CHAPTER XX.

FISHERIES.

§ 1. General.

NOTE.—A specially contributed article dealing with Marine and Fresh Water Fisheries of Australia is given in § 6 of this Chapter.

1. **Fish Stocks.**—Australia possesses an abundant and varied fish fauna, which embraces both tropical and temperate varieties and includes destructive as well as valuable species. In rivers and lakes both indigenous and imported varieties thrive. The latter have been introduced and acclimatized for industrial and sporting purposes by Governments and angling societies. Exploitation of the fishing areas—for some classes of fish for the whole year, for others during the breeding season only, or until a certain size is attained—is, where necessary, forbidden; proclaimed localities are closed against net-fishing, and a minimum size of mesh for nets is fixed. The sea-fishermen in some districts have made regulations in their own interests for the purpose of controlling the market supply.

2. **Progress of Industry.**—(i) *Transport and Marketing.* Despite the abundance of edible fish, the progress of the fishery industry in Australia has been slow, and transport and marketing of the proved supplies have not been satisfactorily dealt with.

In New South Wales, as shown in § 5 and § 6, the matter of exploiting trawlable fish was undertaken by the State Government, which also took steps to improve the conditions under which ordinary coastal fishing is carried on. In Queensland State trawling was undertaken in 1919, and good trawling areas have been located and charted between Cape Moreton and Caloundra.

(ii) *Economic Investigations.* Although valuable work has been done by the State Governments in the way of experiment and culture, a uniform policy of development for Australia is desirable, and recommendations have been made that the Fisheries Departments of the various States should co-operate with the Federal Government with a view to increasing the productiveness of Australian waters, and bringing about uniformity in fisheries laws. All live fish imported into Australia are examined on shipboard in order to prevent the importation of undesirable fish. With the object of ascertaining the movements of oceanic fishes, and of estuarine fishes which make periodical oceanic migrations, reports are furnished regarding the various kinds of fishes, etc., and their movements along the coast. Details regarding the activities of the States in fish-culture are given in Official Year Book No. 6, pp. 471-2. By arrangement with the Commonwealth Fisheries Department some years ago members of the staff of the Australian Museum, Sydney, accompanied the F.I.S. *Endeavour* on various cruises. Specimens were collected, mounted for scientific purposes, and distributed to other Australian Museums, a considerable number being put aside for the Commonwealth Fishery Museum. As pointed out later, however, this vessel was lost with all hands in 1914, and has not since been replaced.

3. **Consumption of Fish.**—It has been said that the Australians are not an "ichthyophagous" race, seeing that the annual consumption of fish per head of population in Great Britain is set down at 42 lbs., while in Australia it has been estimated at only 13 lbs. The heavy imports of dried and preserved fish indicate, however, that there is scope for the development of the industry, which now seems to be ill-managed, the price to the consumer being high, while the fisherman's gain is uncertain, and the system of distribution lacks method.

4. Oyster Fisheries.—Natural oyster beds exist on the foreshores in the shallow waters of inlets and estuaries in several parts of Australia. By husbanding the natural crop, and by judicious transplanting, the output has been very materially augmented. The areas are leased by the Government to private persons, lengths of foreshore being taken up under oyster leases. In New South Wales and Queensland the industry has thriven, and small yields are obtained in South Australia, Victoria, and Tasmania.

5. Pearl-shell, Pearls, Bêche-de-Mer, etc.—(i) *General.* Pearl-shelling is carried on in the tropical waters of Queensland, the Northern Territory, and Western Australia. The pearl-oyster inhabits the northern and western coastal waters from Cape York to Shark Bay, a length of shore of over 2,000 miles. The shells are marketed in considerable quantities, and pearls also are obtained in Queensland and Western Australia. The fishing is generally conducted with the aid of diving apparatus, in water varying from 4 to 20 fathoms in depth. In Queensland and the Northern Territory the bêche-de-mer industry is carried on, and tortoise-shell is obtained on the coasts. Experiments have been made in cultivating the pearl-oyster on suitable banks. In October, 1911, a pearl weighing 178 grains, and valued at £3,000, was obtained at Broome. Further details regarding pearl-shelling are given in Official Year Book No. 6, p. 463. Trochus-shell to the value of £7,383 and £10,008 was raised in Queensland during 1921 and 1922 respectively.

(ii) *Royal Commission on Pearl-shelling Industry.* In accordance with the "White Australia" policy it was originally determined that the employment of Asiatic labour in the pearl-shelling industry should be restricted, and ultimately cease, and it was proposed that after 31st December, 1913, permits to indent Asiatics for the pearling-fleet should no longer be issued. In view, however, of the disorganization of the industry occasioned by the war, the time was extended to the 30th June, 1918, after which date permits to introduce Asiatic labour were to be granted only in cases where the diver and tender of a boat were Europeans. The Royal Commission appointed in March, 1912, presented its final report in 1916. The Commissioners stated that, though it might be practicable, they did not consider it advisable or profitable to attempt to transfer the industry from Asiatics to Europeans. They further stated that, while the labour now employed is almost entirely Asiatic, they did not consider that the "White Australia" policy would be weakened or imperilled by allowing the industry to continue as at present conducted.

§ 2. The Fishery Industry.

1. Boats and Men Engaged, and Take.—(i) *General Fisheries.* The returns have been compiled from particulars supplied by the State Departments, and while the data do not generally lend themselves to presentation on a uniform basis, the principal facts have been incorporated in the tables hereunder :—

GENERAL FISHERIES, 1922.

State or Territory.	No. of Boats Engaged.	Value of Boats and Equipment.	No. of Men Employed.	Total Take of—		Value of Take.	
				Fish.	Spiny Lobster (Crayfish).	Fish.	Spiny Lobster (Crayfish).
	No.	£	No.	cwt.	doz.	£	£
New South Wales	1,063	76,553	*g* 3,385	*b*177,940	7,190	*b*464,452	*c* 27,518
Victoria (*e*) ..	870	106,493	1,319	89,306	18,408	142,966	16,373
Queensland ..	645	39,614	1,226	47,820	..	95,096	..
South Australia ..	900	36,000	964	(*a*)	(*a*)	(*a*)	(*a*)
Western Australia	259	32,147	522	25,588	12,638	71,644	6,319
Tasmania (*d*) ..	134	12,595	345	doz.89,546	8,350	18,900	4,586
Northern Territory(*f*)	2	90	10	102	..	205	..
Total (*d*) ..	3,873	303,492	7,771	..	..	793,263	54,796

(*a*) Not available. (*b*) Including 48,256 cwt. fish, valued at £101,337, obtained by State trawlers and private fishermen. (*c*) Including £14,058, the value of 3,042 cwt. prawns and 2,331 dozen crabs (*d*) Incomplete. (*e*) Year ended 30th June, 1923. (*f*) Year ended 30th June, 1922. (*g*) Number of licensed fishermen.

Returns for the past five years are given in the table below :—

GENERAL FISHERIES.—AUSTRALIA, 1918 TO 1922.

Particulars.		1918. (a)	1919.	1920.	1921.	1922.
No. of boats engaged		3,287	3,838	3,624	3,684	3,873
No. of men employed		6,515	7,774	7,634	7,846	7,771
Fish obtained—						
Quantity	cwt.	490,612	b387,680	b397,250	b377,614	b350,350
Value	£	755,059	b629,120	b689,568	b708,670	b793,263
Lobsters obtained—Value	£	32,250	b26,896	b44,885	b43,329	b54,796

(a) Exclusive of Tasmania. (b) Exclusive of South Australia.

(ii) *Edible Oyster Fisheries.* The returns from oyster fisheries are given in the next table. Edible oysters are not found in Western Australia, and information is available for the first time regarding the small production of oysters in Tasmania :—

EDIBLE OYSTER FISHERIES (a), 1922.

State or Territory.	Number of Boats Engaged.	Value of Boats and Equipment.	Number of Men Employed.	Number of Leases.	Oysters Taken.	
					Quantity.	Value.
	No.	£	No.	No.	cwt.	£
New South Wales ..	502	23,501	513	4,028	43,198	74,433
Victoria (b)	15	1,640	24	15	847	850
Queensland	107	9,866	130	617	24,471	35,022
South Australia (c) ..	..	..	..	..	..	..
Tasmania	4	600	19	..	234,000 (doz.)	d 4,056
Total	628	35,607	686	4,660	..	114,361

(a) Practically no oyster fisheries in Western Australia and Northern Territory. (b) Year ended 30th June, 1923. (c) Included with General Fisheries. (d) Including £3,588, value of scallops.

Returns for Australia for the last five years are given in the appended table :—

EDIBLE OYSTER FISHERIES.—(c) AUSTRALIA, 1918 TO 1922.

Particulars.		1918.	1919.	1920.	1921.	1922.(a)
No. of boats engaged ..		550	(b) 503	(b) 532	(b) 591	624
No. of men employed ..		598	(b) 492	(b) 539	(b) 602	667
Oysters obtained—						
Quantity ..	cwt.	78,668	78,430	72,767	63,804	68,516
Value ..	£	92,261	100,910	108,694	96,808	110,305

(a) Exclusive of Tasmania. (b) Exclusive of Victoria. (c) Exclusive of South Australia.

(iii) *Pearl and Bêche-de-Mer Fisheries.* The pearling industry is carried on in the tropical waters of Queensland, Western Australia, and the Northern Territory. Bêche-de-mer is obtained in Queensland and the Northern Territory, the product being exported to China. Particulars for the year 1922 are as follows :—

PEARL, PEARL-SHELL, AND BÊCHE-DE-MER FISHERIES, (a), 1922.

