timore, the Eddy Company of Windsor, Conn., the Jenney Company of Indianapolis, and the Rockford Electric Company. Wires for electrical uses were shown by the New York Insulated Wire Company, the Edison Machine Company, the Electrical Supply Company of Chicago, the India-Rubber and Gutta-Percha Company and the Bishop Gutta-Percha Company, the Ansonia Brass and Copper Company, and the Okonite Company. There was also a fine display of Grimshaw wire. Carbons were exhibited by the Standard and the National carbon companies of Cleveland, conduits for inside electric wiring were shown by the Interior Conduit and Insulation Company of this city, and an interesting exhibit of the new Edison-Lalande batteries was made by the Edison Manufacturing Company of Newark. The elements of this new battery are zinc, a caustic-potash solution, and oxide of copper, the latter being made up in the form of a plate and clamped in a copper frame. The zinc plates are suspended from a binding-post resting on the cover and hanging on either side of the oxide plate. The caustic potash is furnished in shape of sticks, two sticks accompanying each cell. These sticks are placed on either side of the zinc, and the cell is filled with water within an inch of the top, a thin layer of oil being then poured over the top of the water in order to prevent formation of creeping salts. The internal resistance of the cell is only .025 of an ohm. The electro-motive force on open circuit is about one volt, .8 of a volt on light closed-circuit work, and about .7 of a volt on heavy closed-circuit work.

THE FISHERIES OF NEW ZEALAND.

THE colony of New Zealand is now celebrating its jubilee—the jubilee of its separation from the parent colony of New South Wales — by a series of demonstrations at Auckland, its chief northern town, and by an intercolonial exhibition at Dunedin, the southern metropolis. The latter town is barely forty-two years old, its first settlers having landed from Scotland in March, 1848. It is therefore all the more remarkable to find it now holding an exhibition which, alike by its size, excellence of character, and the illustrative nature of its exhibits, is attracting attention throughout Australasia and Polynesia.

The island colony has hitherto developed only two of her natural sources of wealth; namely, her mines and her agriculture (including pastoral resources under this head). Both, but especially the former, are still capable of great extension and improvement. The third great source to which we desire to draw attention at present is that of her fisheries. These are still almost totally undeveloped, but in time to come they will certainly occupy a very important position. In the Dunedin exhibition there is a very fine display of the mineral, agricultural, and pastoral wealth of the colony, while the fisheries are almost unrepresented. There are no doubt many hundreds of individuals dependent on the industry for their daily bread; but, while the amount of capital invested in agriculture and mines amounts to millions of dollars, that engaged in the fisheries can only be counted by thousands. The promoters of the exhibition obtained almost no response from those occupied in the fishing industry, few of them being able, or finding it to their advantage, to figure as exhibiters. As population increases and means of transit are improved, this state of affairs gives promise of being altered.

A glance at a map of Australasia shows, that while Australia has a great area of land as compared to her coast-line, New Zealand, on the other hand, reverses these conditions. Her coast-line extends to about 5,300 miles, and is indented by numerous deep bays, fiords, and estuaries. At all seasons of the year the seas round her coasts literally swarm with fish, most of them of excellent quality, and many very suitable for canning or curing. In past days New Zealand was noted for her whale and seal fisheries, and American vessels reaped a very considerable share of the maritime harvest; but indiscriminate fishing has nearly exterminated these animals in the local waters, and the enterprise now rarely proves remunerative.

Hitherto very little organized effort has been put forth to develop the fishing industry; but very recently the freezing of fish for the Melbourne and Sydney markets, and the sending over of fresh fish in ice, are both being tried with great promise of success. The appliances in use are still very primitive, small open boats with seine fishing-nets being used in most parts. Only in a few localities are there trawlers or well-boats. Therefore the fishing is limited to inshore work, and is largely conditioned by the weather. Very little is known of the ocean-currents and of their variations of temperature; yet, from what little has hitherto been learned of the distribution of the various species of fish, the latter seems to depend to a considerable extent upon the former. Still less is known as to the development and life-history of the fish themselves. When it is remembered that important questions of this nature have only of very late years received attention from the scientific men and the governments of the oldest and wealthiest countries, it is not to be wondered at if the government of one of the youngest communities of the world has not yet found time or means to do any thing in this direction. The Marine Department has done a little, by way of commencement, in obtaining regular records from the lighthouse-keepers round the coast; but as none of these men are trained observers, and many of them are totally ignorant of the subject, the results, except in a few instances, have not been satisfactory.

