

## SOME POPULATIONS OF THE AUSTRALIAN "SALMON",

Arripis trutta

by

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## ABSTRACT

A preliminary account is given of the investigation of the Australian Salmon (*Arripis trutta*) principally as an examination of the distribution (in all life-phases) of different stocks of the species along the Australian coast, and the taxonomic status of these stocks. Morphological and other evidence is presented to support an hypothesis that the stocks constitute distinct races with separate breeding grounds.

The Australian salmon is a percomorph, and not in any way related to the Salmonidae. The popular name was presumably given to it by the early settlers in this country, on the strength of some superficial resemblances to the true salmon and trouts.

The present paper is only a progress report. The results are not yet fully tested and definite, but it was thought that delegates might be interested as much in the lines along which the work is progressing as in the final results. The story which is emerging is, as a matter of fact, somewhat unexpected; and it is of considerable interest to workers in Australia.

The subject is that of raiation.

In the so-called Australian "salmon" we have a common, well-known species, of which there are several very full taxonomic descriptions. Yet when we come to investigate it, we find that an apparently homogeneous and continuous stock is divisible into two distinct subspecies; and one of those subspecies is probably further divisible into two separate populations. The morphologic differences which we have found between the populations are of standard taxonomic characters, which however the early taxonomists apparently overlooked.

An idea of the appearance of the fish can be got from Plate 2 (upper).

In general the species is used for canning. It is not greatly fancied as fresh fish.

There are two main fishing centres—namely in the south-east and the south-west corners of Australia. The fishery in the south-east is capable of producing about 4 million pounds a year. The fishery on the south-west is of quite recent development, and last year the production was 5½ million lb.

Australian salmon occur in large shoals, usually close inshore. They have the habit of coming close into the beach while in these shoals, especially in certain localities, and it is then that the fishermen catch them.

This is usually regarded as an onshore species. Shoals are not commonly sighted beyond the continental shelf; but there are reports, apparently reliable, of salmon shoals being sighted, and specimens caught, well out in the Tasman Sea.

Figure 1 shows the general world distribution of the species. In Australia it extends up the east and west coasts to about latitude 30°S, though occasionally it is taken very much further north. There is a large, and apparently quite untapped, population of salmon in New Zealand. It occurs also in the waters around Norfolk Island and Lord Howe Island.

When the present investigation was started in 1947 it was believed—for want of contrary evidence—that the salmon of south-east Australia were probably all of one stock, probably distinct from the salmon of south-west Australia. It was believed that the Western Australian fish were in some way different from those of the south-east because of geographical separation, and because the salmon of the south-west are very much larger, and the scales indicate a very much faster growth-rate.

*The first and most important discovery of the present investigation* was that the salmon from south-west Australia have fewer gillrakers than the salmon of New South Wales. The Western Australian salmon have 25 to 30 gillrakers, and the New South Wales salmon have 33 to 38. Each group shows a spread of about 5 gillrakers, but there is no overlap and, in fact, there is a sizeable gap between the two groups.

This shows that there is indeed a definite difference between the salmon of the west and of the east.

Following quickly on this discovery it was found that some of the juvenile salmon from Tasmanian and Victorian waters also belonged to the group with the low count. In other words, they were distinct from the salmon of New South Wales.

