Feeding distribution and behaviour of Shelduck in relation to food supply

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Introduction

The mid-winter population of Shelduck *Tadorna tadorna* in north-west Europe is estimated at about 125,000, of which between 40% and 70% spend November to March on estuaries within the British Isles (Atkinson-Willes, in press). A large proportion of Shelduck in Britain winter at a few main sites; in 1971–1972 twelve estuaries had peaks of over 2,000 birds and together held a large percentage of the population (Prater, 1973). It has been shown that the small gastropod mollusc *Hydrobia ulvae* is a major food source for wintering Shelduck (Olney, 1965) and it is probable that most Shelduck concentrations, at least in Britain, occur where *Hydrobia* is abundant and available. The purpose of the present study was to examine within one of the major wintering areas, the detailed pattern of Shelduck feeding in relation to the distribution, abundance and behaviour of invertebrates. In particular to investigate the relationship between wintering Shelduck and *Hydrobia* and the disturbance of any possible direct relationship between food abundance and feeding intensity, by tide and weather conditions and human interference. Because the Shelduck is among the largest and most conspicuous of British shore birds, and has a rather restricted diet, the complication of bird identification and observation at long range and the problems arising from a diverse diet are minimized.

In the context of wildfowl conservation it is important to locate the major Shelduck feeding areas so that they may be safeguarded. This is especially so in the upper Firth of Forth where large numbers winter but where reclamation in recent years has resulted in a 16% reduction in the area of intertidal mud in the most favoured shore bird feeding areas (Bryant, 1974). In addition, an understanding of why certain areas are important for feeding is valuable, so that the impact of pollution, barrage schemes, canalization and natural accretion can be more readily predicted.

Materials and methods

The study was carried out at the intertidal area known as Skinflats in the upper Firth of Forth (Figure 1) from 1st September 1972 to 31st March 1973. The field observations may be divided into two sections, firstly sampling of inter-tidal organisms and secondly recording the extent of feeding in different areas throughout the winter.

Sampling and analysis of intertidal organisms

Cores of mud of 100 cm² surface area and 10 cm in depth were collected at low water at 50 or 100 metre intervals along transects running from the high water (MHWS) to low water (MLW), spaced at approximately 0·5 km intervals across the study area (Figure 1). Because Shelduck usually feed at the mud surface and the major food items generally reside within the upper 2 cm, this section only was retained for analysis from the larger core. The most significant food item *Hydrobia ulvae,* was thus retained within the analysed sample (see Thamdrup, 1935). A proportion of the other invertebrates, such as *Nereis* spp, would be missed in such a shallow low tide sample though could be available to the Shelduck at the mud surface at certain tidal states (Vader, 1964). As these organisms usually comprise only a small proportion of the diet (Campbell, 1947; Goethe, 1961; Olney, 1965), this treatment of the sample was considered acceptable. The samples were sieved in the laboratory and all organisms retained in a 1 mm sieve were counted and identified, and in addition annelids retained within a 0·5 mm sieve. The organisms were freeze dried and weighed to give a total dry weight for each species or group at each transect station. The mollusc data were corrected to eliminate the contribution of the shells, which ranged from 80% to 95% of the total dry weight, according to species. No samples could be taken in the area to the south-east of the low bank and trench, A–B (Figure 1), because of the restrictions imposed during the laying of a waste acid pipeline in that area. General observations were made on the floating behaviour of *Hydrobia,* by wading at the leading edge of the flow tide. The number of *Hydrobia* crawling on the mud surface at low tide was recorded in 100 cm² plots associated with selected transect stations and the mud temperature was measured simultaneously 2 cm below the surface. The data on food densities for each

