The Food Consumed by Shags and Cormorants around the Shores of Cornwall (England).

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With 2 Figures in the Text.

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I. INTRODUCTION.

AT a meeting held in the County Hall at Truro, Cornwall, on 30th August, 1911 (**2**, *a*), the Cornwall Sea Fisheries Committee decided to offer a reward of one shilling for the head of every Shag and Cormorant killed within the limits of the sea fisheries district under the jurisdiction of the Committee, the reward to become payable on and after the first day of September—just two days later.

This action was taken as the result of many and bitter complaints having reached the Committee concerning the destruction of marketable fishes—especially young flatfishes—by these birds in Cornish waters. Within one month after the initiation of this scheme for reducing what was then believed to be a serious menace to Cornish inshore fisheries, 751 birds' heads were received. Although this heavy initial slaughter did not for long continue unabated, the Fishery Officer for the County, in his quarterly report submitted to the Committee at their meeting on 26th May, 1915 (**2**, *e*), stated that he had then paid for a total of 4,220 birds since the order was first issued in September, 1911. He also further stated in that report that "from information gathered along the coast it is the

general opinion of the longshore fishermen that since the destruction of so many of these birds there is a marked improvement in the quantity of fish in our coves and estuaries."

In July, 1915 (**2**, *f*), owing to certain difficulties which had arisen in connection with the continuation of the scheme, the offer of rewards for the destruction of Shags and Cormorants was withdrawn.

The scheme was again brought into being in September, 1925 (**2**, *h*), and remained in operation until the end of 1929, when the payment of rewards was again discontinued (**2**, *j*). During this second period in which the reward was offered, 6,739 heads were received and paid for, making a total of 10,959 birds killed, payment for which had involved an outlay of approximately £550.

From time to time, while the scheme for the destruction of Shags and Cormorants was in operation, doubts were expressed in various quarters as to its efficacy, no appreciable beneficial effect having become evident in the fisheries. Apparently even the fishermen's previously avowed belief in its usefulness had also faded, for the Fishery Officer's report to the Committee, dated 12th December, 1929 (**2**, *j*), contains the following statement. "During my periodical visits throughout the County I have interviewed several fishermen as to the effect of the operation of the scheme on the fisheries. The consensus of opinion is that there is no positive evidence that the destruction of these birds has been sufficient to influence the fisheries to any appreciable extent."

This purely negative result of the Committee's action could be explained by the operation of either of two entirely different factors—(1) that although the birds are definitely harmful, their numbers had not been reduced sufficiently to have any appreciable effect upon the fish stocks ; or (2) that the birds are not so harmful as the fishermen had stated and as the Committee had been led to believe. If the former explanation were the true one, the launching of a more intensive campaign against the offenders would probably have been the proper course to pursue ; whereas if the latter hypothesis should be correct the destruction of the birds in the past had been entirely unnecessary and unjustifiable and ought in no circumstances to be continued.

In order to dissipate the fog of uncertainty in which the Committee had gradually become enveloped, Dr. E. J. Allen, Director of the Plymouth Laboratory, undertook to have the stomach contents of any birds sent to him examined and their food reported upon by members of his staff. Following upon this offer by Dr. Allen, 39 birds were received at the Laboratory during the autumn of 1929. They were examined by Mr. V. C. Wynne-Edwards, who submitted a report of his findings to the Committee at their meeting of 18th December, 1929. In this report Wynne-Edwards stated that "the Shags seem to be feeding almost

entirely on inshore fishes and very seldom take any marketable species. Out of a total of 84 fishes which I have been able to name only 3 have been marketable and of these the one I have entered as ' Gadus sp.' was almost certainly a Poor-cod, and the ' Clupea sp.' was probably a Sprat. This leaves one small Dab on the black list."

Four of the Cormorants examined by Wynne-Edwards contained identifiable food in their stomachs but no food fishes were included. Too few birds had been examined, however, to justify his making any definite statement concerning them.

It was after consideration of this report that the Committee hurriedly issued a notice withdrawing their offer of rewards for the heads of Shags and Cormorants. At the same time, they agreed to contribute towards the cost of further investigations by the Marine Biological Association.

Shortly afterwards Mr. Wynne-Edwards left the country and the subsequent investigations have been carried out by the present writer.