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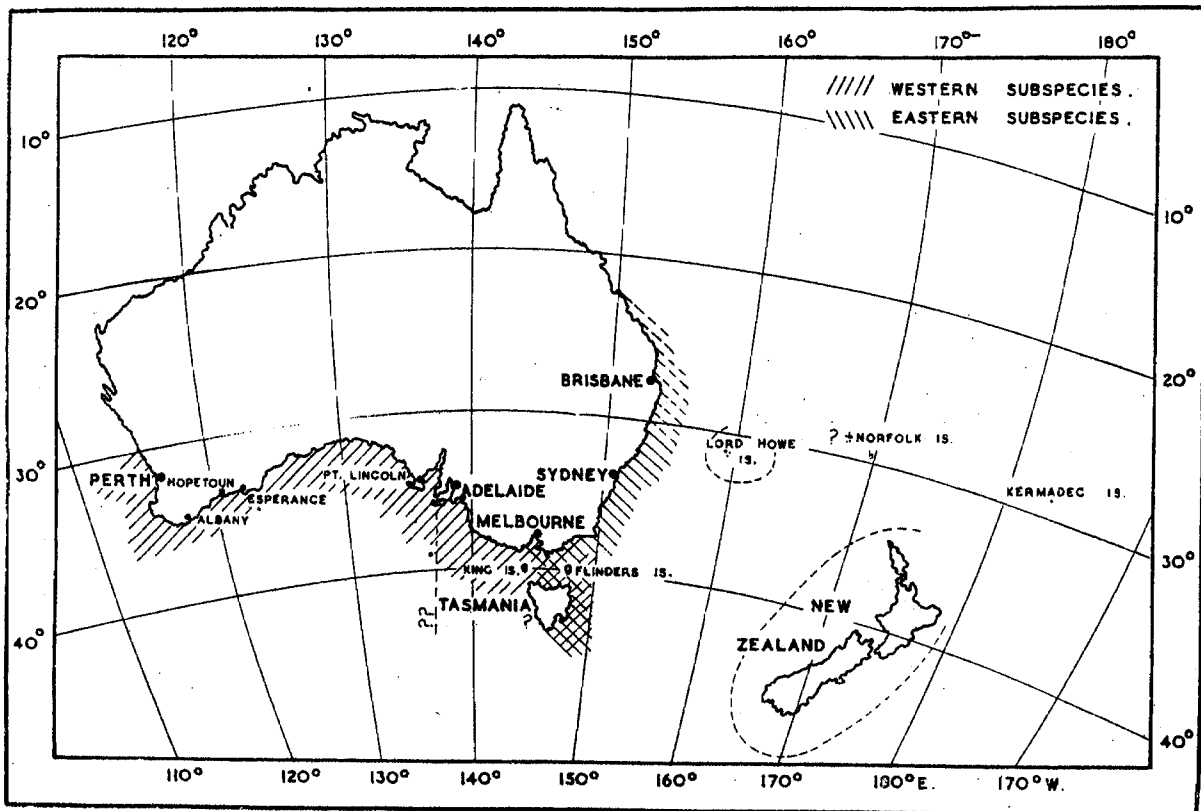


Figure 1

(Hereafter, these groups will be referred to as the western and eastern subspecies—the western subspecies has 25 to 30 gillrakers, and the eastern has 33 to 38. These juveniles of the western subspecies which are found in the south-east of the continent, were fish of from 6 cm. length (mere fingerlings) up to 30 or 40 cm. in length (at which size they are several years old). It was found that in Tasmanian and Victorian waters, and in Bass Strait generally, the two subspecies often occurred mixed in the one shoal. Such shoals might be preponderantly of one or the other subspecies.

In Figure 1, the distribution of the eastern subspecies is distinguished from that of the western subspecies by hatching, and the area where the mixed shoals occurs is shown similarly. There is no information yet from the west coast of Tasmania. Though it is known that there are salmon there, it is not known to which subspecies they belong. The zone of mixing of the two subspecies in Victorian waters—between Wilson's Promontory and the south-east corner of the continent—is of some interest. It happens to be the approximate division between two previously well-established zoogeographical areas.

The next step in this work was to obtain samples of salmon from New Zealand and from Lord Howe Island. It had been effectively established by the work on the gillrakers that there was no appreciable interchange between the stocks supporting the fisheries of the *south-east* and of the *south-west*, but it was possible that there was interchange between New Zealand and New South Wales waters.

Two good samples of New Zealand salmon (about 50 fish) were obtained; and a small sample was obtained from Lord Howe Island (about 10 fish). Unfortunately it has so far been impossible to get any fish from Norfolk Island. The samples obtained were compared with New South Wales specimens by means of 18 proportional measurements, and by counting scales, fin-rays, vertebrae and so on.