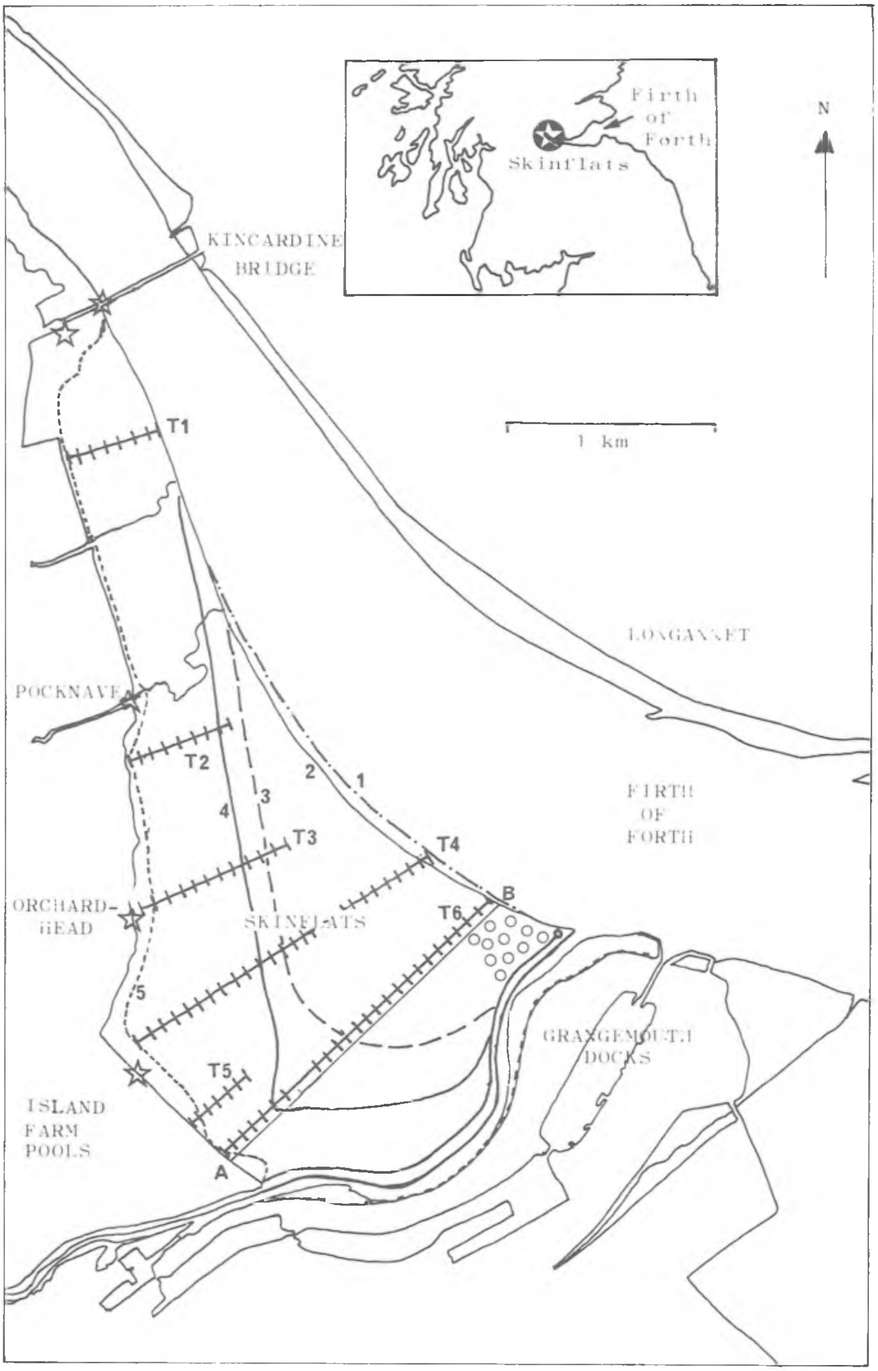

Figure 1. The study area, Skinflats, in the upper Firth of Forth. The observation points are indicated by stars. For explanation of line A–B, see text. The transect lines are shown, T1 to T6. Tide contours are numbered 1 to 5:— (1) – · – · MLWS; (2) ——— MLWN; (3) – – – Contour taken from an aerial photograph; (4) ——— approximate MTL; (5) - - - - - - MHWS, marks the lower fringe of the saltmarsh. Open circles (O) mark the position of a shell bank.

transect station was used to draw up abundance contours for the dry flesh weight of *Hydrobia* and other invertebrates.

Observation and analysis of Shelduck feeding

The Shelduck were observed from five stations, though mainly from two of these, Pocknave and Orchardhead (Figure 1). The number, activity and position of the birds was recorded at 0·25 hour intervals throughout a 7-hour daylight period on each of three or four days during each month of the study period. The location of the birds was determined by reference to the transect marker posts, and to the state of the tide, by making observations from two points, and by alignment with distant topographical features. Subsequently these observations were allocated to one (or occasionally two or four) of the 90 squares on a 0·20 km square grid (area = 0·04 km^2) covering the study area. The activity of the birds could be broadly divided between roosting and feeding. However within the latter category further divisions were distinguished and these will be described below. Feeding was defined to include the intervals between periods of active mud sieving because such intervals are an integral part of the feeding behaviour. The mean daylight 'Shelduck × feeding hours' in each month, was determined for all grid squares from the spot-mapped field observations and the total 'Shelduck × feeding hours' for the winter could then be calculated. (The mean 'Shelduck × feeding hours' per seven hour daylight observation period were summed for all days in each month; then the resulting totals were combined for the six month period October 1st to March 31st). Because the availability of food and feeding behaviour was influenced by the tidal state, this was noted; and additional information was gathered from aerial photographs (Figure 1).