State or Territory.	Number of Boats Engaged.	Value of Boats and Equipment.	Number of Men Employed.	Quantity of Pearl-shell obtained.	Value of Pearl shell obtained.	Value of Pearls obtained.	Value of Bêche-de-mer obtained.	Value of Tortoise-shell obtained.
	No.	£	No.	Tons.	£	£	£	£
Queensland (b) ..	129	65,000	1,040	952	125,124	(d)	63,630	463
Western Australia..	221	117,325	1,571	1,312	177,222	38,163	..	..
Northern Territory(c)	6	1,650	28	7	1,106	..	2,049	200
Australia ..	356	183,975	2,639	2,271	303,452	38,163	65,679	663

(a) No pearl-shelling industry in New South Wales, Victoria, South Australia, and Tasmania (b) Also trochus-shell to the value of £10,008. (c) Year ended 30th June, 1922. (d) Not available.

For obvious reasons the returns in regard to the value of pearls obtained can be regarded as rough approximations only. The trochus-shell raised in Queensland is used principally in the manufacture of "pearl" buttons.

Particulars regarding these fisheries for the last five years are given below:—

PEARL, PEARL-SHELL, AND BÊCHE-DE-MER FISHERIES.—AUSTRALIA, 1918 TO 1922.

Particulars.	1918.	1919.	1920.	1921.	1922.
No. of boats engaged ..	401	471	515	334	356
No. of men employed ..	2,935	3,453	3,738	2,403	2,639
Pearl-shell obtained—					
Quantity .. tons	1,616	2,300	2,126	1,422	2,271
Value.. .. £	224,115	387,034	337,917	189,276	303,452
Pearls obtained (a)—					
Value.. .. £	63,487	74,212	68,610	36,163	38,163
Bêche-de-mer obtained —					
Quantity .. tons	468	308	(b)	(b)	(b)
Value.. .. £	48,933	42,721	70,898	52,201	65,679
Tortoise-shell obtained—					
Quantity .. lbs.	695	172	552	2,112	992
Value.. .. £	350	96	302	1,080	663
Trochus-shell obtained—					
Value.. .. £	37,886	30,280	41,698	7,383	10,008

(a) Incomplete; but as returned. (b) Not returned.

2. Fish Preserving.—To encourage the industry, the Federal Parliament provided a bounty of ½d. per lb. for fish preserved as prescribed during the ten years 1907–8 to 1916–17. The payment, which amounted to only £3,005 during the period, or at the rate of £300 per annum, failed to develop the industry, and the bounty was not renewed on its expiration in 1916–17.

3. State Revenue from Fisheries.—The revenue from fisheries in each State during the year 1922 is given hereunder:—

FISHERIES.—REVENUE, 1922.

State or Territory.	Licences.	Leases.	Fines and Forfeitures.	Other Sources.	Total.
	£	£	£	£	£
New South Wales ..	1,427	9,550	341	928	12,246
Victoria (a)	854	22	95	34	1,005
Queensland	1,791	3,376	28	14	5,209
South Australia	964	5	8	..	977
Western Australia ..	3,412	1,226	139	..	4,777
Tasmania	618	2	52	100	772
Northern Territory (b) ..	26	..	..	..	26
Total	9,092	14,181	663	1,076	25,012

(a) Year ended 30th June, 1923. (b) Year ended 30th June, 1922.

Similar particulars for Australia for the last five years are given in the following table :—

FISHERIES.—REVENUE, AUSTRALIA, 1918 TO 1922.

Particulars.	1918.	1919.	1920.	1921.	1922.
	£	£	£	£	£
Licences	8,903	10,959	11,760	9,164	9,092
Leases	12,646	11,969	13,432	13,106	14,181
Fines and Forfeitures ..	438	523	536	472	663
Other Sources	575	3,919	524	586	1,076
Total	22,562	27,370	26,252	23,328	25,012

§ 3. Oversea Trade in Fishery Products.

1. **Imports of Fish.**—The development of the local fishing industry leaves much to be desired, as is evident from the large imports. For the last five years the imports were as follows :—

FISH.—IMPORTS, AUSTRALIA, 1918–19 TO 1922–23.

Classification.		1918–19.	1919–20.	1920–21.	1921–22.	1922–23.
Fresh (oysters) ..	cwt.	2,321	520	2,092	2,297	2,927
	£	1,617	762	2,708	3,675	4,091
Fresh, or preserved by cold process	cwt.	5,383	9,444	17,558	25,130	38,508
	£	15,144	39,796	81,126	107,999	127,172
Potted	cwt.	(a)	(a)	(a)	(a)	(a)
	£	10,075	97,340	64,310	72,788	69,422
Preserved in tins	cwt.	62,426	148,684	103,505	163,034	175,322
	£	345,918	989,742	649,610	885,781	867,708
Smoked, dried, and n.e.i.	cwt.	2,313	6,106	10,179	13,170	13,633
	£	15,863	38,298	52,774	59,038	56,190
Total	cwt. (b)	72,443	164,754	133,334	203,631	230,390
	£	388,617	1,165,938	850,528	1,129,281	1,124,583

(a) Not available. (b) Exclusive of potted fish.

Tinned fish constitutes by far the largest proportion of the imports, most of it consisting of salmon from the United States of America, Canada, Norway, and Alaska. The potted fish comes chiefly from the United Kingdom. New Zealand supplies the largest proportion of the fresh fish, the bulk of the remainder coming from the United Kingdom and South African Union. The small import of oysters is supplied by New Zealand.

2. **Exports of Fish.**—The exports of local fish produce for the five years 1918–19 to 1922–23 are given hereunder :—

FISH (AUSTRALIAN PRODUCE).—EXPORTS, 1918–19 TO 1922–23.

Classification.		1918–19.	1919–20.	1920–21.	1921–22.	1922–23.
Fish, fresh, smoked, or preserved by cold process	cwt.	530	790	10,193	9,865	9,692
	£	2,591	6,017	86,474	89,095	66,104
Preserved, in tins, dried, salted, etc.	cwt.	7,072	9,259	102	78	162
	£	45,342	66,255	195	306	433
Total ..	cwt.	7,602	10,049	10,295	9,943	9,854
	£	47,933	72,272	86,669	89,401	66,537

The quantity of fresh fish exported from Australia is trifling, and the amount of £66,104 shown in the table above consists chiefly of cured bêche-de-mer exported to Hong Kong from Queensland.

3. **Exports of Pearl and Other Shell.**—The exports of pearl, tortoise, and trochus-shell, of Australian origin, are given hereunder for the five years 1918–19 to 1922–23 :—

PEARL, TORTOISE, AND TROCHUS-SHELL.—EXPORTS, AUSTRALIA, 1918–19 TO 1922–23.

Article.		1918–19.	1919–20.	1920–21.	1921–22.	1922–23.
Pearl-shell ..	cwt.	49,300	45,040	31,480	38,900	41,027
	£	316,154	462,152	319,143	317,623	320,602
Tortoise-shell ..	lbs.	239	1,542	2,922	1,938	2,812
	£	138	1,011	1,864	1,243	2,012
Trochus-shell ..	cwt.	..	26,000	11,900	14,320	13,186
	£	..	105,894	37,602	26,285	25,095

The bulk of the pearl-shell exported during 1922–23 was consigned to the United States of America and the United Kingdom, the respective values of the shipments amounting to £262,322 and £56,921, while trochus-shell to the value of £55,460 was dispatched to Japan.

§ 4. The Commonwealth Department of Fisheries.

In 1907 the Commonwealth Government decided to demonstrate what might be attained commercially by the application of modern methods in fishery. A Federal Investigation Ship, the *Endeavour*, was constructed specially for the work, and a Director of Fisheries was appointed. Experimental cruises were undertaken, which showed that Australia possesses an asset of considerable value in her sea fisheries. The *Endeavour* was unfortunately lost at sea with all on board at the end of 1914, and has not been replaced. A description of the trawling grounds discovered, data regarding oceanography to the east of Australia, and a list of the publications of the Department are given in pp. 333 to 335 of Year Book No. 14.

§ 5. The State Trawling Industry—New South Wales.

The State Trawling Industry was established in 1915, and fishing operations were conducted with seven steel steam trawlers. The catches were landed at Sydney and Newcastle, and the fish distributed through retail shops, of which there were fourteen in the Metropolitan area, one in Newcastle, and five in country towns. During the year ended 30th June, 1922, the State trawlers landed 2413 tons of fish, valued at £101,337. Early in the year 1923 the Government decided to discontinue trawling operations, as the venture was not a commercial success, the accumulated net loss amounting to £210,518, and most of the assets have since been disposed of.

§ 6. Marine and Fresh-water Fisheries of Australia.*

1. **General.**—Australians generally have little idea of the importance and possible value of their own fisheries. It cannot therefore be expected that those associated with the commercial development of fisheries elsewhere should be aware of the great possibilities in Australian waters in connexion with all known departments of fishery enterprise.

There are, however, a few observers who not only believe in the immediate practicability of an all-round development of an Australian fishery industry, but see the time approaching when the world's " centre of gravity " in commercial fisheries shall be moved to Australia. A claim of this nature will be regarded by many as hyperbolic. It is the

* Contributed by David G. Stead, author of " Fishes of Australia," " Edible Fishes of N.S.W.," " Fisheries of N.S.W.," " Fisheries of British Malaya," etc., etc.

aim of the writer, therefore, so far as it can be effected within the compass of the present brief article, to justify this claim. It may be noted, however, that a similar view was expressed by several of the delegates, familiar with world fisheries, who attended the recent Pan-Pacific Science Congress in Australia.

