overflowing so as to displace the air, and then completely empty it.

If the water is to be taken from a tap, let enough run to waste to empty the local lateral before sampling; if from a pump, pump enough to empty all the pump connections; if from a stream or lake, take the sample some distance from the shore, and plunge the sampling vessel a foot and a half below the surface during filling, so as to avoid surface scum.

In every case fill the demijohn nearly full, leaving but a small space to allow for possible expansion, and cork securely. Under no circumstances place sealing-wax upon the cork, but tie a piece of cloth firmly over the neck to hold the cork in place. The ends of the string may be afterwards sealed if necessary.

Bear in mind, throughout, that water analysis deals with material present in very minute quantity, and that the least carelessness in collecting the sample must vitiate the results. Give the date of taking the sample, as full a description as possible of the soil through which the water flows, together with the immediate sources of possible contamination.

STARFISHES OF THE INDIAN OCEAN.

BY DR. R W. SHUFELDT, TAKOMA, D. C.

BIOLOGICAL work of a very excellent character has within the last few years been accomplished in the Indian Seas through those employed on board H. M. Indian Marine Survey steamer, "Investigator," Commander C. F. Oldham, R.N., commanding. Much of this success is due to the labors of Mr. A. Alcock, Surgeon-Captain, I.M.S., and late Naturalist to the Survey.

Mr. Alcock has recently sent me from Calcutta a copy of his work, entitled "An Account of the Collection of Deep-Sea Asteroidea," from the region just mentioned — it being an extract from the *Annals and Magazine of Natural History* (Ser. 6, Vol. XI.) for February, 1893. From it, it would appear, that since the year 1885 many parts of the Indian Ocean, in waters varying from 100 fathoms to 1,000 fathoms and over, have been very profitably dredged by the naturalists of the "Investigator."

Mr. Alcock remarks, "A large collection of littoral and shallow-water forms [of starfishes] has also been made, but these are not here considered. If it be thought objectionable to have separated the deep-water from the shallow-water forms, it may be urged in justification that within the limits of Indian seas, so far as our experience at present goes, there is no instance of the two sections overlapping, and on another ground, that almost nothing has been published, and nothing else is promised, about the extremely interesting Asteroidea of the deeper waters of India. Of the basins into which these waters may conveniently be divided, the Bay of Bengal proper—the basin best explored by the dredge so far — gives us the smallest number of unknown species. Beyond the limits of the 30-fathom line it would seem as if the overwhelmingly muddy bottom of the bay presented conditions specially unfavorable to the existence of starfishes; and after passing this limit we usually dredge nothing until we reach true bathybial conditions in the middle of the bay" (pp. 73, 74).

On the Andaman side, however, in 561 fathoms of water, they met with *Brisinga*, and opposite to the Kistna and Godávari Deltas, in 500 to 700 fathoms, where the bottom was of a hardening clay, *Flabellum (japonicum* and *laciniatum*), *Bathyactis*, *Phormosoma*, and Spatangoids, *Pentagonaster*, again appeared. In the middle of the bay, with a bottom of accumulating *Globigerina*-ooze, the well-nigh cosmopolitan forms of *Pararchaster*, *Dytaster*, *Porcellanaster*, *Styracaster*, *Hyphalaster*, *Paragonaster*, *Zoroaster*, *Marsipaster*, *Hymenaster*, and *Freyella* rewarded the efforts of the dredger.

Peculiarly favorable to starfish-life is the enclosed basin of the Andaman Sea, which thus far, however, has only been examined up to 600 fathoms. Of twenty-one species here collected, no less than sixteen were new to science, including three very remarkable generic types. Eighteen species were dredged in the Laccadive Sea, and other very interesting localities were examined. Little, however, was added to our knowledge of the life-habits of the deep-sea starfishes, though "like some of the common reef-forms they must sometimes live in swarms, as, for instance, *Zoroaster carinatus*, of which over a score have been taken at one haul, *Pontaster hispidus*, of which about fifty have been dredged at the same time, and *Nymphaster florifer*, of which a 150 have come up on the tangle-bar."

The food of these deep-sea types seems mainly to be mollusks, prawns, and amphipods, and in some cases they gorge themselves with *Globigerina*-ooze. "A curious case of symbiosis, which has been observed too often to be a merely accidental association, occurs between *Dictyaster xenophilus* and an annelid."

Mr. Alcock's work forms a brochure of about fifty pages, with some good figures on plates, and throughout the whole he has followed the classification of Mr. Sladen, now well-known to the students of the Asteroidea, through their reading of it in those classical volumes, the "Challenger Reports," to which it was contributed.

THE USE OF POISONS AS FUNGICIDES AND INSECTICIDES.

BY L. R. TAFT, AGRICULTURAL COLLEGE, MICH.