The trade returns of the colony give no information as to the value of the fish taken for home consumption, but the export and import returns show that the local supply is still barely equal to the demand. During the six years ending 1885, the colony imported fish (dried, pickled, salted, potted, and preserved) to the value of £252,000, on which the government levied £31,887 as duty. During the same period the export only reached £3,031. In 1888 the imports were as follows: dried, pickled, and salted fish, to the value of £6,006, chiefly from Great Britain; and potted and preserved fish, to the value of £22,361, from Great Britain and the west coast of the United States. On these two items the government realized a duty of £6,062. The value of fish exported during 1888 was £7,450. This is exclusive of the oyster-fishery returns. The export of these mollusks in 1888 was valued at £11,927. These figures show that the outside trade in fish is still in its infancy, and is capable of immense extension. The number of species of marine fish already described as occurring in the coastal waters of New Zealand is close on two hundred; and of this number, over thirty are used as food, and appear in the markets. Many are locally called by names familiar to the settlers who emigrated from Britain, as, for example, cod, haddock, perch, etc.; and the general facies of the fishes of New Zealand is similar to that of the northern hemisphere. More than one-half of the described species are peculiar to the New Zealand seas, but a large percentage, including many pelagic forms, are common to Australasian waters.

One of the most valuable and abundant food-fishes of the colony is the hapuka or groper (*Oligorus gigas*), which is taken with bait all round the coast in from twenty to fifty fathoms. It is a big heavy fish, sometimes nearly six feet long, and varying in weight from forty to one hundred and twenty pounds. Its flesh is very solid and rather coarse, but admirably adapted for curing.

The kahawai (*Arripis salar*) is another abundant fish, especially in the northern portion of the colony. It appears to be migratory, swarming in the warmer seas during the summer months, but avoiding the cold southerly current which washes the southern and south-eastern coasts of the South Island. It is a handsome fish, somewhat resembling a small salmon in appearance, and running from two to seven pounds in weight. It is a capital fish for sport, and takes the fly or spoon-bait readily. The Maoris used to catch it by a bit of pawa-shell (*Haliotis iris*), the bright iridescent hues of which, when drawn rapidly through the water, gave the appearance of a fish swimming quickly. The writer has caught it in the Bay of Islands with such a bait, towing behind a yacht which was scudding along in a half-gale at twelve knots an hour. The

kahawai appears very commonly in the markets, but its flesh is rather dry.

The snapper (*Pagrus unicolor*) is also very abundant, and is one of the best edible fishes in these seas. It is taken up to thirty inches in length, and, though commonly from five to ten pounds, is not infrequently twenty-five pounds in weight. It may be taken by bait, and is a grand fish for sport, but it is commonly caught in seine-nets, in which enormous hauls, weighing several tons, are sometimes taken. Two species of *Latris*, known respectively as trumpeter and moki, are common round the coast. The first is always taken by bait, and the latter only by seine-nets or trawls. They are deep and compressed in form, and range up to twenty or thirty pounds in weight, though often brought to market when only weighing two or three pounds. They are two of the best curing fishes in the colony.

The fish most valued for its gastronomic qualities is the frost-fish (*Lepidopus caudatus*), which is very similar to if not identical with an Atlantic species. Indeed, it is one of the most remarkable features of the fish fauna of the south temperate zone that it resembles in general features that of the north temperate zone, from which it is separated by a totally dissimilar tropical fauna. The frost-fish is a long, narrow, silvery fish, which is apparently never taken either in nets or by bait, but gets stranded on sandy beaches, especially after cold frosty nights: hence its popular name. Numerous theories have been advanced as to the cause of its coming ashore, but no satisfactory explanation has yet been given. Numerous papers on the subject are to be found in the volumes of the "New Zealand Institute Transactions" and in the *New Zealand Journal of Science*, but the subject has not been cleared up. The fish commands a ready sale at a high price, — often as much as half a crown per pound, —and hence is never cured.