2. **Extent of Fishable Waters.**—The coastline of Australia is about 12,210 miles in length. Great as that length is, however, it is exclusive of the shore lines of the bays, estuaries, and sea-lakes, of great importance in the development of commercial fisheries, and these would add at least another 2,000 miles. But a mere statement of mileage is of little practical utility, unless it is shown that the whole length is productive of commercial marine organisms. Not only is this so, but the waters throughout may be "worked" by known fishery methods, since there are no portions which are not always accessible, regardless of season. Yet, at the present time, a very limited expanse only of this extensive coastline is under tribute even to the smallest extent.

3. **Fishery Production.**—The amount of fresh fish taken from the small fishable area worked is by no means insignificant. Indeed, the quantity so taken per annum, including much that is consumed near the point of capture, and a great deal that escapes official record, is probably not less than 51,000,000 lbs. This total is exclusive of a considerable take of crustaceans, such as lobsters (crayfish), prawns, and crabs, and of edible oysters, the latter probably averaging an annual production from New South Wales alone of about 48,000,000.

4. **Difficulty in obtaining Returns.**—It may be mentioned here that it is difficult to obtain exact figures relating to fisheries production for the whole of Australia, owing to the lack of organization in the various administrations. This condition of affairs will continue until Australians become fully seized of the potentialities for production of Australian waters, and of the necessity for providing the greatest possible amount of information—biological, commercial, and statistical—to persons who might enter the many avenues of fisheries activity.

5. **Need of Expert Advice.**—No great development of any semi-enclosed or enclosed fishery should, however, be permitted except under the guidance of expert fisheries authority. This is essential for the continuance of the fishery. In this connexion it may be noted that the highly valuable fisheries of the Gippsland Lakes, in Victoria, were for many years subjected to practically a bank-to-bank wholesale destruction of immature edible fishes.

6. **Available Methods of Fishing.**—Reverting again to the "fishable" area in Australian waters—and neglecting for the moment both fresh waters (rivers and non-coastal lakes) and the extensive littoral areas of bays, estuaries, and sea-lakes—it may be stated that the whole of the waters lying within an average distance of 20 miles of the coastline may be fished by one or other of the methods known to modern fishery science. Roughly speaking, these methods include (*a*) trawling, bottom-seining, and long-line work for waters free from reefy obstructions; (*b*) trammel-netting, trapping, and hand-lining for reefy stretches, including the vast Great Barrier Reef area; and (*c*) a modified otter trawl, seines, drift-nets, with "jigs" and other trolling lines, for midwater and surface work. Some of these methods may be worked from small craft, using oars, sails, or small motors, while others would necessitate and would be most economically worked from large vessels using motive power from steam (in the case of trawlers) or internal combustion engines.

7. **The 100-fathom Line.**—In non-coralliferous areas the 100-fathom line is situated at a mean distance of about 20 miles from the coast. Sometimes this line approaches to within 10 miles of the littoral, and sometimes is as much as 30 miles therefrom. There is, of course, no clear line of demarcation, and commercial fishing is practicable down to 200 fathoms and more.

8. **The Oceanic "Food Province."**—It is somewhat on the conservative side to take a mean fishing distance of 20 miles from the coastline of Australia as being available for general commercial fisheries work. Yet this indicates the existence of a "food province" of no less than 244,200 square miles in extent. No other country can boast

of such a vast field available at all times and all seasons (except during storms). Possibly no other country can show either such a vast fish-fauna, or such a great aggregate bulk of commercially-usable fishes, crustaceans, molluscs, seaweeds, etc., etc.

9. **Value of Inshore Fisheries.**—(i) *General.* Notwithstanding the prime importance given to the oceanic fisheries, the inshore fisheries—both present and potential—are extremely valuable. These embrace many capacious bays, estuaries, and coastal lakes, in which the water is usually shallow, and, generally speaking, is naturally heavily-stocked with edible fishes, crustaceans, and molluscs, as well as with other commercial sea-products. In the older or more settled parts of Australia—especially from Moreton Bay southwards to Port Phillip—fishing has been conducted for many years. Naturally the waters on the New South Wales coastline have been most heavily fished, but there is no indication that the supply is likely to give out. There is some evidence of localized over-fishing, especially in certain of the coastal lakes, but, on the whole, the position is as stated. With careful administration, moreover, there is no reason why even these semi-enclosed fisheries should not become permanent sources of fish supply.

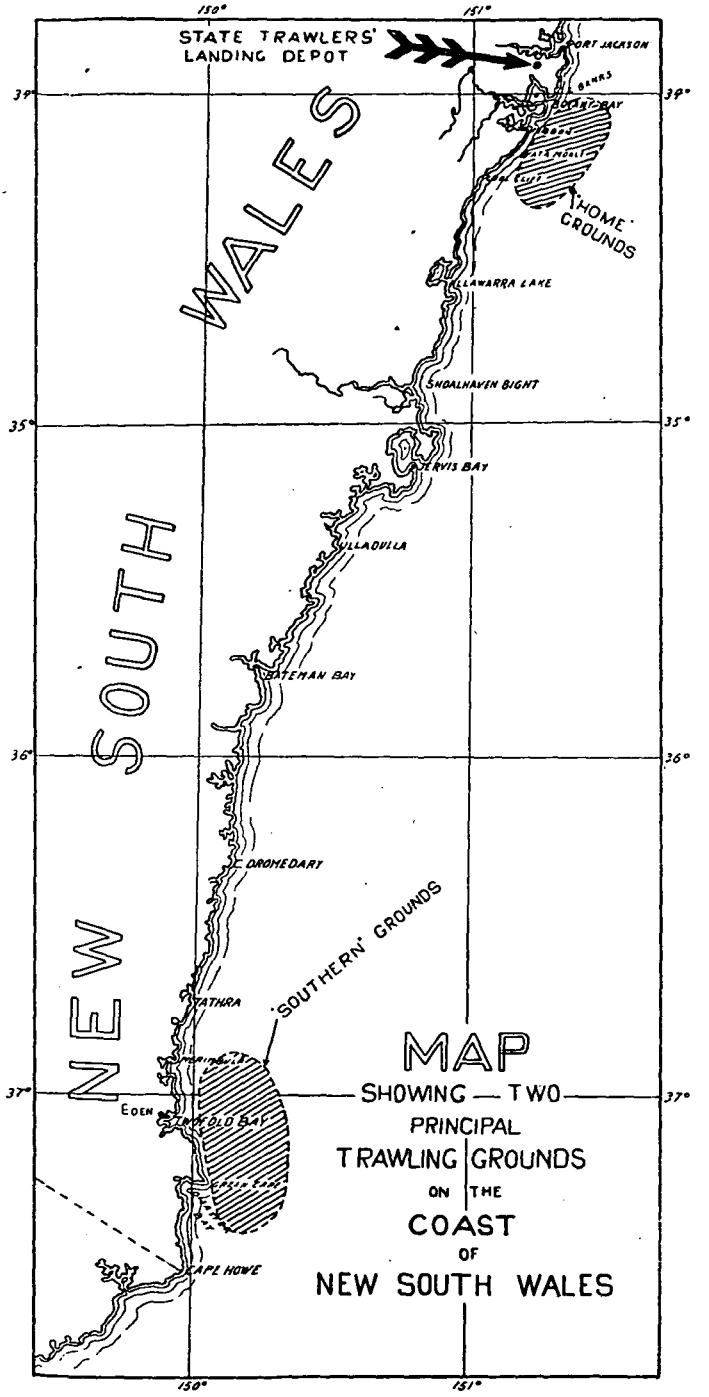
(ii) *The Clarence River, New South Wales.* Lest it might be thought that this view is unduly optimistic, the experience of New South Wales may be quoted in regard to its most prolific coastal water—the estuary and lower reaches of the Clarence River. For many years it has been asserted that the fishery would give out because of the alleged over-fishing. The fact that the principal single species of food fish taken from this water—the sea mullet—was captured in thousands every year immediately prior to the spawning period caused very many people to think that the fishery—and particularly of this species—must terminate. The matter was placed before the author in his capacity of Superintendent of Fisheries fifteen years ago by the New South Wales Board of Fisheries, when, after reviewing the general conditions of fish life in these estuaries, and especially after taking into consideration the fact that the fishermen, with almost every haul of the net, were destroying many fish enemies of the mullet (and other edible kinds), the opinion was given that not only was there no fear of exhaustion but that, with careful management of the fishery, the supplies would increase. " Management " in this case did not necessarily mean the curtailing of catches of particular species by means of close seasons, although with some kinds such measures are at times necessary. In the five years 1903 to 1907, the total output from the Clarence River fishery was 8,041,025 lbs. (see " Edible Fishes of N.S.W.," 1908, p. 11), and this after being for many years under tribute. In the five years 1918 to 1922, or fifteen years later, the marketed output was no less than 15,781,275 lbs.

This aspect of the fisheries question cannot here be dealt with in greater detail, yet too much stress cannot be laid upon it, in view of its bearing upon future commercial developments. If such an advance is possible in one water only, the prospects for the whole of the inshore waters of the Australian region appear extremely favourable.

(iii) *Other Districts in New South Wales.* The State of New South Wales is the best served by nature in the matter of estuarine waters and lakes, having them dotted at short intervals along the coastline, and the prolificness of such waters had a restraining influence upon the development of the deep-sea fisheries.