The researches were continued until early in 1933, when it was considered that a sufficient number of both species had been obtained to justify definite conclusions being drawn from them concerning the normal food of these birds in this area. The total numbers of Shags and Cormorants examined in the years 1929–1933 inclusive are shown in Table I.

TABLE I.

NUMBERS OF SHAGS AND CORMORANTS EXAMINED IN EACH OF THE YEARS 1929–1933 INCLUSIVE.

	SHAGS.			CORMORANTS.		
	Stomach containing recognisable food.	Stomach empty.	Total number of birds examined.	Stomach containing recognisable food.	Stomach empty.	Total number of birds examined.
1929	23	11	34	4	1	5
1930	12	14	26	0	1	1
1931	35	8	43	1	0	1
1932	115	1	116	19	0	19
1933	3	0	3	3	0	3
Totals	188	34	222	27	2	29

II. METHODS EMPLOYED.

In 1929 birds shot from time to time in the neighbourhood of St. Austell and Mevagissey were sent to the Plymouth Laboratory for examination of their stomach contents. All the birds had been dead for some time, therefore, before their stomachs could be opened and their food recorded. Thirty-nine birds (34 Shags and 5 Cormorants) were

dealt with in this way and one small Dab was the only food-fish found in them.

It was considered not unlikely that these results had been vitiated by the digestion which continues in the birds' stomachs for a considerable time after life is extinct. In order to eliminate this possible source of error arrangements were made in the summers of both 1930 and 1931 by which all birds were examined almost immediately after death. The results obtained after adopting this precaution were similar to those previously recorded. It can safely be concluded, therefore, that the 1929 results are perfectly reliable.

As most of the birds dealt with in the years 1929–31 had been shot during the summer months around rocky and exposed shores it was decided that, in order to make the investigation complete, birds shot during the winter months and in other localities ought also to be secured for examination. In the winter of 1931–32, therefore, an effort was made to obtain birds from sandy bays, harbours, and river estuaries, where flatfish are known to be numerous and where fishermen state that they frequently see Shags and Cormorants devouring large numbers of them.

By this means also it was hoped to receive a larger proportion of Cormorants than formerly when most of the birds shot were Shags. This was due to the fact that where shooting had been carried on Shags are plentiful and Cormorants relatively very scarce. The Shag is essentially marine, seldom venturing inland or even into the more or less enclosed waters of harbours and estuaries unless compelled to forsake its usual haunts by stormy weather. The Cormorant, on the other hand, normally frequents harbours, estuaries, and tidal rivers, and may even visit lakes and reservoirs far inland. Very occasionally it will venture out along the open coast but never goes far to sea.

In spite of these efforts, however, only four birds (two Shags and two Cormorants) were obtained from such localities during the winter of 1931–32, none of which contained any food-fishes.

As the following winter (1932–33) approached, a still more determined effort was made. In November, 1932, the reward offered for each bird shot in or near any harbour, sandy bay, or river estuary was increased from one shilling to two shillings and sixpence. The assistance of the Fishery Officer for Cornwall (Mr. W. H. Barron) was also enlisted. Mr. Barron was asked to select suitable men to shoot birds in specified localities around the coast and forward them to the Plymouth Laboratory. These measures were unexpectedly successful. Birds soon began to arrive in large numbers and in a very short time sufficient data had been collected to complete the investigation.

Throughout this work the numerical method of recording the stomach contents has been adopted, the number of recognisable organisms

of a species or group being noted.* Many stomachs contained also a mass of highly comminuted and unrecognisable food fragments. No attempt was made to deal with this in any way. Identification of fishes from the otoliths† accumulated in the bottoms of the birds' stomachs were likewise not attempted as this was considered unnecessary in view of the numbers of food organisms directly and more accurately identifiable.

One point of considerable interest and of no little importance in the future conduct of the investigation came out clearly from the work done in the summer of 1930. Twenty-two Shags (12 adults and 10 young) were shot near Port Isaac on July 7th, all before 7 o'clock in the morning. Not one of these birds had a particle of food in its stomach; without doubt the birds had all been shot before feeding had begun. It was therefore decided that in future no shooting should take place very early in the morning. This precaution had the desired result, and very seldom afterwards were birds received whose stomachs did not contain recognisable food material.