Another important pelagic species is the voracious barracouta (*Thyrsites atun*), which appears in enormous shoals about October, and remains on the coast for seven or eight months. It is a common South-East Australian and Tasmanian fish. It is a long narrow fish, bluish-white in color, usually from thirty to thirty-six inches in length, and weighing five or six pounds. It flashes through the water like a knife, and, though it takes bait readily, is not a pleasant creature to hook, as its formidable teeth will cut through any line. Sometimes when half a dozen lines are out from a boat for cod, a barracouta will seize one of the hooks, and, dashing off at a great pace, will in half a minute kink all the lines into an almost inextricable tangle. The usual mode of capture is very simple and interesting. The writer sat on the cliffs at Otago Heads on a summer's morning, watching the fishermen in the still water down below filling their boats. The bait used consists of a piece of red-cedar wood with a bent nail driven through it near one end. This is fastened to a couple of feet of stout cord, which again is attached to the end of a short strong rod. As soon as a shoal is observed to be passing, the oars are unshipped, and each of the two men in the boat, seizing his rod, begins to whisk it round and round in the water. The fish dash at the bait, and are rapidly jerked into the boat, several being often caught in the space of a minute. In perhaps two or three minutes the shoal is past, and the boat is again pulled about till another shoal is met with. The flesh of the barracouta is firm and white. It is especially palatable when smoked, and in this state is exported to a considerable extent to New South Wales and Victoria.

The only true cod (*Gadus Australis*) found in New Zealand waters is called locally the haddock, and is not common. The red cod (*Lotella bacchus*), on the other hand, is extremely abundant, and is also an excellent fish for curing. Its usual weight is from four to five pounds, though it is taken up to ten pounds. Another equally good fish is the representative of the northern fish of the same name, —the ling (*Genypterus blacodes*). This is very common in the southern part of the colony. The so-called rock-cod or blue cod (*Percis colias*), which belongs to a totally different family of fishes from the *Gadidae*, is abundant in all rocky parts of the coast.

The gray mullet (*Mugil perusii*) is met with in enormous quantities in the northern part of the colony, and especially in tidal estuaries. It is the richest of all New Zealand fishes, and is now being extensively canned as well as cured for export in the Auckland and Kaipara harbors. According to Sir James Hector, the Maoris frequently catch this fish on still moonlight nights by paddling their canoes close to the banks of the streams. The fish are startled by the beat of the paddle, and, leaping up, fall into the canoe. The fishermen take them in large seine-nets, as many as two thousand fish at a time having been recorded; and, as each fish weighs from one to four pounds, it sometimes happens that the nets tear with the weight of the haul. The sea mullet (*Agonostoma forsteri*), which is very abundant round the coasts, is a much smaller fish, and not so rich in quality. It is usually caught in all the harbors by persons fishing from the jetties. This fish is sometimes called the herring in popular parlance, but a fish (*Chanos salmoneus*) more closely resembling the true herring is taken occasionally by the trawlers: and, when this mode of fishing is more commonly resorted to, it will no doubt be a common fish in the market.

The true pilchard or sardine (*Clupea sagax*) occurs in enormous quantities round the coasts. Its capture and curing are made a specialty in Queen Charlotte and Pelorus Sounds, and the cured fish is known in the colony as the Pictou herring. An anchovy (*Engraulis encrasicholus*, var. *Antipodum*) has also been taken in the Thames estuary, but not yet in any quantity.

Other fishes common in the local markets are horse mackerel or scad (*Trachurus trachurus*); trevally (*Caranx georgianus*); king-fish (*Seriola lalandii*); John Dory (*Zeus faber*); mackerel (*Scomber australasicus*); gurnard (*Trigla kumu*), called by the local name of "Jack Stuart" in the southern part of the colony; gar-fish (*Hemiramphus intermedius*); butter-fish (*Coridodax pullus*), which is commonly called kelp-fish because usually found among the seaweed fringing inshore rocks and reefs; and the skate (*Raja nasuta*).