(iv) *Other States.* In the States of Queensland and Western Australia and in the Northern Territory there are many inshore fishery areas awaiting development, the majority of which have hardly been touched.

10. **Fresh-water Fisheries.**—(i) *General.* Australia's fresh-water fisheries are extensive, though restricted to definite areas. It is customary to speak of Australia as a " land of few rivers," and, while this expression is accurate when used in a relative sense—bearing in mind the great land area of the continent—it may mislead people into forming an erroneous idea regarding the actual extent of the permanent or semi-permanent inland waters. Several of the rivers of the northern portions of Australia will, later on, prove of considerable importance in fisheries, but those at present of greatest value—notably the vast system of rivers, creeks, billabongs, and lakes associated with the drainage area of the Murray River system in New South Wales, Victoria, Queensland, and South Australia—will always maintain the leading position. Further reference to this will be made later on in dealing with individual species of fresh-water fishes.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MAP
SHOWING — TWO — PRINCIPAL TRAWLING GROUNDS ON THE COAST OF NEW SOUTH WALES

(ii) *The Murray Cod Fishery.* Mention may be made here of the fishery whose principal object is the capture of the Murray cod. This fishery is carried on mainly in the Murray, Murrumbidgee, Darling, and Barwon rivers. No exact figures of the catches can be furnished, as the Murray cod and other riverine fishes are extensively sought by anglers; but it is worthy of note that from six to seven hundred thousand lbs. weight is despatched annually by rail from stations situated on the rivers mentioned, exclusive of a very large quantity despatched from the Lower Murray in South Australia. Most of this fish is Murray cod, reckoned by connoisseurs one of the finest edible fishes in the world.

11. **Australian Fish Fauna.**—(i) *Archaic Types.* With its northern shores close to the equator, and its southern portion washed by the cold waters of the Southern Ocean, Australia possesses a varied and extensive fish fauna. On the whole, as in the case of the land fauna, but not to the same extent, this fish fauna is somewhat archaic in character. There are, for example, the Port Jackson sharks (*Heterodontus* and *Gyropleurodus*), the small, harmless species abundant around the rocky portions of the coastline of the southern half of the continent, and the strange frill-gilled shark (*Chlamydoselachus*). The latter is an anguilliform or eel-shaped shark, of ancient lineage, of which the sole example seen by the author measured about 10 feet in length. It has enormous saucer-like eyes, and probably occurs in the deeper ocean waters. There is another very ancient fish type in the fresh-water herring (*Potamalosa*), one of the "rough-backed herrings," well known in the world from the many fossil species described.

(ii) *Number of Species.* Approximately 2,000 species of fishes have been determined from the waters of Australia; but, with more extensive fisheries exploration, this number will doubtless be greatly increased. In the northern half of Australia especially, further investigation will most probably demonstrate the existence of species of fishes of commercial importance which have not yet been recorded. Taking into consideration the large number of known fishes of the Indo-Malayan region and of "Oceania," which probably extend their range into the northern waters of Australia, together with undescribed species yet to be discovered, a conservative estimate would place the total number of kinds of fishes inhabiting Australian waters at 3,000. Probably at least two-thirds of these will prove to be of commercial value.

(iii) *Edible and Inedible Varieties.* It is here worthy of mention that ideas of what are commercially usable fishes are likely to expand with the growth of various fishery industries. At present many kinds of valuable food fishes are rejected as inedible, but others which a few years ago were looked askance at are now being used. The same remarks apply in a minor way to the edible molluscs (other than oysters).

(iv) *Marine Fishes.* (*a*) *Sharks.* By far the greater bulk of the known fishes are of marine origin. The cartilaginous fishes (sharks, rays, &c.) are represented by many kinds, ranging from the gigantic white shark (*Carcharodon*), or "White Death," attaining a length of not less than 40 feet, and the giant sea-bat or devil-fish (*Manta*)—a great skate or ray reaching to a width of 15 feet across the body—down to the tiny, harmless, and commercially useful dogfish (*Squalus*), usually about 2 feet in length. Included in this group are many sharks, of which the principal are as follows:—(*a*) The "man-eater," whaler, or mullet shark (*Carcharhinus*), which is found not only in open ocean waters, but infests the sequestered waters at the heads of estuaries and harbors, where it is greatly to be feared by man. It attains a length of from 9 to 12 feet. (*b*) The tiger shark (*Galeocerdo*), an ocean species, penetrating slightly into estuaries, and reaching a length of 18 feet. It is not a known man-eater. (*c*) The grey nurse (*Carcharias*), a very common "outside" species, also penetrating to some extent the estuaries of the southern half of Australia, but never found very far away from the ocean, although it is sometimes stated in the newspapers that the type has been seen far up the estuaries. In every such case the shark is the whaler, whose general habits are quite different. The whaler is a "lurking" ground shark, while the grey nurse is a midwater fish. (*d*) The blue shark (*Prionace*) is widely distributed in all seas, and is found in the ocean waters of every State. It grows to a length of 15 feet or more. (*e*) The blue pointer (*Isurus*), which must not be confused with the blue shark. It is a beautifully modelled shark, with a torpedo-shaped body, exceedingly active, a fine swimmer, and of a beautiful blue colour in life. This shark is very troublesome to snapper fishermen on the New South Wales, Victorian,

Queensland, and Western Australian coasts. It grows to a length of 16 feet, and is peculiarly an oceanic or pelagic fish, hardly ever penetrating the estuaries. Like the grey nurse, this species may be found at times in large shoals, "working" schools of fish at sea. (*f*) Hammerhead sharks (*Sphyrna*) of, perhaps, at least three species, are found in the waters of some of the States. The largest kind grows to a length of as much as 18 feet. Great sawfishes or saw sharks (*Pristis*) are common in all tropical estuaries of Australia, and are found occasionally in the southern portions. There are probably three species at least in these waters, all attaining a large size—the largest over 20 feet (including the saw-like snout).

Many other species of sharks, both large and small, are found, including the giant basking shark (*Cetorhinus*); the "whale" shark (*Rhineodon*), an ocean Goliath, which, though harmless, attains a length of probably not less than 70 feet; the thresher shark (*Alopias*), with its flail-like tail; the little saw-shark (*Pristiophorus*), an excellent food fish; the quaint carpet sharks or wobbegongs (*Orectolobus*); the abundant school sharks (*Galeorhinus*), found in each State (but more commonly in southern waters); the goblin shark (*Mitsukurina*), found so far only in the south; the harmless and quaintly-shaped and coloured zebra shark (*Stegostoma*) of the tropical parts; the little cat-sharks (*Parascyllium* and others), whose purselike egg-cases are occasionally found cast up on ocean beaches; the turtle-head shark (*Scymnorhinus*); and the long-snouted dog-shark (*Acanthidium*).

One could add considerably to this list, but the kinds mentioned cover almost the whole range of variation of form and size.

All the sharks are of commercial value, and some are edible. All are suitable for preparation in the dried form for export to the East. (Two distributing emporiums suggest themselves here—Singapore and Hong Kong.) The Australian climate is well suited for open air drying operations, and possibly has no superior in this respect, except perhaps the north of Norway. (See "Fish Drying.")

(*b*) *Rays or Skates.* Rays or skates are numerous, especially in the northern and more tropical parts of the Australian waters. They include many of the finest edible kinds, similar in flesh texture and edible value to the finest of the skates (*Dasyatidæ*) landed regularly at Grimsby, Aberdeen, Hull, and other British ports by the trawlers. These fishes were not consumed locally until the advent of the New South Wales State trawlers, which practically revolutionized fisheries ideas and fish consumption in Australia. Since the year 1915, when these trawlers began their work, millions of pounds weight of rays and skates (the names are practically synonymous in England as here), mostly of the genera *Dasyatis* and *Urolophus*, were consumed by the public. With the fillip given to fish consumption by the State's enterprise, inshore fishermen found a demand also for the rays taken by them in the course of their work in the coastal estuaries. The demand has also found some reflection in Victoria and Queensland, and particularly in the former State, where so-called "trawled skate" were sold in the Melbourne shops. The fish was not trawled, of course, but was caught by local fishermen.

Skates of the genus *Raia* (well known in England) are also taken by the trawlers, but they are, commercially, not so valuable as are several kinds of stingrays.

At present, New South Wales is the only State possessing deep-sea fishing vessels working the otter trawl, and there private enterprise is carrying on the work initiated by the State.

Disregarding for the moment their economic importance, one may mention a few of the more striking among the group of the *Batoidei*, to which the edible rays and skates belong. First, the numb-fish, "nummy," or electric ray (*Hypnarce, Narcine, Narcobatus*, and probably others). There are several kinds of this remarkable fish, all possessing natural electric batteries, situated in the head portion, and some can discharge a powerful electric shock. They are found in the waters of each State. The great eagle rays (*Myliobatis* and *Aetobatis*), with their remarkable "pavement teeth," are sometimes called "flying rays," because of their habit of coming to the surface of the sea and dashing out into the air in long flying leaps. With their strong jaws and ivory-like tooth-pavements, they are able to destroy large oysters, crushing the hard shells with ease. Many of the rays have the tail armed with one, two, or three large barbed, ivory-like spines, with which they can inflict a dangerous wound. In the greater rays or skates the tail spines reach as much as 18 inches in length. There are various species of these

stingrays known as " whip " rays, because of the long whip-like tail. Some of the rays approach in form to the sharks. Notable examples are the fiddler (*Trygonorrhina*), and the shovel-nosed rays—principally *Rhynchobatus*, a large kind, mostly abounding in the waters of Queensland, the Northern Territory, and the north of Western Australia, and attaining a length of 10 feet.

