THE FOOD AND FEEDING HABITS OF SHELDUCK *TADORNA TADORNA*

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INTRODUCTION

Shelduck *Tadorna tadorna* are found throughout the year on most of the coastal flats and estuaries of the British Isles. Usually they occur in small parties, though at times large numbers gather in certain areas. For example, in January flocks of over 5,000 have been counted on the Thames and on the Dee estuaries, and the now well-known moult-gathering grounds in Bridgwater Bay, Somerset, have held over 3,000 birds in September (Eltringham & Boyd 1963). If these birds are feeding on a limited range of food species, it is obvious that such species must be present and available in considerable quantities.

This bird is now completely protected in most European countries and the numbers have increased greatly during this century. A knowledge of its food and the reasons why it congregates in certain areas, may well be essential in any management plans that become necessary.

METHODS AND MATERIALS

The Shelduck being a protected bird the number available for food analyses was necessarily small, though 30 birds were collected under special licences issued by the Nature Conservancy. Additional clues as to the diet have been obtained from 18 birds found dead or dying during the cold weather of 1963, from faecal analyses, from field observations and from the literature. The methods of analyses were the same as those described in detail elsewhere (Olney 1961, 1963). The nomenclature of all seeding plants follows that of Dandy (1958), and of all marine species that of the Marine Biological Association (1957).

RESULTS

Sample 1.

Eighteen birds were collected from the Greenborough and Milfordhope islands in the River Medway, Kent, from September to February. The contents of the food tracts up to and including the gizzard are shown in Table 1.

The small marine prosobranch snail *Hydrobia* (=*Sabanaea*) *ulvae* was found in all 18 birds and from each month, and accounted for 89·5% of the total volume of food eaten. In one bird obtained in December, over 3,000 shells of this species were found, of which

TABLE 1. *Stomach contents of* 18 *Shelduck* Tadorna tadorna *from the Medway Islands, U.K.*

	Frequency	Volume in ml.	% total volume
Animal material			
Hydrobia ulvae	18	36·65	89·5
Hydrobia jenkinsi	1	1·3	3·2
Corophium volutator	1	trace	—
Plant material			
Enteromorpha spp.	6	2·6	6·4
Vaucheria sp.	1	0·3	0·7
Seeds			
Scirpus maritimus	1	0·1	0·2
Suaeda maritima	1	trace	—

Note. Total volume =40·95ml. Animal material=92·7% volume and 100% frequency. Plant material=7·3% volume and 50% frequency.

an estimated 90% still contained the snail. The only other animal materials found were Jenkin's Spire Shell *Hydrobia jenkinsi* and the small amphipod *Corophium volutator*. Plant material, though rarely taken in quantity, was found in nine birds, with the alga *Enteromorpha* being taken the most frequently. This was eaten in sufficient quantity to discount accidental ingestion.

A Shelduck from Lancashire shot by mistake in December was found to contain over 50 individuals of *C. volutator* and some 30 *H. ulvae*.

Sample 2.

A further 18 birds found dead or dying in the severe cold of February to April 1963 were examined as soon after death as possible. Post-mortems showed that their deaths were due either to starvation or to the effects of disease probably accentuated by the cold and lack of food. Nevertheless only three of the birds had no sign of food above the small intestine, and the rest contained some food, though often only in small quantities.

Of nine birds picked up on the Isle of Sheppey, Kent, in February and March, the stomach of one was empty and eight contained *H. ulvae*, ranging from 0·1 to 1·4 ml. in volume (40 to 500 individuals). Of four birds picked up in February on Chetney marshes, Kent, two stomachs contained *H. ulvae* (about 120 and 50) and two were empty. The stomachs of five birds picked up in February on the High Halstow marshes, Kent, all contained *H. ulvae* though mostly only as traces, and in only one bird were there whole shells (about 40) present. A few seeds of Orachè *Atriplex patula* were also found in one bird, and the seeds and stem of Marsh Samphire *Salicornia* sp. in another. In one bird there were also the " jaws " of a nereid worm—probably *Nereis diversicolor*.