III. Food of Shags (*Phalacrocorax graculus graculus* (L.)).

In Table II are summarised the results of the examination of the 188 Shag stomachs which contained recognisable food. It will be seen that the food consisted almost entirely of fishes, with, in addition, a very small proportion of various crustaceans. Twenty-four kinds of fish have been recognised with sufficient accuracy to place them in their Genera, and in twenty cases the species also has been determinable. Ninety-six birds—or 51 per cent of those containing recognisable food—were found to have been feeding on Sand Eels (Ammodytes spp.), and 69 of them had *nothing but Sand Eels in their stomachs.* There can be no doubt that Sand Eels constitute the staple food of Shags in this area throughout the whole year. Wrasses, Gobies, Rocklings, Blennies, Dragonets, and other non-marketable species are also regularly eaten in smaller numbers.

In the winter months, however, Sprats and other Clupeoids also enter to some extent into the diet of Shags. In one stomach approximately 200 small Clupeoids up to about 2 inches in length (recorded as Clupeoid Britt) were found. Seven birds had devoured one or more Anchovies.

The Clupeoids are marketable species but, with the exception of the Anchovy which is not fished here, they are present in such large numbers that any depletion which Shags may be able to effect cannot possibly be

* See also Appendix II, p. 291.

† Remarkably large numbers of otoliths (up to 73) frequently were found in the stomachs. Possibly they accumulate and are used for breaking up the food in somewhat the same way as fowls and pigeons use small pebbles.

TABLE II.

Food of Shags (Summary).

Total number of birds examined 222—of which 188 contained identifiable food organisms in their stomachs.

Name of food animal.*	Number of birds in which found.	Highest number found in one stomach.	Total number recognised in all the stomachs examined.
Sprat (*Clupea sprattus*)	**20**	**50**	**278**
Anchovy (*Engraulis encrasicholus*)	**7**	**15**	**24**
Britt (Small Clupea spp.)	**2**	**200** (estimated)	**350** (estimated)
Clupeoid (Herring, Sprat, etc.) Remains	**21**	—	—
Conger Eel (*Conger vulgaris*)	**2**	**1**	**2**
Bib (*Gadus minutus*)	**2**	**1**	**2**
Pollack (*Gadus pollachius*)	**2**	**2**	**3**
Ling (*Molva molva*)	**1**	**1**	**1**
Gadoid (Gadus spp.) Remains	**3**	—	—
Dab (*Pleuronectes limanda*)	**2**	**7**	**8**
Flatfish (Pleuronectid) Remains	**3**	—	—
Sea Stickle (*Spinachia vulgaris*)	2	1	2
Pipe Fish (*Syngnathus acus*)	1	1	1
Sand Eel (Ammodytes spp.)	96	30	440
Five-bearded Rockling (*Onos mustelus*)	1	1	1
Three-bearded Rockling (*Onos tricirratus*)	8	1	8
Blenny (Blennius spp.)	1	1	1
Blenny (*Chirolophis ascanii*)	3	1	3
Weever (*Trachinus vipera*)	1	1	1
Dragonet (Callionymus spp.)	19	5	36
Goby (*Gobius flavescens*)	1	1	1
Goby (*Gobius minutus*)	2	35	45
Goby (Gobius spp.)	3	1	3
Sea Scorpion (Cottus spp.)	2	2	3
Ballan Wrasse (*Labrus bergylta*)	12	5	17
Cuckoo Wrasse (*Labrus mixtus*)	3	4	7
Corkwing Wrasse (*Crenilabrus melops*)	3	5	11
Gold-sinny Wrasse (*Ctenolabrus rupestris*)	24	10	63
Wrasse (Labrid) Remains	5	—	—
Comber (*Serranus cabrilla*)	1	1	1
Unidentifiable Fish Remains	28	—	—
Prawns (Palæmonidæ)	9	5	16
Shrimps (Crangonidæ)	5	2	7
Miscellaneous Crustacea	3	—	—

* Marketable fishes in heavy type.

considered to constitute a menace to any commercial fishery for them which exists in this area.

Bib, Pollack, and Ling are other species, of more or less value commercially, which are occasionally eaten by Shags, but the numbers killed in this way are so small as to be quite negligible—more especially since these fishes, though marketable, are not very valuable.

