XLVI. NOTE ON THE IODINE CONTENT OF FISH-THYROIDS.

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The presence of iodine in the tissues of, and oils from, various fishes has been known for a considerable time. It was found in herrings by Jonas [1838], in the oil from the liver of *Raia clavata* by Girardin [1842], and in crabs by Rieger [1853]. Barral [1877] states that iodine is always present in the oils from fish-livers. Stanford [1883] analysed a large number of fish oils, and invariably found iodine present. His analyses seem to have been controlled carefully, although the amounts quoted are minute. Thus:

Cod liver oil (various samples)	averaged 0.000322 per cent. iodine (0.000138—0.000434).		
Dry cod fish	contained 0.000829	„	„
Scotch herring, salted	„ 0.00065	„	„
Scotch herring brine	„ 0.00012	„	„
Seal oil	„ 0.00005	„	„
Cod liver oil dragées (liver residues from which oil had been removed)	contained 0.05637	„	„

Bourcet [1899], using analytical methods similar to those of Baumann, found iodine present in a large number of different species of fish, in amounts somewhat larger than those just quoted, ranging from 0.0007% (*Leuciscus cephalus*) to 0.024% (*Merlangus carbonarius*). *Raia clavata* contained 0.002%. It is uncertain from his published data whether Bourcet's figures refer to fresh or dried fish.

Baumann and Goldmann [1896] fed dried cod to a dog as a probable source of iodine, and confirmed the presence of the element indirectly by noting that such feeding increased the iodine content of the thyroid.

So far as I am aware, fish thyroids have not hitherto been tested for iodine, although in them, as in mammals, its presence is to be expected, and in larger amount than in other tissue. Some indirect evidence on the normal presence of iodine in the thyroids of fishes is afforded by the results of

Marine and Lenhart [1910], who found that the so-called thyroid carcinoma of brook-trout is severe endemic goitre, which can be cured by the administration of iodine as in mammals. This would seem to indicate that these thyroids function in the same way as mammalian thyroids, and hence should contain the same constituents.

While it is still to be proved that iodine is an indispensable constituent of the thyroid, there can be no doubt that it is almost invariably present. Even in those cases where absolutely negative results have been recorded (compare for example Roos [1899], who found that the thyroids of many carnivorous animals contained no trace of iodine), the method employed—that of Baumann and Roos [1895]—is inconclusive for minimal amounts, since it frequently yields too low figures, indicating that minute quantities might entirely escape detection. (See in this connection Seidell [1911].) The actual amount of iodine found varies considerably, and seems to depend largely, if not entirely, on the diet. Roos' results [1899] show that the thyroids of herbivorous animals, whose food contains small quantities of iodine, are richer in iodine than those of carnivorous animals, whose food contains little of the element. For further literature in this connection see Swale Vincent [1912].

There is direct experimental evidence that when iodine compounds are fed the iodine content of the thyroid is markedly increased. Thus Baumann [1896] found that the thyroids of dogs previously fed for some weeks on lean meat (iodine free) contained little or no iodine. That of a dog which had received sheep's thyroids (9 grams) 14 days before death contained 0.34 % (dried gland). Roos [1899] obtained a very similar result. While a large number of analyses showed that the usual iodine content in the dried thyroid of the dog averaged about 0.1 %, that of a dog to which potassium iodide had been administered for some time contained 0.35 %. Baumann and Goldmann [1896] removed the left thyroid of a dog. Its weight, fresh, was 1.92 grams, and the iodine content 0.06 milligram. After the wound had healed, the dog was fed for 14 days on 14 pounds of dried cod (see above). The right thyroid was then removed. It weighed 2.5 grams fresh, 0.8 gram dry, and contained 2.9 milligrams iodine (0.36 %).

It might therefore be expected, taking into consideration the constant presence of iodine in sea-water, that the thyroids of salt-water fishes would contain a maximum amount of iodine. If the conclusions of Gautier [1899] are correct, and the iodine in sea-water is largely present in organised matter, it should be the more capable of assimilation and transmission.

The results given below afford evidence that unusually large amounts are

constantly present in some species, and hence lend support to the view that *the iodine content of the thyroid is a function of the iodine in the diet.*

Through the kindness of the authorities we have been furnished by the Marine Biological Association, Plymouth, with samples of glands of two species of elasmobranchs, *Raia clavata* and *Scyllium canicula*. In all, six samples were received, each consisting of a large number of glands. These had been obtained during the early spring of this year, and stored in absolute alcohol during collection. The alcohol was subsequently evaporated, and the residue added to the glands. The weights of fresh glands given below are therefore only approximate.

The samples were dried in a steam-oven until constant weight was attained, and were analysed by Hunter's method [1910]. This has now been tested by a number of investigators (see for example Seidell [1911]), and is undoubtedly very accurate when appreciable quantities of iodine are present. (In testing for minimal quantities of iodine in other work I have not found this method completely satisfactory, and my results so far seem to support Kendall's conclusions [1912].)

In all, four blank determinations were carried out (one with each series of analyses) using powdered fibrin as organic material; each gave an absolutely negative result. A test of the accuracy of the method, with a known quantity of potassium iodide, gave the following result:

Amount of iodine taken 0·000306 gram.
 „ „ found 0·000310 „

This is of a lower order of magnitude than the amounts shown below, and in these the error is probably less. The data for the thyroids are seen in the following table:

Species	Sample	Weight (grams)		Amount taken (gram)	Amount of iodine (gram)	Percentage of iodine (dry substance)
		Fresh	Dry			
<i>Raia clavata</i>	(1 & 2)	(10·5)	2·541	0·503	0·002208	0·439
				0·503	0·002198	0·437
						(Mean 0·438)
	(3)	(6·4)	1·053	0·513	0·001678	0·327
	(4)	(?)	1·294	0·544	0·001542	0·283
<i>Scyllium</i>	(5)	(4·5)	0·987	0·516	0·003712	0·719
<i>canicula</i>	(6)	(?)	4·393	0·504	0·005831	1·157
				0·524	0·006099	1·164
						(Mean 1·160)

All the thyroids in sample 5 except two were from male specimens and all those in sample 6 from female specimens.

The results may be contrasted with the *maximum* iodine content hitherto observed in different mammals. In all cases the figures indicate percentage iodine in the dried gland.

Maximum iodine content in thyroids.

Fish thyroids 1·160 per cent.

Dog	„	0·692	„	recorded by Marine and Lenhart [1909, 2].
Human	„	0·588	„	„ Seidell [1911].
Stag	„	0·54	„	„ Blum [1899].
Pig	„	0·531	„	„ Seidell and Fenger [1913] (fat-free).
Sheep	„	0·53	„	„ Baumann and Roos [1895, 1].
Beef	„	0·477	„	„ Marine and Lenhart [1909, 1].
Goat	„	0·28	„	„ Blum [1899].

The *average* iodine content can probably be taken as from 30 to 50% of these figures.

While the thyroids of *Raia clavata* only contain a quantity of iodine of the same order as these maxima, both samples of *Scyllium canicula* contain more, and one *much more iodine than any thyroid previously reported on*. This is the more remarkable since this figure is the average for a large number of glands, while several of the other maxima (including the next three highest figures) are for single individuals. The theory that the iodine content of the diet plays a considerable, if not the whole, rôle in determining that of the gland therefore receives strong support from these figures.

The different results from the two sexes in *Scyllium* are possibly accidental. No previous marked variation seems to have been noted.

I hope to examine other species shortly, and to contrast thyroid with other tissue in what seems most probably the optimum condition for maximal iodine content.

I wish to thank Professor Swale Vincent for his kind interest in this work.

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