ALTHOUGH copper sulphate has been used for many years for the destruction of the smut spores of wheat and oats, it is only about ten years since it was first employed upon fruit and similar crops as a fungicide, and for fully one-half of this period it was only used in an experimental way.

Its effects have proven so beneficial, however, that the fruit-growers, of the State of Michigan alone, will this year use several tons in combatting the various diseases that infest their crops.

The amount in time and materials expended in the use of fungicides in the United States must then reach many thousands of dollars, and it is very desirable that as much light as possible be secured upon the time and number of the applications that are necessary to obtain the best results, as well as upon the mixtures that will be most effective and economical. It has been clearly shown by many experiments that, to be most effective, the applications must be made early in the season, before the disease has obtained a foothold; but, as the number of sprayings required to hold the disease in check will depend upon such conditions as character of crop, season, and location, and the prevalence of the disease, it is doubtful if anything more than a general rule can be given, and this must be modified to suit the conditions.

Experiments have demonstrated that very small amounts of the salts of copper will destroy the spores of fungi, and have shown that the original formulæ for most of the fungicides were deficient in water, or, in other words, the mixtures were unnecessarily concentrated. Although, as now used, the strength has been greatly decreased, the limit has by no means been reached. The amount of copper sulphate in Bordeaux-mixture has been reduced from sixteen to six pounds for twenty-two gallons of water, and the experiments of the writer tend to show that for many diseases one or two pounds are fully as beneficial.

Two or three years ago most writers recommended some form of ammoniacal solution of copper carbonate, but, after a thorough trial, most fruit-growers have come to consider Bordeaux-mixture preferable to any of the ammonia-containing mixtures. The ammonia solutions were commended as being cheaper and easier to apply, but, in fact, the Bordeaux-mixture of the same strength is much less expensive; if properly strained it is not likely to clog the pump or nozzles; it is less easily washed from the plants; and it is not only less likely to injure the foliage, but it allows the arsenites to be used at the same time, thus forming a combined fungicide and insecticide, and the lime also prevents all injury from the arsenic.

For these reasons the Bordeaux-mixture is preferable, and its use should be commended.

This lime-mixture covers the plants with a sort of whitewash, and, although this is in one way objectionable, in another, from the consumers' standpoint at least, it is preferable to some of the clear solutions, which, although they contain fully as much poison, are not very noticeable upon the plants.

Fruits sprayed within a few days of the time of gathering would in one case not be saleable, and in the other, although they might have upon their surface a sufficient amount of poison to produce injurious effects, would seem above suspicion.

The results obtained from spraying various fruits with a combined fungicide and insecticide in 1892 convinced the writer that too great care cannot be taken in the use of these poisons upon all crops, any exposed portions of which are edible, and that in no case should they be used within one month of the time of ripening, while an interval of six weeks to two months will be preferable. The fruits experimented upon were strawberries, raspberries, currants, gooseberries, cherries, and pears. The experiment was conducted in the same manner with all of the fruits, and when ripe they were analyzed and tested for arsenic and sulphate of copper. The spraying was done about as in ordinary practical work, except that it was rather more thorough, the amount used being perhaps double that generally employed. Except that the raspberry and strawberry retained rather more of the poison, the results were quite similar, and those obtained with two of the fruits will answer for all.

Gooseberries sprayed June 18, 29, July 8, and 22 with Bordeaux-mixture (copper sulphate, 2 pounds; lime, 1½ pounds; water, 32 gallons) and London purple (1 pound to 200 gallons), using one-half gallon of the mixture to a very thick, full row two rods long. One pound of fruit gathered Aug. 2 gave, on analysis, .0365 grains of arsenic and .355 grains of copper sulphate. In making the analysis, the fruit was first washed in ten per cent hydrochloric acid, and the amounts of arsenic and copper sulphate thus abstracted were, respectively, .0203 grains and .208 grains, after which there remained of each .0162 grains and .147 grains.

Fruit from another row that had been sprayed in a similar manner, except that the Bordeaux-mixture was made from the usual formula (copper sulphate, 6 pounds; lime, 4 pounds; water, 32 gallons), gave of arsenic .0723 grains, and of copper sulphate .62 grains, from one pound. In each case the last spraying was eleven days previous to the date of picking.

The pears were sprayed with the same mixture as the first lot of gooseberries, on June 15, July 7, 21, and Aug. 7, and were gathered and analyzed Sept. 6, or thirty days after the last application. The result from one pound of fruit gave, of arsenic .0089 grains, and of copper sulphate .0745 grains.

The above analyses were made under the direction of Dr. R. C. Kedzie, chemist of the Michigan State Experiment Station.

Attention is called to the fact that only about one-fifth as much copper sulphate was found upon the pears thirty days after spraying as upon the gooseberries gathered eleven days after receiving the last application, also that with a weak solution as compared with a strong one, the amount both of copper and arsenic remaining upon the fruit was reduced in about the same ratio as the strength of the mixture used.