Only 5 out of the 188 birds were found to have eaten flatfish. Two

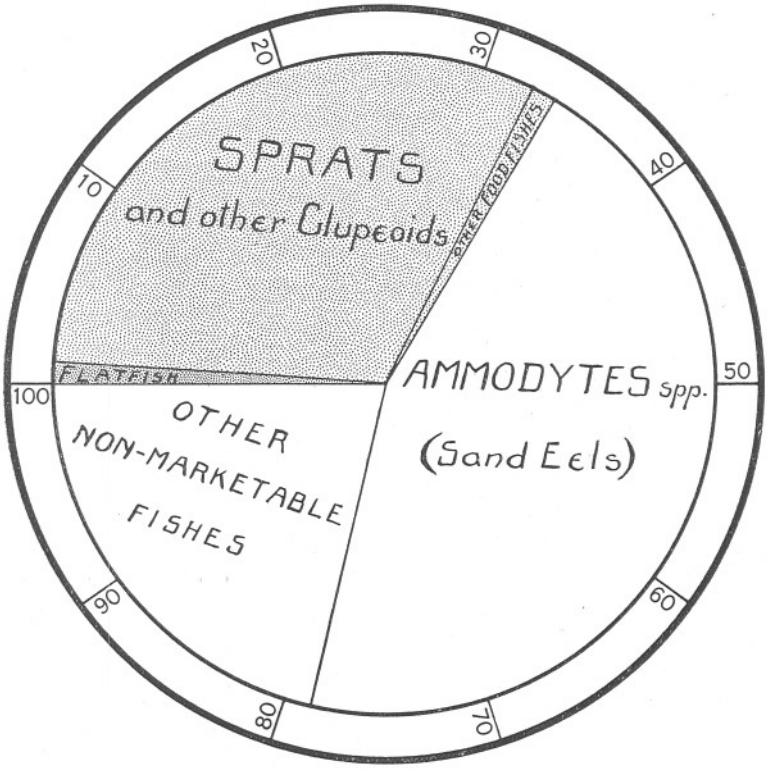

FIG. 1.—Diagrammatic representation of the percentage numerical composition of the food of Shags (Clupeoid Britt and Crustaceans omitted).

of those were shot in Mevagissey Bay, one on November 2nd, 1929, and the other on November 23rd, 1932. The former had eaten one small Dab and the latter had unidentifiable flatfish remains in its stomach. The three others, it is important to note, were all shot in river estuaries. Two of them were obtained from the Camel River in November, 1932, one of which contained the remains of a single flatfish (Flounder ?) and the other had in its stomach seven small flats—five of them obviously Dabs and the two others either Dabs or Plaice. The fifth bird, shot in the

TABLE III.

Food of Cormorants.

Total number of birds examined 29—of which 27 contained recognisable food organisms in their stomachs.

Serial number of bird.	Date examined.	Locality where shot.	Herring (*Clupea harengus*).	Sprat (*Clupea sprattus*).	Freshwater Eel (*Anguilla vulgaris*).	Conger Eel (*Conger vulgaris*).	Grey Mullet (*Mugil chelo*).	Father Lasher (Cottus sp.).	Dragonet (Callionymus sp.).	Goby (Gobius spp.).	Flounder (*Pleuronectes flesus*).	Plaice (*Pleuronectes platessa*).	Dab (*Pleuronectes limanda*).	Flatfish remains.	Gurnard (Trigla sp.).	Pogge (*Agonus cataphractus*).	Ballan Wrasse (*Labrus berggylta*).	Corkwing Wrasse (*Crenilabrus melops*).	Gold-sinny Wrasse (*Ctenolabrus rupestris*).	Prawns (Palaemonidæ).	Shrimps (Crangonidæ).
	1929																				
1	July 15	Mevagissey			1				2												
6	,, 15	,, ...															1				
12	,, 26	,, ...															1				
19	September 20								1										1		
	1931																				
93	July 29	Newlyn															1				
	1932																				
113	February 4	River Erme (Estuary) . .																1	1		
114	,, 4	,, ,, ,, . .																		2	