A very fine flounder (*Rhombosolea monopus*) is common in all the shallow estuaries, bays, and coastal lagoons. It is the fish most commonly sold in the markets the whole year round, and is certainly very good eating. A sole (*Peltorhamphus novæ-zealandiæ*) and a sole-like flounder (*Rhombosolea leporina*), commonly known as "yellow-belly," are also frequently caught.

Reference has been made in previous numbers of *Science* to the great success which has attended acclimatization efforts in the fresh waters of the colony. Most of the rivers and lakes now teem with trout of several kinds, including the beautiful American brook-trout (*Salmo fontinalis*). Salmon (*S. salar*), perch, tench, and cat-fish are increasing in various parts. Already the various acclimatization societies raise a considerable amount of revenue from licenses, and sales of fish and ova, and no doubt every year the value of the inland fishery will increase. The great experiment, that of the complete acclimatization of the salmon, has not yet been accomplished, but breeding-fish are now to be found in several ponds, so that the supply of ova is assured.

Outside of fishes proper, there are only two species which attract much notice on account of their economic importance: these are crayfish and oysters. The former (*Palinurus*) occurs on all the rocky parts of the coast in great numbers, and is usually taken in a baited ring-net. It is the only representative of the European lobster in these seas. There are no large edible crabs, like those of the northern hemisphere. Shrimps (*Crangon*) and prawns (*Palæmon*, etc.) are hardly ever taken for food, though common enough in places. Oysters are of two kinds, — small rock oysters, which are found all round the coasts; and the mud oyster, of which the most valuable fisheries occur in Stewart Island. The latter kind are very large in size, and fine in quality, and make a formidable mouthful. The quantity dredged has increased so much of late years, that, if not looked after, the beds will soon be exhausted. The export only dates from 1879, when £12 was the declared value. The value has steadily increased each year, standing at £12,000 for 1888. The consumption in the colony must have been very

large, and the low retail price—threepence per dozen—shows how great the take has been.

It is clear, from the mere enumeration of the species named here, that there is great variety in the fish fauna of these islands; and, when the testimony of observers in all parts of the colony as to their immense numbers is taken into account, it is certain that from her fisheries New Zealand will yet reap an immense harvest.

BOOK-REVIEWS.

A Popular Treatise on the Winds: Comprising the General Motions of the Atmosphere, Monsoons, Cyclones, Tornadoes, Waterspouts, Hail-Storms, etc. By WILLIAM FERREL, M.A., Ph.D. New York, Wiley. 8°.

THOSE of us who, about to reach the twoscore prime of middle age, nevertheless feel a little hurt at the respect shown for our advanced years by a younger generation who call us old, may take comfort on realizing that the science of meteorology has been made over again by a man whose labors upon it began only when he had reached our measure of life. William Ferrel was born in 1817, a farmer's boy in Pennsylvania. He grew up in Virginia, dividing his time between the field and the rough country schoolhouse. A love for mathematics then led him into teaching, and afterwards to our Nautical Almanac Office. In 1856, at the age of thirty-nine, Maury's facts made him so dissatisfied with Maury's impossible theory of the winds, that, at the solicitation of a friend, he wrote an outline of what seemed to him a truer conception of the general circulation of the atmosphere; and with this essay the new school of mathematical meteorology began. A few years ago the appearance of Ferrel's "Recent Advances in Meteorology" gave occasion to state the outline of his theory,[1] in comparison with others generally in vogue. Another volume now allows another reference to this attractive subject.

This "Popular Treatise on the Winds" embodies the substance of a series of forty lectures delivered by Ferrel before a class of army officers of the Signal Service in February and March, 1886. It is now much expanded by deliberate statement of the fundamental principles of atmospheric rest and motion, and is illustrated by abundant citation of pertinent observations and records. The book is too serious, too severely argumentative, for general reading; but it will for a long time have no equal in our language as a volume to which teacher and student may make safe reference in the search for the solution of difficulties. The plan of the book may be judged by a brief review of its contents. It opens with preliminary chapters on the constitution and nature of the atmosphere, and on the motions of bodies relative to the earth's surface; the latter being a subject which Ferrel has made his own, and without which no safe step can be taken in the discussion of atmospheric movements. The third chapter discusses the theoretical circulation of an atmosphere lying on a rotating globe, and heated around the equator, deducing therefrom certain critical consequences, and confronting them with the facts as ascertained by observation. He must indeed be wanting in the scientific turn of mind who does not find mental entertainment in the logical order of investigation here traced out, quite apart from its bearing on the special science to which the book is devoted. Next follow a chapter on the climatic influences of the general circulation of the winds, in the production of wet and dry zones and of wet and dry mountain slopes, and in the determination of equable and variable temperatures on the west and east sides of continents, and another chapter on the monsoons, littoral breezes, and mountain and valley winds, by which the general terrestrial circulation is more or less broken up. Thus the first half of the book is occupied. The second half discusses those great travelling whirls known as cyclones, and the more local tornadoes and thunder-storms, on all of which the impress of Ferrel's methods is most clearly marked.