This certainly emphasizes the advice previously given, (1) to use a solution as weak as will secure freedom from disease, and (2) cease spraying with all poisons at least one month before the fruit ripens.

LIGHTHOUSE ILLUMINANTS.

BY WM. P. ANDERSON, CHIEF ENGINEER OF MARINE DEPARTMENT, OTTAWA, CANADA.

IN *Science* for Feb. 6, 1885, a sketch was given of the progress of lighthouse illumination in Great Britain and Ireland, together with a short description of the strongest lights and apparatus utilized up to that time. Since that article appeared the conflict between the advocates of electricity, mineral oil, and gas, respectively, has not decreased, nor has any settlement satisfactory to all parties yet been reached. The matter has on several occasions been brought before the Imperial Parliament, and in February last some further correspondence on the subject was laid before the House of Commons.

A consideration of some of the points lately elicited will be an interesting addition to Mr. Kenward's notes on lighthouse apparatus in *Science* for April 21 last.

The lighthouses of the United Kingdom are under divided control: the English lights are managed by the Trinity House, the Scotch lights by a board of commissioners, and the Irish lights by a separate commission; all under the general direction of the Government Board of Trade, and each anxious to maintain lights of the highest efficiency, almost regardless of cost.

The English authorities, from the observations made in 1885, are satisfied of the superiority of electric arc-lights where the highest possible power is required, and consider oil-lights the cheapest and most easily managed for ordinary purposes. The Scotch commissioners endorse this view of the case; but the Irish board seems to favor the use of illuminating gas.

The chief opposition to the decision of the English Trinity House appears to be instigated by Mr. John R. Wigham of Dublin, the inventor of the gas system. He claims that he did not get fair play in the trials of 1885, because a rule was adopted restricting the size of the lenses and lanterns within limits that prevented him from obtaining the best results from his gas-lights. Since that time he further claims that by enriching common gas with hydrocarbon a greater amount of light can be obtained from it than from the richest cannel-coal gas. Actual experiments have shown that cannel-coal gas has an illuminating power of 28 candles, nearly double that of ordinary Newcastle-coal gas, 16 candles. By passing the ordinary gas through the vapor of solid napthaline, or albo-carbon, a perfectly safe and inexpensive material, it is enriched with hydrocarbon to such an extent as to give double the illuminating power of cannel gas. He also suggests, as an improvement in lighthouse illumination, placing lenses so as to form a quadrilateral or trilateral figure, which would permit the use of lenses of much larger illuminating surface and of much longer focal distances than is possible with the 6, 8 or even 16-sided lenticular apparatus heretofore used, thereby immensely increasing the illuminating power of the lighthouses.

Mr. Wigham has had a lens of long focus made, with a bulls-eye or central portion 19 inches in diameter, and two concentric rings, one 4 and the other 4½ inches wide, giving a total diameter of 36 inches, all in one piece. This is surrounded by a belt of prisms 2 feet 10 inches wide, consisting of ten rings, outside of which is a third portion consisting of eight rings of totally reflecting prisms, partially surrounding the second portion, so as to complete a lens about 10 feet 10 inches wide by about 8 feet high. In the focus of this lens is placed an "intensity" burner composed of 148 fish-tail jets, grouped to burn the enriched gas, which, when lighted, forms a solid flame of 14 inches diameter by 6 inches high. The illuminating power of the burner is calculated to be about 8,500 candles, which should give an actual intensity of light through the lenses of about 2,300,000 candles. Experiments made with this apparatus showed splendid results at a distance of 6½ miles. In full moonlight the beam cast a strong shadow, and was very large and dazzlingly bright, reducing a neighboring first-order fixed light to what seemed by comparison a remote and feeble glimmer.

The case for and against gas as a lighthouse illuminant seems to be as follows: Its advantages are facility in increasing or decreasing the power of the light to suit the various states of the atmosphere, and also speed and sharpness in eclipsing lights by cutting off the supply of gas, and thus occulting them while at the same time saving the illuminant; as well as the fact that where gas is used for illumination it can be utilized at a minute's notice to operate a gas-engine in connection with a mechanical fog-alarm, while with any other source of power delay must occur in putting the fog-alarm into operation. It is further claimed that the large size of the gas-flame, giving an unusual number of extra-focal rays, has a better effect in illuminating a large area of fog, and consequently makes the light more readily visible.

The weak points of gas are the difficulty of manufacturing it at some isolated stations, and also the necessarily large size of the flame, which involves the use of very large lenses, and a long focus, to prevent a wasteful distribution of extra-focal light.

The arrangement of illuminating apparatus proposed by Mr. Wigham for a most powerful light is a battery of four giant lenses, surrounding a central burner, intensified by having similar lenses with additional burners arranged one over the other in three tiers, or "in triform." To accommodate such an apparatus would require a lantern with glazing at least 20 feet in diameter