Though there were so few in the sample from Lord Howe Island, it was apparent that one had to do here with a very different looking fish. The head was shorter than in the others, and the body was much stouter; in addition, the flesh was extremely oily. Oil is very low in Australian salmon at all times of the year, and was low in both of the New Zealand samples. All these characteristics of the Lord Howe

Island fish point to good feeding and fast growth, and that conclusion is confirmed by the scales. Of more importance, it was found that the gillrakers were substantially different in number in comparison with the finding for the eastern subspecies of Australia: they varied between 36 and 41, and this feature seems to distinguish the Lord Howe Island salmon from all others.

The New Zealand salmon were much less distinct from the New South Wales stock than were the Lord Howe Island salmon. However it is almost certain that they are distinct from the New South Wales salmon, because there was a difference of about 1 scale in the girth and about 0.34 in the dorsal ray counts. The material is not yet full enough to eliminate any chance that *sex* and *year-group* may be affecting these meristic counts; but the data do show that if either variable has an effect, it is not of such magnitude as to invalidate the differences in the girth scale count.

The proportional measurements have not yet been tested statistically, but there *appears* to be absolutely no difference between the New Zealand and the New South Wales salmon. The two are undoubtedly very closely allied. There are considerable differences, as stated above, between the New South Wales and the Lord Howe Island salmon, mainly involving the short head and the great girth of the Lord Howe Island fish. Such differences are not necessarily genetic, but might be merely the effect of particularly good conditions in the waters around Lord Howe Island. However there are other differences, such as the *length of the anal fin* and the *diameter of the eye*, which do not seem to be merely the effect of good feeding, but probably mark off the Lord Howe Island salmon as a separate breeding population from the other groups studied here.

Further samples were obtained from Western Australia and, after some difficulty, several dozen specimens from South Australia.

It should be pointed out that all along this study has been hampered by the fact that this species has a very wide distribution. It is usually sporadic in its appearance, and its distribution covers some completely uninhabited stretches of coastline.

As previously stated, there are two centres of the fishery, south-east and south-west. In the south-west, the roads all run inland and not coastwise, and the coastline is desolate. East of Esperance there is nothing but desert. From Adelaide to Melbourne is also sparsely inhabited, with no salmon fishery. The west coast of Tasmania is very desolate, with no fishery. There are therefore many gaps in the records of the species which must be filled in by supposition, or at times by fewer samples than one would like.

The South Australian specimens came from the "Gulf" area. It was found that they agreed very closely with the samples from Western Australia in everything but the girth scale count—and that apparent difference may prove not to be significant when larger samples are obtained.

Even more significant perhaps, was the *growth-rate* of the South Australian salmon, as shown by their scales. The faster growth and larger size of the West Australian salmon, compared with the New South Wales salmon, has been previously mentioned. Though the South Australian fish were young—mostly 2 and 3 year olds—their scales showed a growth-rate that agreed very well with the West Australian salmon.

We may now examine the tables of gillraker counts, girth scales and dorsal rays. These figures do not embrace all the material available, but have been drawn up simply for the purpose of illustration. It must be emphasized that the work is to be regarded as very incomplete as yet.

The samples in this table have been divided up into the possible or suspected discrete populations.

It will be seen that, as far as gillrakers are concerned, there is no doubt about the break between the eastern and western subspecies. There is probably no significant difference between New Zealand and New South Wales, nor between Western Australia, South Australia and south-east Australia.

There is a single instance of a salmon with a high gillraker count taken in Western Australia. Presumably there is *some* admixture between the two subspecies. They have very similar habits, and no doubt cross-breeding might occur between isolated specimens and the main body of fish.

These tables also give the distribution of the two other meristic features which show variability.

Taking the dorsal rays first, the material obviously falls into two groups, corresponding with the two subspecies distinguishable from the gillrakers.