Through all this there runs a single theme. Some fact of occurrence calls for explanation. A fit explanation is devised, strictly in accord with a full knowledge of physical law, and its consequences are then deduced as minutely as may be. These are matched with the facts, and the validity of the theory is measured by the degree of correspondence then detected. No one can read such a work as this without feeling a distinct intellectual gain from the keen vigor of its methods.

There is one feature in Ferrel's theory of the atmospheric circulation that does not seem to be generally appreciated. We may perhaps best approach it through its misapprehension by certain commentators. Professor Supan, editor of *Petermann's Mitteilungen*, whose extended reviews give us the best means of keeping abreast with the advance of geography in all its branches, referred four years ago to Ferrel's theory in a notice of Sprung's

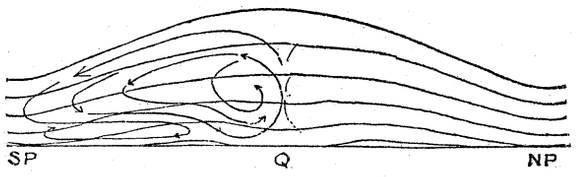

FIG. 1.

"Lehrbuch der Meteorologie." He said in effect that the distribution of atmospheric pressure was the control, not the result, of atmospheric motion; and that, as there is low pressure at the poles and high pressure at the tropics, the hypothetical return current from poles to equator cannot exist, for it would have to move against the barometric gradients.[1] The same question is asked by M. Léon Teisserenc de Bort, one of the specialists of the Bureau Central Météorologique de France. In an essay on the general circulation of the atmosphere,[2] this author says, "Mr. Ferrel does not explain the cause of the gradient that is directed toward the equator, and that is necessary for the return current from pole to equator, which he places at a middle altitude in the atmosphere. This gradient is the more difficult to explain, inasmuch as the pressure at sea-level decreases towards the pole, and as a similar decrease must exist aloft to determine the flow of the

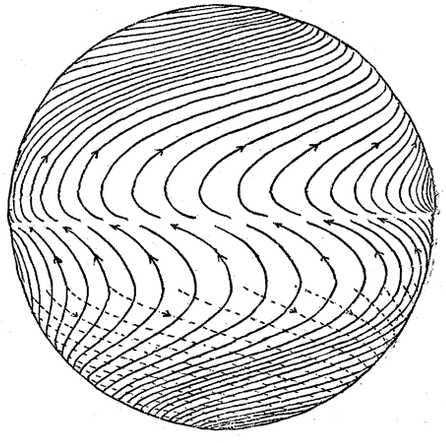

FIG. 2.

upper current from the equator." These criticisms appear reasonable enough at first sight, but this is because they fail to apprehend one of the essential points in Ferrel's theory. The case may be stated in brief as follows:—

Given a uniform distribution of temperature in the atmosphere, its imaginary isobaric surfaces will stand level, essentially equidistant. Given two adjacent regions, one maintained at a higher temperature than the other, the isobaric surfaces can no longer be level or parallel. A convectional interchanging motion will be established, as a consequence of which there will come to be a slight excess of pressure in the colder region. The isobaric surfaces, not parallel, but diverging from the region of cold and compressed air to the region of warm and expanded

[1] Science, iv. 1887.

[1] Petermann's Mitteilungen, Lit. Bericht., 1886.

[2] Ann. Bur. Centr. Mét., 1885, part. iv. Mét. Générale.