115	October	18	Mouth of Yealm River . .	1																				
168	November	23	River Camel (Estuary) . .										8										1	
172	,,	23	St. Austell Bay . . .										1	1										
174	,,	23	,, ,, . . .																3					
175	,,	23	,, . ,, . .						5														+	
192	,,	23	,, ,, . . .		1						4	4										11	3	
221	,,	24	River Camel (Estuary) . .								1	1											+	
222	,,	24	,, ,, ,, . .									1												
224	,,	24	Mevagissey Bay . . .				1																	
227	,,	24	,, ,, . . .							1				2		1					+	+		
237	,,	26	River Lynher . . .			1									1									
238	,,	26	,, ,, ...	4																			+	
241	,,	29	River Tamar . . .												3								31	
242	December	5	River Tamar (Estuary) . .										1											
243	,,	5	,, ,, ,, . .											2			9							
244	,,	5	,, ,, ,, . .					1																
245	,,	5	,, ,, ,, . .											2										
	1933																							
248	January	12	River Lynher . . .	4											+								+	
249	,,	23	Sutton Harbour (Plymouth) .										4											
251			River Lynher . . .								26	1	6	1	7							+	4	
Total number of birds in which present . . .				3	1	2	1	1	1	3	3	7	3	4	4	1	1	4	1	2	4	9		
Total number of fish recognisable in birds examined				9	1	2	1	1	5	4	31	17	11	7	12	1	9	6	1	2	15	44		

\+ signifies "present."

River Lynher on January 5th, 1933, had unidentifiable flatfish fragments in its stomach.

The accompanying diagram, Figure 1, shows the approximate percentage numerical composition of the total food eaten by the Shags examined—excluding Clupeoid Britt and a few Crustacea. A single glance at this diagram will immediately reveal how insignificant is the number of flatfish and other food-fishes which enter into the diet of Shags and how largely these birds depend upon Sand Eels and other non-marketable species for their sustenance. During periods of stormy weather, however, some of them are often compelled to forsake their normal feeding-grounds and driven to seek their prey in the more sheltered waters of harbours and river estuaries where they occasionally devour flatfish. But even in these circumstances they do not appear to do so if they can find other food. Eleven birds driven inland in this way have been shot and found to contain recognisable food, but only three of them had any trace of flatfish in their stomachs. The very last Shag examined was shot in the River Lynher at the same time and in the same place as a Cormorant. The two birds had obviously been feeding together, for both their stomachs contained many Gobies—the Shag 35 and the Cormorant 26 of them. But whereas the Shag's stomach contained only Gobies the Cormorant had eaten in addition no less than 15 small flatfish.*

IV. Food of Cormorants (*Phalacrocorax carbo carbo* (L.)).

Twenty-nine Cormorants have been secured in the course of this investigation.† Twenty-seven of them contained recognisable food, the examination of which has yielded very definite and interesting results quite different from those obtained from the Shags. In Table III these results are shown in detail for each bird.

From this table it will be seen that 16 out of the 27 birds containing food material have been obtained from river estuaries as the result of the special efforts made to secure birds from such localities. Of these no less than 14 birds were found to have eaten one or more flatfish. It is clear, therefore, that flatfish form a large proportion of the food of Cormorants when they are feeding in the shallow waters of estuaries or harbours, which are their normal hunting-grounds. When foraging farther at sea, as they occasionally do, Cormorants devour the same kinds of fishes as Shags—with the exception of Sand Eels, which they appear seldom to capture ; at any rate, not one of all the Cormorants examined had any trace of a Sand Eel in its stomach.

Figure 2 shows in graphic form the percentage numerical proportions

* See Table III. † See p. 280.

of marketable and non-marketable fishes eaten by all the Cormorants examined in the course of this investigation. Flatfish formed nearly 40 per cent of the total. Other marketable species, including Clupeoids, formed roughly 10 per cent of the fishes devoured by them. Thus *very nearly half of the fishes eaten by these birds were marketable species of greater or less value.*

V. Discussion of Results.

Because of their habit of frequenting harbours and river estuaries Cormorants are observed hunting their prey much more frequently than