(c) *Ghost and Elephant Sharks.* Among the shark-like animals are the extraordinary fishes known as the ghost shark (*Chimœra*), and the elephant shark (*Callorhynchus*). Both are found in the ocean waters of the southern half of the continent. They are highly primitive fishes, dating back in their origin to remote geological times.

In dealing with the Australian fish fauna, precedence has not been given to the sharks and rays because of any outstanding importance, since they form relatively but a small portion both by kinds and total bulk. It is usual, however, in discussing any faunal group to speak first of the most primitive or archaic forms—those from which the great bulk sprang. In this case it has the additional advantage of drawing public attention to a vastly important group, commercially speaking, which people in this prosperous country are generally inclined to pass by with something akin to contempt.

(d) *Teleosteans or Bony Fishes.* The ordinary teleosteans, or, as they are commonly known, the " bony " fishes, are well known to most people through their acquaintance with many common edible kinds. The term " edible," however, requires some elucidation. What is looked upon by one section in Australia as an edible fish may not be regarded as such elsewhere, while fishes which a few years ago were regarded as inedible are now included in the edible kinds. The term " edible " is here taken to include all those kinds which are recognized as such by human beings, because, ultimately, taste has a tendency to become unified. Looked at from this point of view, and excluding the sharks, there are not less than 1,200 edible species of fish in Australian waters. With the exception of a very few examples, it is difficult to draw any hard-and-fast line of demarcation between edible and inedible kinds, but whatever doubt there may be about some kinds they are nearly all commercially usable in some way or another.

In considering the edible fishes, those kinds will first be dealt with which are the regular standby of the markets, rather than the " fancy " kinds. There are certain outstanding groups or families of fishes which loom up as being of the first importance. Among these are the many species of mullet, the flatheads (*Platycephalus*), the whiting (*Sillago*), the garfishes (*Hemirhamphus*), the bream and snapper family (*Sparidæ*), the yellowtail family (*Carangidæ*), the barracouta (*Thyrsites*), jewfish (*Sciæna*), perches (*Serranidæ*), blackfish or ludrick (*Girella*), Australian salmon (*Arripis*), the sea carps or morwongs (*Cheilodactylidæ*), and the mackerels (*Scombridæ*). It must, however, be noted that, although these fishes and some others at present hold pride of place, there is good reason for believing that, as time goes on, and greater fisheries development takes place, many kinds of fishes which at present are of little or no importance in the markets will rapidly come to the fore.

It is impossible, within the limits of the present article, even to mention by name those fishes which are of greater or lesser importance, or the many extraordinary kinds which are of great interest to the student because of some outstanding feature in structure or habits.

Attention may also be drawn here to the highly confusing vernacular nomenclature applied to fishes in different parts of Australia.

The most important individual fish at present is the large mullet (*Mugil*), known as the sea mullet in New South Wales, Queensland, and Western Australia, and as the sand mullet in Victoria. Immature varieties are known variously as hardgut mullet (New South Wales), mangrove mullet (Queensland), and poddies (Victoria). This species occurs in the waters of every State as well as in those of the Northern Territory, but is specially abundant between the latitudes of 25° S. and 37° S. Where it does not occur in great abundance its place is frequently taken by one or other kinds of mullet, with which the inshore waters abound. Millions of pounds weight of this fish is marketed, and finds a ready sale at all times of the year. In addition, it is not only a fine canning fish, but lends itself well to smoking, pickling, and drying, while the large roes make an excellent caviare. The roes are obtained principally in the months of May and June, when the fish leaves its quiet up-estuary feeding places and puts to sea for the purpose

of spawning. The egg is a pelagic one, less than 1 mm. in diameter. At the period of spawning, the mature fishes are four years old, and average from 14 to 16 inches in length for the males and 18 to 22 inches for the females. Later on in the development of the fisheries the sea mullet should bulk largely in the ocean (surface) fisheries, as well as in the inshore work. The shoals are frequently of enormous magnitude, and thousands of basketfuls might be taken with nets of the type of the purse-seine. The spawning fish always travel in a northerly direction. This is no "grand migration," however, but is merely a short northward movement to compensate for the southerly drift of the pelagic eggs and fry. Very few of the adults ever return to the estuaries, but are destroyed by the shoals of sharks, kingfish (*Seriola*), etc., which harass them from the moment of their adventure into ocean waters.

Other kinds of mullet that are specially worthy of mention are the flattail or fantail (*Liza*), often known in the waters of Queensland as tiger or tygum mullet. It is a much smaller kind than the sea mullet. The sand mullet or tallegalane (*Myxus*) of New South Wales is another small species. The yellow-eye mullet (*Agonostomus*) is widespread around the southern shores, and is known under a variety of titles, such as sea mullet (Victoria), Swan River pilchard (!) in Western Australia, estuary mullet in Tasmania, and herring in New Zealand. Among the tropical kinds of mullet are the large diamond-scaled mullet and the green-backed mullet, both well known in Queensland, the Northern Territory, and north of Western Australia. They are found as far south as the New South Wales coastline, but not in great number.

Among the sparoid fishes there are many fine and useful examples. The yellow-mouthed and red-mouthed snapper (*Lethrinus*) of the north are striking examples, and the well-known bream or "black" bream (*Sparus*), which is found in every State, and esteemed both as a food and sporting fish. The most famous of the fishes of this family is the beautiful snapper (*Pagrosomus*), frequently misspelled "schnapper." This is a splendid fish, attaining a large size, of fine edible qualities, and having, with the Murray cod (*Oligorus*), the sole (*Synaptura*), and some of the flounders, the distinction of being the highest-priced fish in Australia. This does not mean that it is necessarily the best, as popular predilection plays a large part in food-fish preferences. The snapper is very widely distributed in Australian waters. Though it is not unusual to find the fish in small numbers in deep open estuaries (young fry or "cockneys" are regularly found there), it is really an ocean species, frequenting in large numbers sunken reefs and rock bottoms. The snapper is not, however, restricted to such localities, as great schools go roving in "open formation" over sandy, gritty bottoms. There is reason for considering that it is one of the most abundant of Australian fishes, though one would not suspect it from the amount brought into the markets of Australia. A large quantity of snapper has been taken by the New South Wales trawlers on the trawling grounds already discovered, and there is no doubt that vast catches will be made by this method of fishing in the future. Great hauls are made by line fishermen working from small tugs at sea, as many as 800 and 1,000 fish, averaging 3 to 5 lbs., having been taken in a few hours. Snapper is in great demand in restaurants in Australia, so much so, in fact, that substitution of other kinds by unprincipled chefs and others is commonly practised, and many a humble jewfish and mullet is born to end its days as a "snapper."

The Australian salmon or "buck" (salmon trout of Victoria, kahawai of New Zealand) is an "outside" beach-frequenting fish, occurring in prodigious numbers. Though not a first-class edible fish, it is already in great demand, particularly in Victoria, where the choice of good edible kinds is not as yet so wide as in New South Wales, Queensland, and Western Australia. In New South Wales, where a few years ago it was difficult to dispose of it in any quantity, the fish is bringing good prices. During midsummer, the salmon (not a true salmonoid by the way) congregate in schools for spawning purposes. They are then readily captured off the beaches and at the mouths of the estuaries. The quantities at present taken, however, are trifling compared with the available supply, and the salmon is sure to come into a most prominent position in the future. It cans well, gaining great "sweetness" in the process, and "takes the smoke" nicely. It commonly grows to a weight of several pounds, and, being remarkably uniform, is a good trade fish.

The smaller and closely-related "roughy," so often seen in the markets of South Australia, Victoria, and Western Australia, is also a good fish, but not of the economic importance of the salmon.

Just as the mullets are the characteristic fishes of the shallow estuarine waters, so are the many kinds of flathead typical of the bottom or deep-water fish fauna. This applies to both inshore and outside fishing. There are at least a score of species of these valuable food fishes, of both present and future importance in sea fisheries. White and firm of flesh, they find a ready sale in all the Australian markets. Undoubtedly the finest, from an edible stand-point, is the kind now known in New South Wales as the tiger, "deep-sea," or "trawled" flathead. Until the advent of the State trawlers in New South Wales, this fish was rarely seen in the markets. A few were taken by long-line fishermen at sea, but since 1915 many millions of pounds weight have been brought in and distributed. The average weight of the mature tiger flathead—about 2 lbs.—makes it an excellent table fish. The flesh is thick, juicy, and white; the sections (myotomes) coming away in large flakes. Though this fish appears to be most abundant off the New South Wales coast, in depths ranging from about 120 feet to about 480 feet, it has been taken in quantities off the coasts of Victoria. Later investigation will, no doubt, prove that it occurs over a much greater range than is at present indicated.

The designation of "trawled" flathead has been given to it by many of the public, but other closely related excellent edible kinds are also taken from the same grounds. Where these particular kinds do not exist their place is occupied by other species of flathead, in company, of course, with the many species of fishes, such as John Dory, boarfish, gurnards (*Latchet*), barracouta, cowanyung (horse mackerel, mackerel-scad of Victoria), snapper, leather-jackets, flounder, rock-ling, morwong, and jackass fish (silver perch or bastard dory of Tasmania). The most abundant estuary kind of flathead in New South Wales and Queensland is the "estuary" or black flathead, while that of Victoria is the rock flathead. The future use of these fishes will not be confined to the "fresh" condition, in view of their great utility for canning and smoking.