Sample 3.

Five birds were obtained during April and May 1963 from the Isle of Sheppey under a special licence from the Nature Conservancy issued to J. Hori for his breeding biology studies (Hori 1964). They were obviously all obtained some longish time after their last meal for the stomachs of none of them contained more than the remains of any food in the gizzard, though in each bird traces of *H. ulvae* were found. In three of the birds, copepod and foraminifera species were also found, though only in small numbers.

Sample 4.

Seven birds were collected in 1963, under a Nature Conservancy licence, from Bridgwater Bay during the moult-gathering period of August to October. The results of the analyses are shown in Table 2.

TABLE 2. *Stomach contents of seven Shelduck* Tadorna tadorna *from Bridgwater Bay, U.K.*

	Frequency	Volume in ml.	% total volume
Animal material			
Hydrobia ulvae	7	12·90	82·4
Macoma balthica	5	1·15	7·3
Corophium volutator	1	1·20	7·7
Nereis sp. " jaws "	1	0·10	0·6
Plant material			
Enteromorpha sp.	1	0·30	1·9

Note. Total volume=15·65. Animal material=98·1% volume and 100% frequency. Plant material=1·9% volume and 14·3% frequency.

H. ulvae was again the most frequent food item, being found in all seven birds from each month and accounting for 82·4% of the total volume. Two birds obtained on different days in September had gorged themselves with an estimated 2,200 and 1,800 snails.

Five of the birds had also eaten small individuals of the bivalve *Macoma balthica*. One bird had also taken large numbers (about 450) of *C. volutator*, and another had eaten the alga *Enteromorpha*. In one other bird there were over 50 " jaws " of nereid worms, and comparison with fresh material showed they closely resembled those of *Nereis diversicolor*. It was thought that these " jaws " may have been from dead worms in the mud, presumably taking longer to decompose than the softer parts of the worm, and were ingested in this way. However, a careful examination of the mud from a number of sites within the Bay, did not reveal any nereid jaws. It seems likely therefore that Shelduck will catch and eat *N. diversicolor* though how frequent this is it is impossible to say.

All the species mentioned as part of the diet are common constituents of the intertidal fauna and flora in the Bay; *H. ulvae* and *N. diversicolor* being particularly abundant in parts of the Bay. The diet of these birds is remarkably similar to that of the 18 birds collected from the Medway Islands during the winter months.

It is of interest that one of the birds from Bridgwater Bay contained an ingested lead pellet and showed the classic postmortem symptoms of lead poisoning (Olney 1960).

Sample 5.

Faecal material collected from eight incubating female Shelduck in June from the Ythan Estuary in Aberdeenshire was analysed and found to consist of 99–100% *H. ulvae*. Traces of *Enteromorpha* and *Corophium* species were found in the droppings from two of the birds and traces of a shrimp species in one other bird.

REVIEW OF THE LITERATURE

In general the literature on Shelduck foods emphasises the importance of small molluscs. Also taken, though to a lesser extent, are small crustacea, small fish and fish spawn, occasionally insects and their larvae, and a small amount of plant material, mainly algae. Jourdain (in Witherby *et al.*, 1940) summarizes the then available information and lists a number of species, though surprisingly, since it had been recorded by Gladstone (1910) and included in Phillips (1923), he did not note *H. ulvae*. Campbell (1947) found in a Shelduck from North Uist in February that the food consisted mainly of *H. ulvae* and the Rough Periwinkle *Littorina saxatilis* with a small amount of unidentified algae. The stomach contents of ten Shelduck from Knechtsand, in the Heligoland Bight moulting area in October (Goethe 1961), consisted chiefly of *H. ulvae*, juveniles of two molluscs (the Sand Gaper *Mya arenaria* and the Baltic Tellin *Macoma balthica*), for aminifera shells and algal chlorophyll. Two birds collected at the beginning of September from Mellum in the Bight contained *H. ulvae* and Mussel *Mytilus* sp. remains.