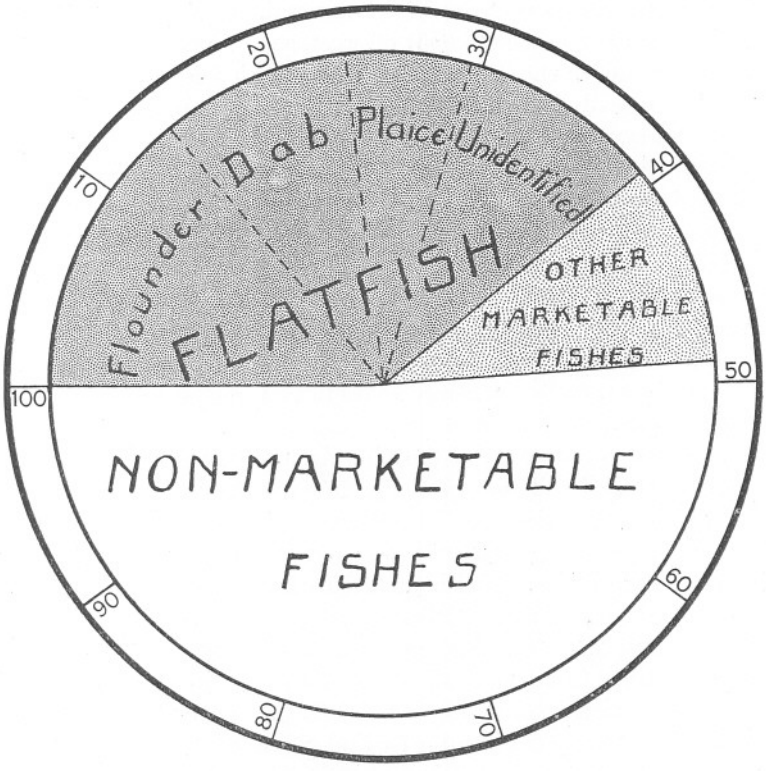

Fig. 2.—Diagrammatic representation of the percentage numerical composition of the food of Cormorants (Crustaceans omitted).

are Shags. There is therefore little doubt that the complaints which from time to time have been made by Cornish fishermen concerning the killing of marketable fishes, and flatfishes in particular, by Shags and Cormorants have been based almost entirely upon observations of the depredations of Cormorants alone. A grave and expensive mistake was made, therefore, in considering Shags

equally destructive. This error arose probably because Shags and Cormorants are very similar in appearance, and fishermen do not as a rule trouble to distinguish between them. It is just possible, however, that the published results of previous workers (applicable to other localities but not to this) had reached the fishermen or their Committee and helped to produce or confirm this erroneous belief. Witherby (**3**, p. 403), for example, states that the food of the Shag consists almost entirely of sea fish such as Plaice, Sillock, Wrasse, Eels (up to 2 ft. long), Herring, Garfish, Father-lasher, etc., and exceptionally also of crustacea and mollusca (Mytilus). Collinge (**1**, p. 220) examined the stomachs of 28 Shags,* 26 of which contained food material. He found that "excepting for a small percentage† (2·55) of crustacean remains and 1 per cent of algæ, the whole of the stomachs were filled with fish, cod, haddock, and whiting being easily identified." In a table (*op. cit.*, p. 221) showing the "monthly percentages of the principal food items of the adult Shag" the diet is recorded as varying between a maximum of 100 per cent food-fishes in November, December, and January and a minimum of 90·50 per cent in June, with an average of 96·45 per cent of food fishes over the whole year. These results are completely at variance with those obtained in the present investigation. The explanation of this disagreement may be that the staple food of Shags varies greatly in different localities, according to the different kinds of food organisms available. Haddocks, for example, are rarely found in this area, so they cannot form any part of the diet of sea-birds in Cornish waters.

With regard to the food of Cormorants, the statements of Witherby (*op. cit.*, p. 400) and Collinge (*op. cit.*, p. 218) and the results of this investigation are more in agreement. Witherby states that their diet consists almost entirely of fish, both fresh and salt water, including Trout, Eel, Pike, Flounder, Plaice, Sand-launce, 15-spined Stickleback, Haddock, young of Coal-fish, Mullet, and Conger (up to $2\frac{1}{2}$ ft.), and that crustacea (including crabs and Pandalus) are occasionally taken. The absence of fresh-water fishes from the food of the birds examined in the course of the present investigation is due to the fact that no birds were obtained or sought from purely fresh-water feeding grounds.

As the result of the examination of 43 Cormorants with full stomachs, Collinge found that their largest food item consisted of food-fishes—95·80 per cent. Where identifiable they were found to be Cod, Haddock, and Whiting. Crustacean remains, believed by the author to be derived from the stomachs of the fishes eaten,‡ were found in 4 stomachs and represented 0·75 per cent of the total food. Miscellaneous unidentifiable matter

* Presumably obtained from various parts of the country, although no details are given.