Various kinds of pike (*Sphyræna* and *Dinolestes*) are found in these waters, and are of considerable economic importance, especially in the south. One kind grows to a length of 4 feet in the north. It is probably identical with a ferocious species seen in Malayan waters, which attacks man, and is known to the Malays as Ikan Alu-Alu. The long-finned pike of New South Wales is the skipjack of Victoria, the snook of South Australia, and the Tasmanian jack.

The perch family is represented in Australia by a great many valuable fishes. That which has, perhaps, the greatest reputation throughout the eastern States is the Murray cod, which is plentifully distributed throughout the whole of the system of rivers, creeks, billabongs, and lagoons of the Murray. This fine food-fish grows to a large size rapidly, and specimens of 20 to 40 lbs. weight are abundant. A number reach 60 lbs., while there are rare records of so great a weight as 150 lbs. Having been obliged to establish itself in a section of Australia subject to periodical droughts, it has attained to a condition of great vitality and prolificness. Hence, wherever previously transient waters have been made more or less permanent by the creating of dams, there has been a great addition to the native stock of these valuable riverine fishes. The same remarks also apply to other fishes of the same area. Two valuable perch-like fishes of the Murray River system are the golden perch or yellow-belly (*Plectroplites*) and the Macquarie perch (*Macquaria*). The former reaches a weight of 8 lbs., and occasionally as much as 15 lbs. Like the Murray cod, it is found sparingly in some of the more northerly east-flowing streams.

In the eastern streams of New South Wales, Victoria, and southern Queensland is found a splendid edible and sporting fish in the Australian bass (*Percalates*), a true perch closely allied to the black bass of America. It is very similar to another species—the estuary perch—but may be distinguished therefrom by its more robust build, oval outline, larger tail, and larger eye. Its habits of daily life and of spawning are also different, and the egg is of the submerged or demersal type, as against the pelagic and separate egg of the estuary perch. In eastern Victoria the Australian bass is known as the Gippsland perch. It attains to a weight of 8 lbs., though 2 to 3 lbs. would be a fair average for large mature fish.

The northern rivers of Queensland and of the Northern Territory contain the giant perch (*Lates*), a fine edible fish, which shares with at least two other Queensland fishes the name of barramundi. It grows to a weight of 40 to 50 lbs. The same species is found in the Malay Archipelago.

One of the greatest percoid fishes in the world, the Queensland groper or black cod (*Promicrops*), is found in estuaries and along the coasts of tropical and sub-tropical Australia. It reaches a weight of between 500 and 600 lbs., and is an exceedingly fine food-fish. A near relative of this giant, and itself of large size, is the so-called black rock cod (*Epinephelus*), a sea fish, living in rocky situations, and growing to a weight of not less than 80 lbs. It is often confused with the larger fish.

The well known epaulette fish or pearl perch (*Glaucosoma*), and the "broad-arrow" marked Government bream (*Genyoroge*), also the Moses perch of Brisbane River, the impetuous wirrah (*Acanthistius*) of the rock fishermen, the quaint old wife (*Enoplosus*), and a whole host of other food-fishes of great present or potential value, are all members of the perch family which is specially well represented in Australian waters.

The well known blackfish of New South Wales (ludrick, black perch, and rock perch of Victoria, and black perch of Tasmania) is exceedingly abundant and very widely distributed. It is an estuarine fish, attaining rarely to a weight of 6 lbs. While being of great food value, it is one of the finest of saltwater sporting fishes; light tackle and green seaweed bait being used. The port which produces the greatest amount annually of blackfish is Port Stephens (New South Wales). The zebra fish (*Melambaphes*), common in South Australia and Western Australia, the blue fish of New South Wales and Lord Howe Island, the rock blackfish of New South Wales, and the large drummer (*Kyphosus*) are among the many useful fishes of this group.

In this sketch of Australian fishes no attempt has been made to treat the various groups in systematic order, or even in order of present or future importance. In the latter event mention would be made at an earlier stage of the herring family, which is so richly represented in these seas. Concerning several of these, it may be said that a valuable return will be obtained in the not distant future from two or three kinds alone. Of first class importance are the pilchard (*Sardinia*), the maray (*Etrumeus*), the southern herring (*Harengula*), the sandy sprat (*Hyperlophus*), the blue sprat (*Stolephorus*), and the anchovy (*Engraulis*). There are others which, with further knowledge, may prove of equal importance. A diversity of kinds will probably be discovered in the inshore waters of the northern coastline, where the fishes generally approach very closely, and often are identical with, those of the Malay Archipelago.

The pilchard occurs in vast shoals in the ocean waters close to the coasts of the south-eastern and eastern parts of Australia. Shoals 30 miles in length have been met with on the coast of New South Wales, and, at times, enormous numbers are driven on to coastal beaches by the harrying shoals of kingfish, salmon, and sharks. Calder, in the Proceedings of the Royal Society of Tasmania, mentions a shoal having been driven ashore at Simon's Cove, Bruni Island. There were at least 100 tons actually on the shore, and 200 tons more suffocated in the water close by. Some years ago, one of the Inspectors of the New South Wales Department of Fisheries reported that a shoal of pilchards had been driven up on a beach near Wollongong. They formed a mound 2 feet in height for over 2 miles. This type of fish is already so well known in commerce that it needs no further description here beyond saying that it is a true sardine (from 6 to 9 inches long), and is already handled in great quantities in both Japan and California. Australia imports a very large quantity of the fish annually in the canned state from Japan and the United States, yet, judging by published records, neither of the last-mentioned countries has anything like the natural stocks of the fish that Australia possesses.

Incidentally, one may urge here the advantages which would accrue from the resuscitation of a Commonwealth Bureau of Fisheries to carry out investigations in Australian seas, both as regards the utilization of aquatic products for food purposes and in the industries. The work of such a Department would be valuable not only to the people of Australia, but would make known to the world the excellent prospects for fisheries in Australia.

The remarks concerning the pilchard may be taken in a general way as applying to the other species specially mentioned. The blue sprat, comparable in every way to the Norwegian brisling, sardine, or sild, is present in the entrance waters and in the shallows over sandy coastal beaches for a length of at least 2,000 miles of coastline. At spawning times this fish swarms in the ocean waters, keeping usually a few feet below the surface. Its capture would be effected in the same way as that of several other of the herring

species by the use of the purse-seine net, as is the case in Norway, Japan, and the United States. The sandy sprat also is widespread, and is equally good for canning purposes, having a most delicious flavour and inviting appearance. It is a little larger than the blue sprat. The anchovy is found abundantly in the waters of every State, mostly occurring at some distance below the surface or on the bottom. It is like the well-known Mediterranean anchovy, and commercially may be treated similarly. The southern herring in its young and half-grown stages commonly occurs in the estuaries (very abundant in Port Stephens). It grows to a length of about 8 inches. At 5 inches in length it is particularly valuable for canning in oil like the French sardine. The maray, though widespread, is chiefly known in the southern portion of its habitat. Large quantities are seen from time to time in Melbourne. It is a sardine, probably of equal value to the pilchard, and appears to be principally distributed around the coastline south of 35° S. latitude, covering a distance of several thousands of miles.

In the herring family there are some giant species of great economic importance, but not comparable in value to the small kinds just mentioned. Among these are the giant herring (*Elops*), growing to 4 feet in length; the Australian tarpon (*Megalops*), the milk-fish or salmon-herring (*Chanos*), and the lady-fish (*Albula*). These become more abundant in the tropical parts, and are distributed over about 8,000 miles of coast.

Of hardly less significance in future fisheries, and of present great importance, are the mackerels, embracing many species, from the little mackerel to the great tunny and Spanish mackerel. The mackerel, like the pilchard, is already well known to Australians, who import it from Japan and California, not realizing nor caring that it is the same fish precisely that is caught at times in such large numbers in Port Jackson and other open ports. The Spanish mackerel is more familiar to the people of Brisbane, many such fishes being sent to that city from Tweed Heads (New South Wales). There are at least six species, all fine sporting fish. Bonito, little tunny, New South Wales horse mackerel, frigate mackerel, and others are all abundant in Australian seas.

In the yellowtail family there are very many valuable commercial fishes, viz., the kingfish of New South Wales (yellowtail of Victoria), reaching a length of 6 feet, the trevally (silver bream, or "silver," of Victoria), the queen-fish of Queensland, and the Victorian horse-mackerel (cowanyung of New South Wales). In the aggregate a large quantity of each of these is handled annually by Australian fishermen, but, compared with the possibilities, the total is infinitesimal.

The Australian whiting is famous for its fine edible quality. There are several species, of which the sand whiting of Queensland and New South Wales is possibly the finest. This fish attains to a weight of 2 lbs. The school whiting is particularly a trawled fish, commonly taken by the State trawlers of New South Wales in depths down to 80 fathoms. Towards the south of Australia it is found at gradually lessening depths—a matter of temperature—and on the southern coasts and in Tasmania is taken with shore-drawn seine nets. The spotted whiting is the longest, and is more particularly a southern fish. The trumpeter whiting, though found commonly in New South Wales estuarine waters, is more abundant in the tropical parts. These whitings, it may be noted, are not members of the cod family, as are the European varieties. The Australian beardie or ling, and the red cod are two prominent members of the true cod family, but are not of great importance.

