographs as are obtained by the combination of a telescope and a photographic plate, for not only do delicate lights and shades become relatively altered, but other errors may and do creep in during the process of reproduction. Further, the attempt to secure such high accuracy in reproduction increases very considerably the cost of publication. It will be gathered, therefore, that the extreme fineness and beauty of the original pictures cannot necessarily be judged by plates that have so far been published.

It is a great pleasure now to record the fact that, by a generous response for financial aid and with the assistance of considerable skill in reproduction, Prof. Barnard has been able to publish a selection of the photographs he took during the years 1892 to 1895. The volume contains 129 plates reproduced by the collotype process, and

1 "Photographs of the Milky Way and of Comets, made with the Six-inch Willard Lens and Crocker Telescope during the Years 1892 to 1895." By E. E. Barnard, Astronomer in the Lick Observatory, University of California. Publications of the Lick Observatory, vol. xi., 1913.