† See footnote, p. 292.

‡ Several of the stomachs examined by the present writer contained Shrimps, Prawns, etc., which could not possibly have been derived from the stomachs of fishes eaten.

amounting to 2·31 per cent, and 1·14 per cent of algæ were also found. Collinge therefore concludes that "if we regard a bird that feeds upon food-fishes as injurious, then there is nothing to be said in favour of the Cormorant." The evidence obtained in this area does not wholly support this downright condemnation of the birds. Around the shores of Cornwall Cormorants feed to no inconsiderable extent upon non-marketable species as well as food fishes.

Perhaps the most striking difference between the food of the Cormorants examined by Collinge and those at present under discussion is the very much greater range of fish species which had been eaten by the latter (*vide* Table III, p. 284).

As Cormorants are observed hunting their prey much more frequently than are Shags, a false impression of the magnitude of the Cormorant population—and therefore of the damage that they do*—is likely to be acquired. It is necessary to point out, therefore, that Cormorants are much less numerous than Shags in both Devon and Cornwall. My colleague, Mr. G. M. Spooner, M.A., an active member of the Devon Bird-watching and Preservation Society, informs me that in South Devon, between Plymouth and Start Point, a careful census has shown that Shags are roughly 10 times as numerous as Cormorants. Although no actual census of the Shag and Cormorant populations in Cornwall has been made, it seems probable that the proportion of Cormorants in that county is even smaller than in Devon. In the whole of Cornwall (excluding the Scilly Isles) there are probably not more than one thousand Cormorants as compared with from 10 to 15 thousand Shags.

VI. Acknowledgments.

I have much pleasure in recording indebtedness to my colleagues, Messrs. E. Ford and G. M. Spooner, for coming to my aid on several occasions when pressure of work made it difficult for me to deal expeditiously with consignments of birds.

VII. SUMMARY.

1. 188 Shags and 27 Cormorants, which had been feeding around the shores of Cornwall and whose stomachs contained identifiable food organisms, have been examined.

2. The Shags were found to have been feeding principally upon Sand Eels (Ammodytes spp.), and other non-marketable fishes.

3. The proportion of flatfishes and other economic species which had been devoured by the Shags was negligible.

* Still another factor operates to convey an exaggerated impression of their depredations among flatfish. Because of their shape, flats are difficult fishes to swallow. A bird's efforts to dispose of a large individual, therefore, often attracts the attention of onlookers, whereas ordinary round fishes are swallowed too quickly and easily to be seen and recognised except on very rare occasions.

4. During the winter months Clupeoids (Sprats, Anchovies, etc.) were included in their diet.

5. The Cormorants had been feeding largely upon flatfish and other estuarine food-fishes.

6. Cormorants, which are frequenters of more or less enclosed waters, are much less numerous than Shags in both Cornwall and Devon.

VIII. LITERATURE CITED.

1. Collinge, W. E. The Food of Some British Wild Birds, 2nd edition. York, 1924–27.

2. Cornwall Sea Fisheries Committee: Minutes of Meetings. (*a*) 30th August, 1911; (*b*) 29th November, 1911; (*c*) 29th May, 1912; (*d*) 27th August, 1913; (*e*) 26th May, 1915; (*f*) 24th November, 1915; (*g*) 30th May, 1923; (*h*) 23rd September, 1925; (*j*) 18th December, 1929.

3. Witherby, H. F. A Practical Handbook of British Birds, Vol. II. London, 1924.

IX. APPENDIX I.

As the food consumed by Shags and Cormorants in this area has been found to differ greatly in important respects, it will be useful here to tabulate the main features by which these birds are distinguished.

Cormorant.	Shag.
1. Body plumage bronze-brown and black (winter and summer).	Body plumage greenish black, the green gloss being less pronounced in winter than in summer but always present.
2. Sides of head and chin brownish white (colour produced by white feathers tipped with brown); in summer, pure white, the feathers having no brown edges.	Chin and round base of lower mandible only, may have varying amounts of white to brownish white; in summer, whole of chin and throat glossy green without any trace of white or brown.
3. In summer, large patch of white feathers at base of thigh.	Never has any white on thigh.
4. Has 14 tail feathers.*	Has 12 tail feathers.*
5. Overall length of adult bird usually between 33 and 38 inches.	Overall length of adult bird usually between 25 and 30 inches.
6. Weight of adult bird usually between $5\frac{1}{2}$ and $8\frac{1}{2}$ pounds.	Weight of adult bird usually between $3\frac{1}{2}$ and 5 pounds.
7. Frequents harbours, estuaries, and tidal rivers, or even inland lochs and reservoirs.	Entirely marine, frequenting open, exposed, and usually rocky sea-coasts. Occasionally is found feeding in sheltered waters when driven in from its usual haunts by stormy weather.