The girth scales, however, are separable into three or four groups. The West Australian counts may or may not be significantly different from those of South Australia, but are significantly different from the eastern sub-species. The New Zealand samples also differ significantly from those from Australia.

Again it is necessary to stress that this material has not yet been fully tested to determine whether age—or year-groups or sex—are causing slight difference between means. But it is known that these factors are not causing large differences, such as are apparent in these tables.

The other obvious meristic features were also counted—vertebrae, and the other fin rays and

spines—but all showed great constancy and little likelihood of being useful. Some other scale counts were made—above the lateral line, and around the caudal peduncle; they seemed to show parallel variation with the girth scales, but because the girth scales could be counted with greater certainty, the other scale counts were neglected.

So far, this paper has been concerned mainly with the taxonomic characters by which the various subspecies and populations may be revealed in this species. But there is a mass of rather scattered information concerning habits, migrations, distribution of young, and so on, which all falls into place if interpreted in the light of the foregoing results.

First of all, in New Zealand it is known there are large numbers of salmon fry which are seen at times in shallow water. This is pretty conclusive evidence that the salmon spawn in New Zealand waters. The same is probably true of Lord Howe Island, where young salmon are taken from time to time. Since the salmon are also known to spawn in New South Wales waters, this is confirmatory evidence that the New Zealand salmon are distinct and independent of the New South Wales stock. As mentioned earlier, there are reports of salmon shoals half way across the Tasman Sea, and it may be that there is some exchange between the populations.

The adults of the eastern subspecies undertake a rather scattered migratory movement. They spend winter and spring in New South Wales, and in summer and autumn move south. They spawn off the southeast corner and apparently move further south, but subsequently move north. The fry are carried south in the current. The Tasmanian waters are the nursery ground for this subspecies; there are no juveniles in New South Wales waters.

But in Tasmanian waters and in Bass Strait there are also large numbers of young of the western subspecies—possibly they predominate. As mentioned earlier, the two subspecies often occur in Tasmanian waters as mixed shoals—one or other subspecies predominating, or else the two occur about equally. There is a striking difference in the growth-rate shown by the two subspecies, even at this stage—the western subspecies appears to grow almost twice as fast as the eastern subspecies, in spite of the fact that the fish seem to be living under almost identical conditions. The difference in growth-rate is so marked that it may be possible later to distinguish between members of the two subspecies on this character alone, without reference to the gillrakers.

In Victorian waters the juveniles appear to be almost all members of the western subspecies.

Now the origin of these juveniles of the western species is obscure. They occur in fairly large numbers as mere fingerlings. They must, therefore, be

spawned somewhere in the vicinity. The set of the currents in this region is to the east. By analogy with the situation in the east, it is tempting to suppose that these fry have been carried to the south and east from somewhere on the South Australian coast. Since there is no fishery for salmon along this part of the coast all this must be rather suppositional. But that is certainly what it looks like. There must be a large population of adults of the western subspecies somewhere on this part of the coast, to the west, to account for the large numbers of fry in Victorian waters and around Tasmania.

It appears therefore that when they reach maturity, or earlier, the mixed shoals of juveniles which occur round Tasmania split up into their respective subspecies, the members of the eastern subspecies moving to the north and east, and those of the western subspecies moving to the north and west.

In Western Australia the behaviour of the salmon is strikingly parallel to that of the eastern subspecies, as we know it in New South Wales and Tasmanian waters.

There is a winter fishery at Hopetoun and Esperance; only a few of the fish are taken west of Hopetoun. In summer, with developing roe, the fish make a westward movement and spawn in the Cape Leeuwin-Naturaliste area in April and May. Subsequently there follows a return movement of the fingerlings and first year fish. A few occur around the south-west, but the real concentration is in Esperance area and perhaps eastward of it. These movements are to be considered in connection with the current flow of this area.