The information collected by Isakov (in Dementiev & Gladkov, 1952) is of particular interest for its account of the summer diet of the Shelduck in the U.S.S.R. It should be remembered however that in the U.S.S.R. the Shelduck is primarily a southern bird frequenting arid areas and inland seas of high salinities. The foods taken are therefore likely to be somewhat different from those of Western European Shelduck. The three main sources of food from a number of different localities were the Brine Shrimp *Artemia salina* and its eggs, Chironomidae larvae and single-celled algae (e.g. *Aphanoteca*). In other areas Orthoptera, particularly the locust *Calliptamus italicus*, and ants (Formicidae) are important items during the summer months. The winter foods of Shelduck in the U.S.S.R. appear to have been little studied though in the Kirov Gulf in the Caspian Sea the main food is apparently plant material, chiefly algae and various aquatic plant seeds (e.g. *Ruppia*). To a lesser extent molluscs are eaten, including *Hydrobia* species.

DISCUSSION

The most striking result of this food survey is the predominance of *Hydrobia ulvae*, for of the 46 birds which contained food (Table 3) all had eaten this mollusc. It seems

that this species, and this is confirmed by the literature, is the most important food item during much of the year and in many different localities. Examination of faecal material provides further support; and though softer bodied material might not be apparent in droppings, their analysis can be accepted as a guide to what is eaten though not to the proportions taken.

TABLE 3. *Stomach contents of* 46 *Shelduck* Tadorna tadorna.

	Frequency	% total frequency
Animal material		
Hydrobia ulvae	46	100·0
Macoma balthica	5	10·9
Corophium volutator	3	6·5
Nereis sp.	2	4·3
Hydrobia jenkinsi	1	2·2
Plant material		
Enteromorpha sp.	6	13·0
Vaucheria sp.	1	2·2
Seeds		
Scirpus maritimus	1	2·2
Atriplex patula	1	2·2
Suaeda maritima	1	2·2
Salicornia sp.	1	2·2

H. ulvae is present in almost all estuarine and saltmarsh mudflats and muddy sands, often in immense numbers. In the Medway in September 1959 an estimated 12,000 per sq. m. were found, Newell (1962) found in the Thames estuary up to 10,000 per sq. m., and Thamdrup (1935) recorded the prodigious number of 60,000 per sq. m. at Skalling in Denmark. In stormy weather huge masses may be washed up, and Linke (1939) noted at the base of a dyke wall on the Jadesbusenwatt, Germany, an accumulation of living snails 20 m. long, 2 m. broad and on average 2 cm. thick, which he estimated contained approximately 55,000,000 individuals.

From what quantitative figures there are it seems that the numbers vary considerably from locality to locality as well as with the time of year. Newell (1964) concludes that in the upper reaches of an estuary *H. ulvae* is restricted to a narrowing belt between the converging isohaline of minimal salinity tolerance and high water mark, and finally disappears in the region of the upper tidal limit of the estuary. Thus, it is not surprising that Shelduck are rarely found feeding far up estuaries. The snails are said to be almost independent of the nature of the ground (Fretter & Graham 1962), though some work by Newell (pers. comm.) indicates that they are limited in their distribution to regions where the organic content of the substratum is high.

The variation in numbers of snails, whatever the factors which control them, may be one of the main reasons why Shelduck congregate in certain areas at certain times of the year. Unfortunately there is little information on long term population trends in *H. ulvae*. It was not possible therefore to see if the increase and spread of the Shelduck could be correlated with a similar population change in its prey, as was noted with the Tufted Duck *Aythya fuligula* and its main inland food *Dreissena polymorpha* (Olney 1963).