* These numbers are not absolutely constant.

In the field the Shag can be distinguished from the Cormorant by its noticeably smaller size, greenish black plumage, and smaller amount of white around the chin and neck. In breeding dress the Cormorant can readily be identified by the conspicuous patch of white feathers at the base of the thigh.

The immature birds are less easy to distinguish except by size. The breast and abdomen of the young Cormorant may, however, be dull white mottled with brown. The breast of the immature Shag is never white.

The Cormorant swims with its bill pointed upwards and when diving usually submerges its head and glides under water with scarcely a ripple. The Shag, on the other hand, often springs quite clear of the water in diving.*

X. APPENDIX II.

Collinge (*op. cit.*, p. 31) expresses the hope that in all future investigations into the food of wild birds the "volumetric or percentage by bulk" method of recording the stomach contents will be employed rather than any of the various modifications of the numerical system.† He urges the adoption of the former method because he is convinced of "its superiority and greater scientific accuracy over any other."

In the opinion of the present writer this conviction can be justified only when applied to the stomach contents of birds whose food consists of vegetable products either wholly or in part, and where the economic values of both plant and animal food materials have to be assessed and balanced against each other. According to Collinge (*op. cit.*, p. 27), however, "if we say that a bird's stomach contains sixty aphids and six bees the idea furnished is a ratio of 60 to 6, but if computed by the percentage of bulk the ratio would be more correctly stated by the figures 3 to 28 of the total food contents of the stomach," and this author believes the second expression to be much the more valuable for the purpose of assessing the usefulness or otherwise of the bird in question. In reaching this conclusion he has failed to take into consideration the fact that the sizes of organisms seldom or never bear any relation to their activities, whether beneficial or harmful, or to their marketable value, either actual or potential. In the present investigation, for example, one Cormorant was found to have eaten 15 small flatfishes between 5 and 10 cm. in length. The combined volume of all these fishes was less than that of a single fully grown adult. But they would have produced 15 adult marketable fishes had they been allowed to live. By destroying these young individuals, therefore, this particular bird had done quite as much *potential* harm to the fish stock as if it had eaten an equal number—*or over* 20 *times the volume*—of adults.

* See also Witherby's "Handbook." † See p. 280.

A further criticism levelled against the numerical method is that it cannot successfully be applied to finely comminuted animal or vegetable matter (**1**, p. 29). In my experience this applies also to the volumetric method, at any rate when dealing with fish-eating birds. Fragmentary food remains which are so far disintegrated as to make it impossible to ascertain from how many individuals they were derived are seldom or never in such a state that they can be accurately identified. To determine their volume, therefore, even when this may be possible with any degree of accuracy,* would add but little to the value of the record.

Again, a bird whose stomach contained, say, three tails of *Gobius flavescens* would, in the numerical computation, be recorded—and accurately so—as having eaten three of these fish. By volumetric computation, if the stomach contained any other food, the proportion of Goby would work out at considerably less than would have been produced by a single whole individual. If, however, no food were present, the percentage proportion by bulk would have to be recorded as 100 *per cent Goby* whether the stomach contained only one recognisable fragment or whether it was packed with a large number of the fish. A " volumetric " or " proportion by bulk " expression of the results in such instances can have no real meaning. Moreover, if such separate readings be taken into consideration when calculating the proportions of the total food eaten by all the birds examined they will produce, or tend to produce, totally false final values. If, on the other hand, in order to eliminate this grave source of error, all stomachs containing only one kind of food organism are disregarded, the final computations will be equally unreliable and misleading.

Ideally, of course, a combination of all possible methods of exact computation is desirable. In the present investigation this would have been quite impracticable. What was believed to be the most satisfactory of the various methods available was therefore chosen.

* The accuracy obtainable is never such as to justify expressing the results correct to two places of decimals (see p. 288).