The jewfish, closely related to the maigre of Europe, a fine fish, growing frequently to a weight of 60 lbs., is greatly sought after, and is abundant in many places. It is the kingfish of Victoria and the butter fish or mulloway of South Australia. The so-called jewfish of Queensland is a different kind, while that of Western Australia is a kind of pearl perch (*Glaucosoma*).

The morwongs or sea-carp, not in any way related to true carp, are represented by a number of valuable food fishes—notably the morwong, the jackass fish (silver perch of Tasmania, tarakihi of New Zealand), the magpie perch (*Goniistius*), the tillywurti (*Dactylophora*) of South Australia, and the sea-carp (*Cheilodactylus*). Though these have usually been looked upon as line fish, they may be taken with the trawl net. This applies specially to the jackass fish, of which the New South Wales trawlers have taken as many as 80 baskets (6,000 lbs.) in one haul. The nearly allied trumpeters—"bastard" and "real"—are large fishes of value, found in the southern waters, the Hobart Town trumpeter being an exceptionally fine fish.

The silver perch or grunter (*Therapon*), which often grows to a weight of 3 to 5 lbs., is a good fish inhabiting the Murray River drainage area. Related to it is a little fish called the bobbi, which is very common in the warm and saline drains associated with the artesian bores of inland Australia. It has been taken from drains in which the temperature was in the vicinity of 100° F. The Queensland trumpeter or javelin fish (*Pomadasys*), and the sweetlips (*Plectorhynchus*) of the more tropical waters, among many allied kinds are of considerable local importance.

In the scorpænoid fishes, of which one of the best known is the red rock cod (*Scorpœna*), there are several kinds of economic importance. Some are taken with the trawl in moderate ocean depths. Others, again, like the eastern Australian fortescue and bullrout, are more remarkable for their poisonous spines than for any edible value.

Among the leatherjackets or trigger-fishes are very many useful kinds of edible fish. Some, like the great yellow leatherjacket or "Chinaman," are of the first importance, being taken at times in great quantities by the trawlers. Mention of trawling calls to mind the splendid John Dory, which has been proved by the trawlers to exist in immense numbers in depths ranging from 20 to 75 fathoms.

While one must, of necessity, pass by many very important kinds, mention must be made of the flounders and soles, and the gurnards. Both groups are very well represented in these waters. The best of the many flat fishes are the Queensland halibut (*Psettodes*), the southern flounder (*Rhombosolea*), and the black sole (*Synaptura*). The former will probably be of importance in later operations in the tropical waters from Moreton Bay round the north to Shark Bay in Western Australia. The gurnards or gurnets, bottom-dwellers, like the flat fishes, are numerously represented by splendid white-fleshed fishes of great economic value. The New South Wales State trawlers were the means of introducing millions of pounds weight of two species—the red or kumu gurnard and the sharp-beaked gurnard. The latter is the more important, and grows to a weight of several pounds. On one day, three trawlers landed as much as 230,000 lbs. of this fish from grounds only an hour's steam from Sydney. There is a great opportunity for building up an export trade in a type of fish well known and greatly esteemed on the London (Billingsgate) market, besides satisfying the demand in Australia for fish fillets (fresh and smoked), a demand which at present is largely met by the most inferior kinds of so-called "Scotch Fillets of Haddock," which have been dipped in annatto and boric acid under the pretence of smoking. These imported fillets are mostly of two kinds—dog fish or flake and, more commonly, the much despised, slimy "cat fish" or "wolf fish" of the North Sea.

The parrot fishes, which occur all round Australia, furnish many important food fishes, such as the blue and brown groper (*Achœrodus*) of New South Wales. With the exception of a few outstanding kinds, this type of fish is chiefly represented in the tropical parts, notably the Great Barrier Reef area.

Among the commercially-valuable kinds strange and bizarre fish forms are found, as well as fishes with quaint and wonderful habits. The nest-building fresh-water cat-fish —a good edible fish; the freakish sea-horses and pipe fishes, in which the male wet-nurses the fry, and actually carries the eggs round after the female has deposited them; the immense ribbon fish (*Trachypterus*); the artful angler fishes; the shark's faithful attendant—the sucking fish; the curious viviparous weed-like blennies (*Cristiceps*) of the seaweeds and rocks; the little pigmy perch (*Amia*) of Port Jackson, which hatches the eggs in the mouth—these, and many others, suggest themselves in a cursory survey of Australian fish fauna. One of the strangest of all is the Queensland lung fish—the "real" barramundi, perhaps, although the huge scaled and archaic Cooktown "salmon" (*Scleropages*) also claims the name. In tropical and sub-tropical estuaries is found one of the most extraordinary examples of parental, and, in this case, paternal solicitude for eggs and young. Here the salmon cat-fish (*Galeichthys*) takes the great eggs—neglected by the female fish after extrusion—into its mouth (or buccal cavity generally) and there hatches them. Not only is this done, but the fry are allowed to swim in and out of the mouth until they are about 2 inches in length.

In conclusion, mention may be made of two of the strangest of nature's adaptations amongst these fishes. There is first the banded fish (*Amphiprion*) of the Great Barrier Reef, which actually seeks and finds a safe refuge in what is a most terrible embrace to other fishes—the stinging folds and mouth cavity of the gigantic sea-anemone—and,

secondly, the little *Fierasfer*, which commonly lives in the intestinal cavity of one of the holothurians (*Trepang*), and sometimes safely ensconces itself in the mantle of the pearl oyster.

12. **Fish Acclimatization.**—Though this article aims chiefly at the furnishing of information relative to the indigenous fish fauna, a little information in regard to introduced fishes will possibly be of value.

In a country like Australia, which has suffered more through the depredations of non-indigenous animals and plants than any other, the word "acclimatization" is largely anathema. It is pleasant, therefore, to be able to record that great success has attended efforts at acclimatization of certain species of fishes. The most notable is the work carried on by Tasmania, New South Wales and Victoria in the introduction and cultivation of the Californian rainbow trout (*Salmo irideus*), which is now abundant in many parts. The European brown trout (*S. fario*) has also succeeded well, but is not so adaptable as the rainbow. To a smaller extent the American brook charr has become acclimatized in Tasmania. Atlantic and Pacific salmon have been experimented with, and various other kinds. Against these useful fishes there is, unfortunately, almost throughout the entire country the little goldfish and its varieties, a veritable "rabbit" of the waters, and an utterly useless river-muddying fish. How it was first introduced is not known. The English perch, another comparatively useless fish, is abundant in the Murray waters.

Some attempts have been made at acclimatization of sea fishes. Most noteworthy were the efforts to introduce the plaice some years ago in New South Wales—a remarkable procedure in view of the vast indigenous fish fauna of the State.

13. **Edible Crustaceans.**—(i) *General.* Australian waters are exceedingly rich in edible crustaceans, but limits of space will permit of only a very brief reference to them.

(ii) *Crayfish or Lobsters.* Marine crayfishes or spiny lobsters (*Palinurus*) of several kinds are found in one or other of the waters wherever there are rocky or firm bottoms. The southern crayfish occurs, as its name suggests, around the southern shores, and most abundantly in Tasmanian waters. The common green crayfish, abundant in New South Wales waters, grows to a weight of as much as 14 lbs. Other forms are found in the tropical parts, and are very beautifully marked. From 90,000 to 100,000 of the green crayfish are taken annually on the New South Wales coast, chiefly in the neighbourhood of Port Stephens and Seal Rocks.

(iii) *Prawns.* Prawns of fine size (belonging to the genus *Penæus*) abound in Australian waters north of about 36° S. latitude. The tiger prawn grows to a length of 12 and 13 inches, and is more abundant in Queensland, though often met with on the New South Wales coast. The king prawn, so abundantly seen in Sydney, grows to 8 or 9 inches in length. There are many other kinds, all of edible value. About 400,000 lbs. weight of these valuable crustaceans is handled annually in New South Wales alone.

(iv) *Crabs.* There are several important edible crabs, and many others not at present consumed would be regarded as edible in other countries. The principal are the large mangrove crab or black crab (*Scylla*), abounding to the north of 32° S. latitude and the swimming crabs of the genus *Lupa*. This kind, which is abundant in many Australian waters, is the exact counterpart of the crab which is so sought after in the United States.

(v) *Freshwater Crayfish.* In the inland rivers is found the Murrumbidgee crayfish or Murray lobster (*Astacopsis*), a huge-clawed crayfish, which grows to a weight of several pounds. Large-sized shrimps (*Palæmon*) are also found in abundance.

14. **Edible Molluscs.**—(i) *Oysters.* Of the vast edible molluscan fauna of Australia, there is only one species which has so far reached a position of commercial importance. This is the 'rock oyster" (*Ostrea cucullata*). There are other kinds of oysters, and perhaps some geographical varieties of this particular species, but none has attained to the eminence of the so-called rock oyster (not necessarily grown upon rocks) in New South Wales and Queensland. The cultivation of the edible oyster has progressed most rapidly in New South Wales, followed closely by Queensland. The Government leases or issues licences for areas used for oyster cultivation, and the trade has already reached large proportions. It has been stated previously that there is an approximate annual output of about 48,000,000 oysters from New South Wales. The figures for Queensland would

be approximately 22,000,000. There is little production in the other States; but Victoria could resuscitate certain fished-out waters, and add largely to the original stocks. With a larger population, Western Australia will develop an edible oyster fishery. In the case of South Australia also, considerable development may be expected.

(ii) *Other Edible Molluscs.* In addition to oysters, other molluscs are consumed in Australia. In Melbourne, mussels find a ready sale, also certain kinds of cockles, whelks, winkles, etc. Mutton fish or ear-shell (*Haliotis*)—the abalone of California—is also frequently sold.