Results

The distribution of invertebrates

Hydrobia ulvae was the dominant organism over most of the study area both in terms of numbers (max = 60,600 m^{-2}) and grams dry flesh (d fl) weight (max = 33·0 g m^{-2}). They were most abundant within the study period in October, and then exhibited a general decline in abundance and extent of distribution through the winter. The decline in biomass of *Hydrobia* is probably due to mortality at a time of year when growth and reproduction are at their minimum (see Anderson, 1971). A proportion of this mortality can be attributed to Shelduck predation, as upward of 3,000 *Hydrobia* have been observed within one alimentary tract after feeding (Olney, 1965). At all times *Hydrobia* biomass was greatest at mid shore stations (Figure 2), a situation similar to that demonstrated elsewhere (Prater, 1972; Newell, 1962). The distribution and relative abundance of *Hydrobia* was very closely correlated with that of all other organisms combined. These included potential Shelduck food items such as Oligochaetes (0 to >5,000 m^{-2}), *Glycera* sp. (0 to 800 m^{-2}) and Nereis diversicolor (0 to 1,600 m^{-2}). All Annelida combined gave a maximum of 79 d fl g m^{-2}. *Macoma balthica* (max = 5·5 d fl g m^{-2} and 1,000 m^{-2}) and *Corophium volutator* (max = 0·5 d fl g m^{-2} and 1,100 m^{-2}) were frequent. *Nepthys hombergi, Cerastoderma edule, Mytilus edulis, Littorina littorea, Carcinus macinae, Retusa alba* and *Chiton sp* were recorded in small numbers or rarely.

Shelduck populations wintering in the upper Firth of Forth

The status of the Shelduck in the Firth of Forth has been described by Jenkins (1972). The Shelduck population in the upper Firth is at a minimum in late summer and early autumn when the adults and non-breeding immatures are on the moulting ground in the Heligoland Bight (Goethe, 1961; Salomonsen, 1968). The birds begin to return to Britain in numbers in October and at this time the upper Forth population begins to build up. The population continues to increase during November and reaches a midwinter level of 1,000 to over 2,000 birds in December which persists until mid March. A sharp decline has usually occurred by April, and the remaining birds largely represent the summering population, an unknown proportion of which will attempt to breed at nearby sites. The seasonal changes in numbers in the upper Forth and at Skinflats are shown in Figure 3. The Skinflats counts carried out during this study, indicate the number of individuals on which observations are based (Total 'bird × observation days' = 4,977; on flocks of 61 up to 780 Shelducks, over 19 days). There is considerable movement between sites, though about one-third of the population is generally present at Skinflats; the remainder mostly feed to the south east of Grangemouth Docks.