Now what is particularly interesting is that half-grown salmon are almost unknown in Western Australia. Some shoals of three and four year old fish put in a brief appearance at Esperance in the summer. But they are never taken in any numbers around the south-west corner. It will be remembered that it was stated earlier that there was no fishing in all the area of the Great Australian Bight east of Esperance. It seems very likely that these juvenile salmon are distributed through the Bight, and perhaps even further east.

The similarity of the samples of two and three year old salmon from South Australia therefore becomes important. These two age-groups are commonly caught in the Gulfs of South Australia. That is highly suggestive. It seems that the salmon of this area (South Australia) are the juveniles of the stock of large, fast-grown salmon upon which the West Australian fishery is dependent; just as the stocks of salmon in Tasmanian waters include the juveniles upon which the fishery of New South Wales is dependent.

To what population then do the juveniles of the western subspecies, which are found in Victorian and Tasmanian waters, belong? They have no connection with the New South Wales fish. Where are the adults that give rise to them? They can hardly have been distributed from Western Australia.

There is, as a matter of fact, no record whence these juveniles can have come.

The South Australian-Victorian stretch of coast, as mentioned before, is known to be populated with salmon, but is virtually unfished. It seems that one must postulate at least one further population which spawns somewhere in this region, and whose fry are carried to the south-east, to be found later in Victorian and Tasmanian waters. A hypothetical boundary between this presumed population, and the supposed eastern limit of the south-west Australian population, has therefore been dotted in.

The extent of present ignorance about this population has been stressed, but the fact must not be lost sight of that there are these juvenile members of the western subspecies, occurring in very large numbers, in Victorian and Tasmanian onshore waters; and one must somehow account for them. Our present ignorance is due chiefly to the lack of observations along the South Australian-Victorian stretch of coastline.

This account completes the picture so far as it has been worked out. It can be described partly as well-established fact, partly as a working hypothesis, which will guide and direct future work. The limits of the stock on which the New South Wales fishery is based have been demarcated; and progress has been made in demarcating the limits of the stock of the south-western fishery.

There is just one further point. It may have occurred to some readers that the two subspecies would be better described as two, full, distinct species. There is a striking difference in the gillrakers, and probably in the rays of the dorsal fin.

No doubt these characters would be sufficient in some genera of fishes to create a new species. However, in the present case there is one other species of the genus *Arripis*—that is, *Arripis georgianus*, the Tommy Ruff (see Plate 2).

The Tommy Ruff is a considerably smaller species—the two have not been magnified to an equal degree in the plate. It will be seen that this species is morphologically very different from the salmon. The eye is larger, the snout is shorter, the caudal peduncle is narrower. Also the scale counts and fin-ray counts are very different from any of the populations of salmon.

All this is in contrast with the salmon—between the populations of which there is a high degree of uniformity in all but one or two characters.

If, therefore, one were to split the salmon—*Arripis trutta*, into a number of species, then the Tommy Ruff—*Arripis georgianus*, would have to be removed from the genus and a new genus created for it, which would then be a monotypic genus.

It seems best, then, all things considered, to leave the salmon as a single species, but to split it up into two subspecies, in each of which there is perhaps more than one population.

**GIRTH SCALES**

	26	27	28	29	30	31	32
Western Australia.			1	5	12	—	1
South Australia.			2	14	14		4
South east Australia							
—western subspecies.			2	4		1	
—eastern subspecies.			1	10	31	5	2
New Zealand.	1	9	16	8			1
Lord Howe Island.		4	5	1			

**DORSAL RAYS**

	15	16	17	18
Western Australia.			15	55
South Australia.			7	20
South east Australia—western subspecies.				6
—eastern subspecies.	2	22	13	1
New Zealand.	6	35	5	
Lord Howe Island.	2	3		

**GILLRAKERS**

	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Western Australia.			10	52	28	21	3				1							
South Australia.		1	11	24	20	11	1											
South east Australia																		
—western subspecies.		1	4	29	39	16	1											
—eastern subspecies.										1	11	50	62	77	25	—	2	
New Zealand.										1	5	22	13	6				
Lord Howe Island.												1	2	2	3	5	1	