Of the naked molluscs (those without shells), the octopus and certain cuttlefish or squids are sold sparingly. Australians have not yet learnt to value these sea-products, which are so highly esteemed in other countries. In some cases octopus is cooked and served up as "lobster" (which it closely approaches in flavour) in salads, patties, etc.

15. **Fish Canning.**—In previous pages the value of particular kinds of Australian sea fishes for canning purposes has been touched upon, and some indication will now be given regarding the prospects in Australia for fish-canning generally. Attention has been drawn to the abundance in these waters of pilchards, maray, anchovies, and sprats; to the shoals of mackerel and other surface-swimming fishes; to the prodigious quantities of gurnard and other bottom kinds—all of which are eminently suited for canning, both for home consumption and for export. Australia is continuing to import in cans kinds of fishes already found here, probably far more plentifully than in those places whence they are sent. In addition, thousands of cases of inferior grades of American salmon are imported annually at heavy cost. Notwithstanding the possession of a fish fauna of remarkable abundance and variety, nearly £1,000,000 worth of fish is imported yearly. It should be possible for Australia not only to supply its own needs in fishery products, as is the case with jams and preserves, but to develop also an export trade, particularly with Asia. Canada is already doing an immense business with China, and there is in Australian waters an abundance of fish (and of other sea foods) which the Chinese and other Asiatic nations fancy. In a number of cases, Australia possesses the identical fishes and crustaceans which they themselves are handling, and for which there is an unlimited sale. The modern fish-cannery may be put down in units which are not individually costly, either by way of prime capital outlay or running expenses. They are not difficult to handle, and, beyond a little experimentation with individual kinds to meet varying needs, and ordinary experience, there is no aspect of the business which could not readily be grasped by Australians who are familiar with the canning of other local products. The question of fish-canning has never yet been seriously tackled here. Small plants have been established at various times in New South Wales, Queensland, and Western Australia. They were of different type, from the most antiquated to some that have been fairly modern; but in each case the fish preserved was of the estuarine type, and the cannery depended entirely, or almost so, upon arrangements made with individual fishermen for supplies. This method is unsatisfactory, and the prospective canner must take the matter up wholeheartedly, make his own arrangements for fish capture on a large scale, and have substantial financial backing. It goes without saying, also, that the product must be properly graded and true to label.

16. **Fish Drying.**—With a suitable climate for the rapid dehydration of fish, with shoals of the right kinds of fishes, and with about 800,000,000 potential Asiatic consumers within reasonable distance of these shores there should be ample scope for the successful establishment of the dried-fish industry in Australia. In this connexion it may be noted that Singapore alone handles about 200,000,000 lbs. of dried fish per annum, and six Chinese (Teochiew) merchants in that city informed the author that if Australia sent the supplies they could handle approximately 20,000,000 lbs. each of assorted dried fish, with the prospect of greatly adding to that amount as supplies were available.

17. **The Whaling Industry.**—Very early in the history of New South Wales, whaling operations in the old style, *i.e.*, by sailing vessels, principally seeking the southern right whale, were carried out from ports of south-eastern Australia. The chief centre was Boyd Town, in Twofold Bay. After a time operations ceased, and the business languished and finally died out, except for a little spasmodic shore work at Eden, and the taking of an occasional whale at Norfolk Island. The work at Eden had always been carried out

under the most primitive conditions, and, had there been no killers to drive the whales, mostly finbacks, inshore, would have been non-existent. The whole take amounted to eight or ten whales only per annum.

In more recent years, however, there was a revival of whaling under modern conditions, using up-to-date steel boats of about 120 feet in length furnished with whaling guns. These vessels had great success, both in the waters of New South Wales, with a base at Jervis Bay, and in Western Australia. The war, however, interfered with the prosecution of the industry by the expert Norwegians who had the work in hand, but lately some attention has been given to the question of its renewal.

During their short sojourn in Australian waters the Norwegians captured many hundreds of finback whales of the following species:—Humpback, black finback, sulphur-bottom (blue), seivhal, and little pike whale. A few black or southern right whales were also taken, and a number of valuable sperms. Out of the latter a large amount of ambergris was obtained. At Jervis Bay a sperm whale, which supplied but little blubber or spermaceti, yielded a piece of ambergris which was sold in London for £12,000.

The principal season for the pursuit of finback whales on the Australian coast is from June to October. After that period the sperm whales and black whales may be hunted in the southernmost parts.

The products of the industry are whale oil, from which margarine and other by-products are made, spermaceti (sperm head oil), whalebone, whale beef (for canning), guano, ivory and bone products, whale leather, and ambergris.

18. **Trawling in Australian Waters.**—As mentioned earlier, trawling is carried on successfully by private enterprise off the coast of New South Wales on fishing grounds discovered with the vessels of the New South Wales State Trawling Industry.

The Government operations started in May, 1915, with three trawlers (of the "Castle" type), which were built in England. Later, owing to the large demand for trawled fish, the construction of four more vessels was undertaken by the Government Dockyard at Newcastle. Owing to the war, however, the latter vessels did not begin effective operations until 1920. As far as preliminary investigation work is concerned, it may be stated that there had been several early trials, and a small iron trawler of antique pattern and construction had made an unsuccessful attempt to start commercial operations. The only work worthy of mention, however, was that carried out by the "Thetis" in 1898, and the Commonwealth Investigation Steamer "Endeavour" from 1909 till 1914. The work of the "Thetis" was continued for a few weeks only, but it showed that, with suitable vessels and gear, the sea-bottom fisheries could be successfully exploited. Ichthyologically the "Endeavour" produced results of great interest and value; but the vessel was not suitable for the successful operation of the commercial trawl net, consequently on many of the grounds practically "samples" only were obtained, of comparatively little use as indicators of commercial possibilities.

The operations of the New South Wales State trawlers, however, during a period of nearly eight years, revealed some of the richest trawling areas in the world. The same grounds have been worked since the vessels passed into the hands of private individuals. On the accompanying sketch map the two principal fishing grounds are indicated; the first called the "Home" ground, roughly extending from Botany Bay to Coal Cliff, and the second, called the "Southern" ground, extending from Merimbula almost to Cape Howe. The best regular catches have been made in water from 30 to 75 fathoms in depth. Space will not permit of the description of other grounds here, or of the discussion of many aspects of the subject of use to the commercial inquirer and scientific investigator.

19. **Fisheries Investigations.**—The results already obtained show the necessity for a further pushing forward of fisheries investigation. Matters such as the distribution and occurrence of food fishes and other sea food organisms, the most effective and economic utilization of both sea foods, and of those sea organisms or their products and by-products, which may be of use in the industries; schemes for conservation; the harmonization of regulations surrounding identical or allied fisheries; the amassing and dissemination of

general technical and biological knowledge of the fisheries; the exploration of new or little known fishing grounds; the testing of all kinds of fishery appliances; the co-ordination of oversight and of conservation work in the inland fisheries; and the carrying out of propaganda work in regard to fish and sea food consumption generally, are all worthy of attention.

20. **Gear Used.**—(i) *Nets.* The only deep-sea nets in use at present are the otter trawls of the New South Wales steam trawlers. In the inshore fisheries, hauling nets or seines are used for beach work, and set meshing nets are employed in places where hauling is impracticable. Hauling nets are sometimes drawn up out of moderate estuarine depths on to the stern of the fishing boat. There are no drift nets, properly so called, although occasionally some short-length meshing nets are used practically as such. Some hauling nets have deep pockets in the bunt or middle portion, and are sometimes hauled for a part of their course entirely beneath the surface (sunk or diver nets). In inland rivers there are short hauling nets, meshing or gill nets, staked nets of various kinds, and a combined net and trap known as the drum net, of which as many as 8,000 have been recorded from the Murray River in a single year.

(ii) *Traps.* In both sea and riverine fisheries traps of various kinds are used, ranging from fixed devices running from the shoreline into the waters of certain estuaries to small fish traps of wire or twine, and crayfish or lobster pots.

(iii) *Lines.* The lines in use embrace the principal kinds met with elsewhere. Long lines or set lines with many hooks are used in the sea fisheries, and, with shorter lengths, in the inland rivers. Ordinary hand-line fishing for market fish is, in some places, also largely followed. This includes trolling. Set lines affixed to poles set in the banks and called "springers," are used in fresh waters, chiefly for catching Murray cod.

(iv) *Oystering Appliances.* In the oyster fisheries, tongs, rakes, and dredges are commonly used in the raising of oysters from submerged beds. Diving dress is also in use.

21. **Pearls, Pearlshell, and Trepang.**—Figures regarding the production, trade, etc., for these items, so far as they are ascertainable, are given. As regards pearls, for obvious reasons no correct estimate can be obtained of the value of those found. Pearlshell (*Margaritifera*) is widely distributed in North Australian waters over an area facing some thousands of miles of coastline, though not intensively over the whole distance. The north-west beds are the most prolific, but those around and to the north of Cape York are also of importance. There is need for further investigation into the occurrence of this valuable shell, as well as of trochus, green snail, window pane shell (*Placuna*), the various types of trepang or bêche-de-mer (*Holothuria*), both in tropical Australian waters and in those of Papua and the mandated area of New Guinea.

22. **Other Fishery Products.**—Investigation is also required in connexion with the seaweeds, sponges, certain shells (other than those above mentioned) suitable for button-making, the handling of fish-skins (for which there is a large demand in the Middle and Far East), and crocodile skins.