Newell (1962) has shown that *H. ulvae* has a cycle of behaviour which is closely geared to the tidal cycle. As the tide recedes the vast majority of the snails are to be seen crawling and browsing on the mud surface. This phase is followed by burrowing which may last for several hours, followed by all the animals surfacing and floating in on the incoming tide. They then sink on the ebb tide at approximately the same mid-tide level from which the incoming tide swept them, and begin their mud-crawling again. It is at this period that they would be at their maximum density, and would be most easily available to feeding birds. This corresponds closely to the observed feeding

behaviour of those ducks known to feed on *H. ulvae*—Shelduck, Mallard *Anas platyrhynchos*, Teal *Anas crecca*, Pintail *Anas acuta* and Shoveler *Anas clypeata* (Olney 1963, 1964, and in press), all of which tend to feed most intensively on the ebb tide. This is undoubtedly a case of the feeding behaviour of the predators being adapted to the behaviour of their prey. This cycle of behaviour in *H. ulvae* also helps to decipher the different types of tracks left in the mud by feeding Shelduck mentioned and illustrated by Swennen & van der Baan (1959). The fern-like tracks left by the bird as it walks along moving its beak from side to side in a scything action are presumably made when the snails are being taken off the surface of the mud. The series of dabbling holes which are sometimes found would be made in that period of ebb tide when the snails have burrowed and have to be taken from within the mud.

If, as the above evidence suggests, Shelduck in Western Europe have a rather fixed type of feeding behaviour which exploits only one feeding niche and therein mainly one food item, then any event which prevents the species from using that niche will be a significant mortality factor. The very cold weather of early 1963 seems to have been such an event for in many areas the estuarine and coastal muds were frozen over and birds were prevented from feeding in the intertidal zone; many dead or dying birds were reported (e.g. in Dobinson & Richards 1964 and elsewhere). In a report on wildfowl and waterbirds found dead in England and Wales from January to March 1963, Boyd (1964) found that in proportion to the numbers likely to have been present in this country, the Shelduck suffered the most severely. Pilcher (1964) in a survey of the birds found dead on the north shore of the Wash between 26 February and 3 March 1963, records 58 dead Shelduck most of which had died of starvation. Similar results are noted by Harrison & Hudson (1964) in their survey of the effects of severe weather on wildfowl in Kent in 1962–63, when 106 dead Shelduck were picked up in the Thames and Medway estuaries.

Prolonged gales which cause the mudflats to be covered for long periods may be another event which prevents Shelduck from feeding. Goethe (1961) quotes several records of Shelduck being found dead in such circumstances, presuming them to have died of starvation.

In the last few years, at least in parts of Western Europe (Great Britain, Holland, Denmark—Poulsen 1959), the Shelduck has increasingly been found breeding inland, and where these areas are far from the sea the young remain until they can fly. Obviously in these cases the food taken will be different from coastal feeding birds. This suggests that the feeding habits are not absolutely inflexible and may even be in the process of changing as the breeding range extends. This may well be the beginnings of new feeding behaviour, for there is enough evidence to suggest that when a new food habit has been learnt by a few individuals it can spread rapidly through the species (Fisher & Hinde 1949, Kear 1963). Perhaps in the not so distant future the rigid adherence to one feeding niche and one food species will not be so noticeable in the Shelduck.

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SUMMARY

The food and feeding habits of Shelduck *Tadorna tadorna* are described, based on the analyses of the viscera of 30 birds collected under special licence, and of 18 birds found dead or dying during

the cold weather of 1963, on faecal material from eight incubating birds, on field observations and on the literature. The birds came from a number of different localities and from each month of the year, apart from July.

The mollusc *Hydrobia ulvae* (Pennant) was found in all 46 birds which contained food, and it is quite obvious, and this is confirmed by the literature and by faecal analyses, that this is the most important food item during much of the year and in many different localities. Other species eaten included the bivalve *Macoma balthica*, the amphipod *Corophium volutator*, the ragworm *Nereis* sp., the alga *Enteromorpha*, and occasionally the seeds of various plants.

The importance of *H. ulvae* is examined in the light of its distribution and numbers, which may be a strong controlling factor in concentrating Shelduck in certain areas at certain times of the year.

The feeding behaviour of Shelduck, and a number of other birds, is apparently closely related to the cyclic behaviour pattern of the main food species, *H. ulvae*.

It seems that Shelduck have a rather fixed type of feeding behaviour which exploits only one feeding niche and therein mainly one food item. Any event (prolonged gales or very cold weather) which prevents the bird from using that niche can be the cause of heavy mortality.

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