

tion of the presence of these bodies. One or two writers have recorded the occurrence of sacs with watery contents in different molluscs. The most notable instance known to me is that of *Modiola modiolus*, which, in the Barrow Channel, opposite the Lancashire and Western Sea Fisheries Laboratory at Piel, frequently contains leathery periostracum pearls in the mantle margin, and, associated with these, cysts lined with epidermis, containing watery or mucoid matter. In one of these cysts, some twenty years ago, I found what appeared to be the spores of a protozoon of some kind, but I have not been able to repeat this observation. If sacs of this kind, whether of parasitic origin or due to some pathological condition of the oyster not of parasitic origin, occurred in the Ceylon pearl oyster, and either occasionally burst or normally dehiscenced to liberate a parasite or its spores, such bodies as small grains of sand, or (as in one of the pearls figured by me) a small quantity of mud containing diatoms, etc., might sometimes be swept into the sacs by the ciliary current and become the "nuclei" of pearls.

The distribution of pearl-producing examples of the various species of molluscs points to the conclusion that the presence of pearls—in other words, the development in the tissues of the mollusc of pearl-sacs—is associated either with parasites which are peculiar to certain localities, or with pathological conditions, following upon particular environmental conditions, which are strictly local in their occurrence. Thus the Ceylon pearl oyster, which produces pearls abundantly in the Gulf of Manar, rarely produces them in Trincomalee Harbour, while the distribution of pearl-producing beds of *Margaritifera maxima* and *M. margaritifera* is still more striking. We find the same local distribution of pearl-producing individuals in the fresh-water pearl mussel *Margaritana*, and more noticeably in *Anodonta*.

Personally I am inclined to anticipate that in many of these cases pearl formation will yet be shown to be associated with unicellular parasites. But, whether the pearl-sac is of parasitic origin, or due to some obscure response of the mollusc to a particular set of environmental conditions, it might well prove a highly profitable enterprise to transplant young examples, particularly of such species as *Margaritifera maxima* and *M. margaritifera* from beds where the percentage of pearl production is low, or where pearls are never produced, to some of those beds where almost every individual contains pearls. This process, if successful, would bring the production of pearls into line with the relaying of edible oysters on grounds where the conditions are such as to secure that they will fatten properly for market.

H. LYSTER JAMESON.

#### Sources and Sinks.

MR. DUFTON'S experiment (NATURE, June 23, p. 522) showing attraction between a source and an equal sink illustrates forcibly a remark by Mr. A. Mallock in the issue for August 19, 1920, p. 777: "In most problems relating to the actual phenomena exhibited by fluids in motion, the simple assumptions on which the hydrodynamical theory of text-books rests are insufficient, and experiments are required." At my suggestion Mr. R. Schlapp has recently been making some experiments on the forces between sources and sinks. The vertical limb (about 80 cm. in length) of a T-shaped glass tube dipped into a tank of water, and the horizontal portion rested on V supports. One end of this horizontal part was sealed, the other was connected by rubber tubing either to a high-pressure water supply or to a water pump, so that the end of the tube in the tank acted as either a source or a sink.

Three types of orifice were used: (a) the open end of the glass tube (internal diameter 0.4 cm.)—this worked well as a sink, but was unsatisfactory as a source; (b) a hollow brass sphere (diameter 2 cm.) with numerous perforations; (c) a short length of rubber tube having the lower end plugged and perforations over about 2 cm. On the whole the last arrangement proved the most convenient, but care had to be taken to ensure that no movement arising from lack of symmetry in the size and spacing of the perforations took place when using an isolated source.

When a single source was in the neighbourhood of a fixed vertical wall, attraction was observed. The attraction was very distinct at small distances, even with a small flow of water. At greater distances and with a stronger source the motion was irregular. Attraction was found also between a sink and a wall.

When two sources were employed it appeared as if they were under the influence of two forces, one attractive and the other repulsive, the former being predominant at distances less than about 2 cm. At such small distances the sources were drawn together and remained in contact as long as the water flowed. Additional evidence for the existence of a repulsive force was afforded by the observation that a fixed source repelled a second tube through which no water was flowing with a force which was greater or less according as the flow of water was large or small; but at small distances the action was attractive. Two sinks attracted one another, no repulsive tendency being observed.

Although Mr. Dufton's experiment showing apparent attraction between a source and a sink in a Winchester bottle was repeated successfully, experiments in an open tank, using the perforated rubber tube as a source and a similar arrangement or an open tube as a sink, showed strong repulsion between source and sink.

It is, of course, obvious that the conditions in such experiments differ in several respects from those assumed in the hydrodynamical theory of sources and sinks in an infinite mass of fluid. H. S. ALLEN.

The University, Edinburgh.

#### Helicopters.

MR. MALLOCK, in his letter in NATURE of June 30, p. 553, omits the chief reasons for the non-success of helicopters so far.

The first and, to the engineer, most obvious difficulty is the extra weight of moving as compared with fixed wings, and this applies to ornithopters equally.

The second, demonstrated conclusively by Riabouchinsky at the Koutchino laboratory in 1909, and recently rediscovered by ourselves, lies in the phenomenon of mutual and self-interference of the blades of an airscrew, now commonly called the cascade effect.

Each blade blows down the next following in the spiral path, then the other blades in turn, then again itself and the others, the effect becoming fainter as the axial distance from the "image" of itself and the others becomes greater.

In aeroplanes and helicopters, as in all structures which are kept geometrically similar, the weight increases as the cube and the lifting surface as the square of the typical dimension, and though some fining down of large structures can be made in comparison with small, this physical law limits the size alike of the vulture, the elephant, the whale, and the aeroplane. In helicopters the limit comes sooner than in the aeroplane, for the two reasons given above.

If this fundamental relation is ignored, the aeroplane or helicopter will be fortunate if it meets no