

operated not only by steam, but compressed air and electricity, have been installed very extensively. The oil operators are also exercising much care in husbanding the supply, and construct reservoirs and pipe lines as the wells are dug, in order to secure the output from the beginning of the flow. The reservoirs are of several kinds. Steel tanks have been erected on a large scale, as well as vats made of cypress wood.

Earth reservoirs are still used, although they are a decided improvement upon those which were hurriedly excavated in the early days of the development. Very few of them are open trenches. Dug out of the prairie, they are lined upon the side with hard clay or concrete, sometimes planking tightly fitted together, while the bottom is generally made of concrete. Over the top is laid a roof of wood covered with asbestos or some other weatherproof material. This form of reservoir is economical in construction, while it has the advantage of holding a large quantity of oil and keeping it free from impurities, although it does not offer as great storage facilities as the steel or wood tanks. The Texas field at present has a reservoir capacity of fully 20,000,000 barrels, but the refineries are taking a large share of the product, as the construction of these plants has been rapidly increasing, and over twenty have been erected since 1901. One which was built at a cost of \$4,000,000 is among the largest in the world.

STARFISH AND THEIR INJURIES.

BY W. FRANK M'CLURE.

Crippled starfish offer a most interesting subject for study among the inhabitants of the deep sea. Very many of them are to be found in the ocean depths, just as there are large numbers of maimed people to be seen on land. The collector seeking perfect specimens will perhaps pass by the crippled starfish, while others will find in their deformity a wondrous thing. In Ashtabula, O., there is a rare collection of several hundred starfish cripples owned by Dr. F. D. Snyder, who is a member of the American Association for the Advancement of Science. Some samples of this, in many ways, remarkable collection, which also includes perfect specimens from widely separated sources, are pictured in the accompanying photographs.

Unlike man, the starfish which loses one of its "arms," or properly its rays, grows a new one to take its place. Under certain conditions it grows two to take the place of one. This

latter accomplishment is illustrated in the picture of the *Echinaster*, which was found in South American waters, also in the *Archaster angulatus* from Mauritius. In one of the specimens of *Asteria vulgaris* injuries to two arms will be noticed, with the wounds healed and new growth started. In the case of the *Echinaster* and the *Archaster angulatus*, the growing of the two rays is accounted for by the fact that in the breaking of the original ray it was split. Had it broken off squarely, only one ray would have taken its place. Other forms of cripples will be easily recognized in the photographs.

A starfish may lose all its rays without losing its life, and very often a cripple with but a single ray left is found by fishermen and collectors. When completely broken in two, the starfish becomes two distinct fish, and the growing process continues. The

brittle starfish, it is believed, in many instances breaks off its own rays at the approach of danger. For this reason it is difficult to obtain as perfect a specimen as that represented in the illustration of the *Ophiocoma aethrops*, which is owned in Ashtabula, and which came from Panama. These rays are almost intact.

But there are other points in connection with the starfish of the world which are wonderful and instructive aside from the marvelous accomplishments of the cripples. The great variety of shapes alone is beyond the conception of those who have not made deep-sea fish a study. To many people starfish would not be starfish unless they were possessed of rays and resembled in construction a star. To all such the *Culcita pentangularis* will be a revelation. As its name indicates, this fish is pentangular in form. The

ach. The mouth of the starfish is in the center of its rays. The specimen of the starfish eating shown in the photograph is a typical one.

The body of the live starfish is comparatively soft. In traveling, it is said that it fully adjusts itself to the irregular surface of the sea bottom. Passing through an opening of small dimensions is accomplished by pushing one arm through first, at the same time folding the others back sufficiently to admit of forcing the body forward.

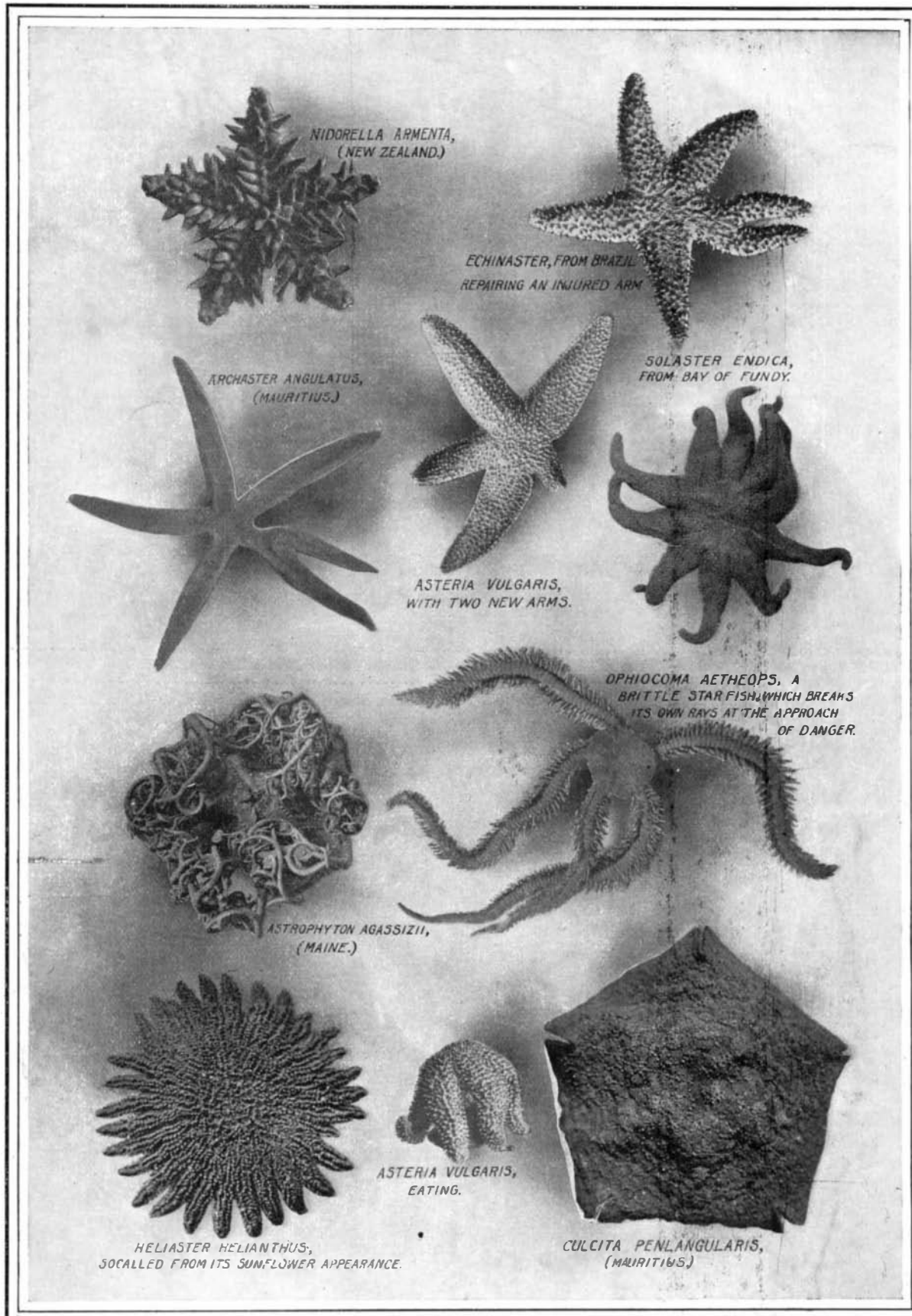
Some great ships are to-day employed almost wholly in seeking for starfish specimens in deep seas, and there are hundreds of men who spend a portion of their time in collecting starfish in the interests of science. Many of the specimens collected by ships are taken from depths of one and even two miles. The pressure which these fish withstand at this depth is of course very great.

How Radium is Obtained.

In spite of the fact that the marvels of radium have been so widely discussed and have created such a flurry of excitement not only in the scientific world but among the general public, probably very few people are acquainted with the method by which it is secured in the minute quantities that are as yet available. That the element is obtained from pitchblende is generally known, but some details of the exact process will be of interest. According to the *Lancet*, operations for the extraction are commenced by crushing the pitchblende, and then roasting the powder with carbonate of soda. After washing the residue is treated with dilute sulphuric acid; then the sulphates are converted into carbonates by boiling with strong carbonate of soda. The residue contains radium sulphate, which is an exceedingly insoluble salt. The soluble sulphates are washed out, and the residue or insoluble portion is easily acted upon by hydrochloric acid, which takes out, among other things, polonium and actinium. Radium sulphate remains unattacked, associated with some barium sulphate. The sulphates are then converted into carbonates by treatment with a boiling strong solution of carbonate of soda. The carbonates of barium and radium are next dissolved in hydrochloric acid and precipitated again as sulphates by means of sulphuric acid. The sulphates are further purified and ultimately converted into chlorides, until about 15 pounds of barium and radium chloride are obtained by

acting upon one ton of crushed pitchblende. Only a small fraction of this mixed chloride is pure radium chloride, which is finally separated from barium chloride by crystallization, the crystals from the most radioactive of the solutions being selected. In this way the crystals ultimately obtained are relatively pure radium chloride of a very high degree of radio-activity.

There are now five coal-producing districts in Siberia, not including the Kouzentsky basin, the development of which, despite its extraordinarily rich deposits, is prevented by lack of transport facilities. In 1900, about 10,000,000 pounds of coal were supplied by the Tcheremkhovo district, near Irkutsk, as fuel for the Siberian railway. The other coal districts are Soudzenkovo, Ekibastouz, Saghalien, and the coast of the Maritime territory.



CURIOUS FORMS OF STARFISH.

specimen in the illustration is from Mauritius. Another interesting shape is found in the *Heliaster helianthus*, which derives its name from its resemblance to a sunflower, and which is often found in South American waters. The creature is one of the most beautiful animals that inhabit the sea.

The manner in which the starfish travels, and the way in which it eats, represent two more interesting features of those queer specimens of deep-sea life. As, perhaps, nearly everyone knows, the starfish can neither see nor hear. Neither has it the sense of smell. In spite of these seeming impediments, nevertheless, it seeks and devours its prey as neatly as an ordinary fish. The starfish lies upon its prey and folds its "arms" or rays completely about it. It then pushes its stomach out through its mouth, and will wrap even a large oyster and shell within the folds of the stom-