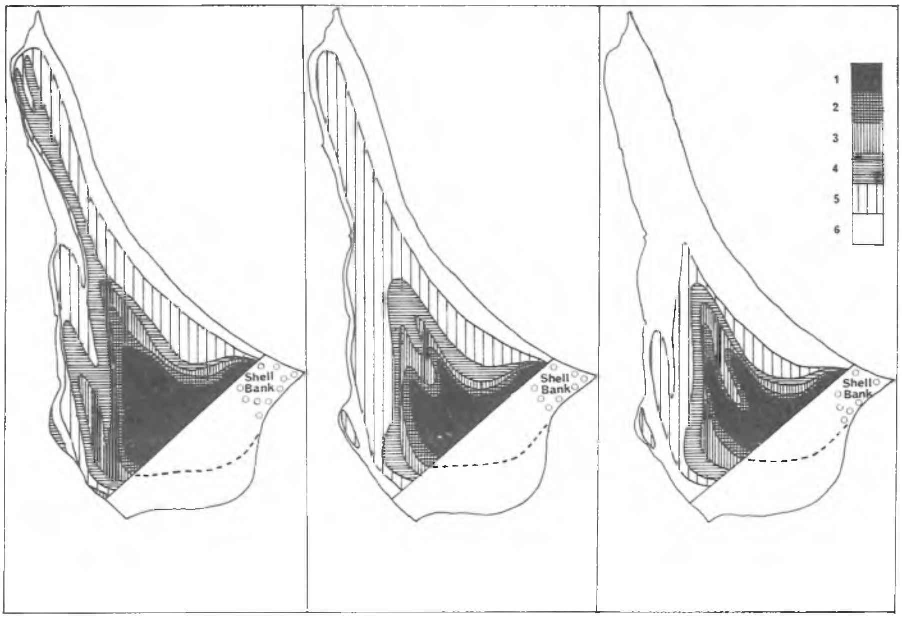

Figure 2. Distribution of *Hydrobia ulvae* at Skinflats through the winter. Abundance data given in grams dry flesh weight m^{-2}; (1) $\geqslant 7{\cdot}5$; (2) $6{\cdot}0 \rightarrow 7{\cdot}4$; (3) $4{\cdot}5 \rightarrow 5{\cdot}9$; (4) $3{\cdot}0 \rightarrow 4{\cdot}4$; (5) $1{\cdot}5 \rightarrow 2{\cdot}9$; (6) $\leqslant 1{\cdot}4$. The dashed line indicates the probable lower limit of abundance categories (1) and (2); see tide contours on Figure 1. Dry flesh weight *Hydrobia* equals, "whole animal dry weight × 0·175" (M. Elliot, pers. comm.).

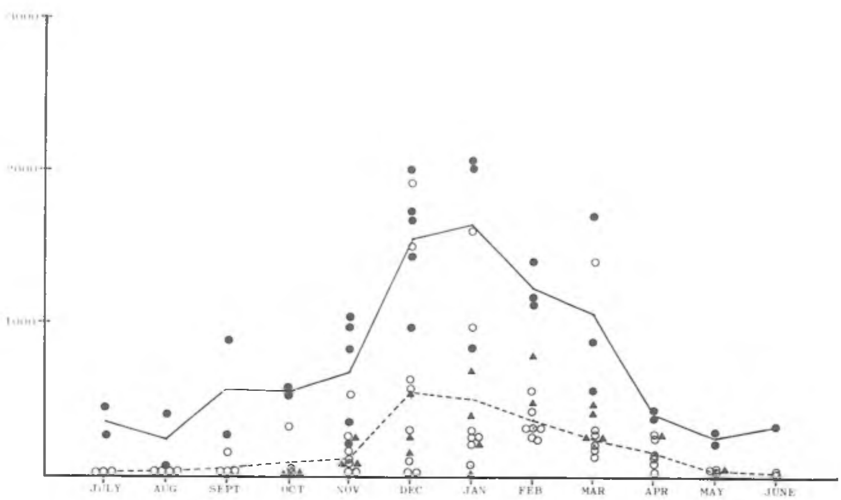

Figure 3. The number of Shelduck in the upper Firth of Forth. The solid line indicates the mean of all counts (●) from the data of the B.T.O., R.S.P.B., W.T., I.W.C., 'Birds of Estuaries Enquiry' (Aug. 1969 to Jan. 1975), where all the main sites have been covered in each month. The dashed line indicates the mean of all Skinflats counts (O) in the same period. Closed triangles (▲) are the Skinflats counts for this study, and indicate the numbers of birds, on which observations were based.

Table 1. Sheldduck activity in relation to tide state. The feeding methods (1) to (5) are illustrated in Figure 4, and described in the text.
The 12 hour tidal cycle is divided into 9 segments.
In order to clearly indicate the pattern of events close to high water, the $\frac{3}{4}$ flow to $\frac{3}{4}$ ebb period is divided into 1 hour instead of the 1·5 hour periods used otherwise. Activity percentages are based on (n) 'Shelduck × observation days'.

Tide state	Low—$\frac{1}{4}$	$\frac{1}{4}$—$\frac{1}{2}$	$\frac{1}{2}$—$\frac{3}{4}$	1st Hr	2nd Hr	3rd Hr	$\frac{3}{4}$—$\frac{1}{2}$	$\frac{1}{2}$—$\frac{1}{4}$	$\frac{1}{4}$—Low
	Low ——→	Flow ——→		High ——→		Ebb ——→			Low
% Use of each feeding method									
(1)	0	0	0	0	0	0	0	0	0
(2)	9·0	26·0	0·2	0·1	0·4	7·4	17·0	9·8	18·2
(3)	0	1·1	2·2	0	3·7	16·3	0	0	0
(4)	0	56·7	79·7	49·5	35·1	14·4	0	1·3	0
(5)	0	2·7	11·4	16·5	28·8	2·5	0	0	0
Total % feeding	9·0	86·5	93·6	66·2	68·1	40·6	17·0	11·1	18·2
% Roosting	91·0	13·5	6·4	33·8	31·9	59·4	83·0	88·9	81·8
(n)	1668	2770	3424	2305	2191	1572	945	953	1820

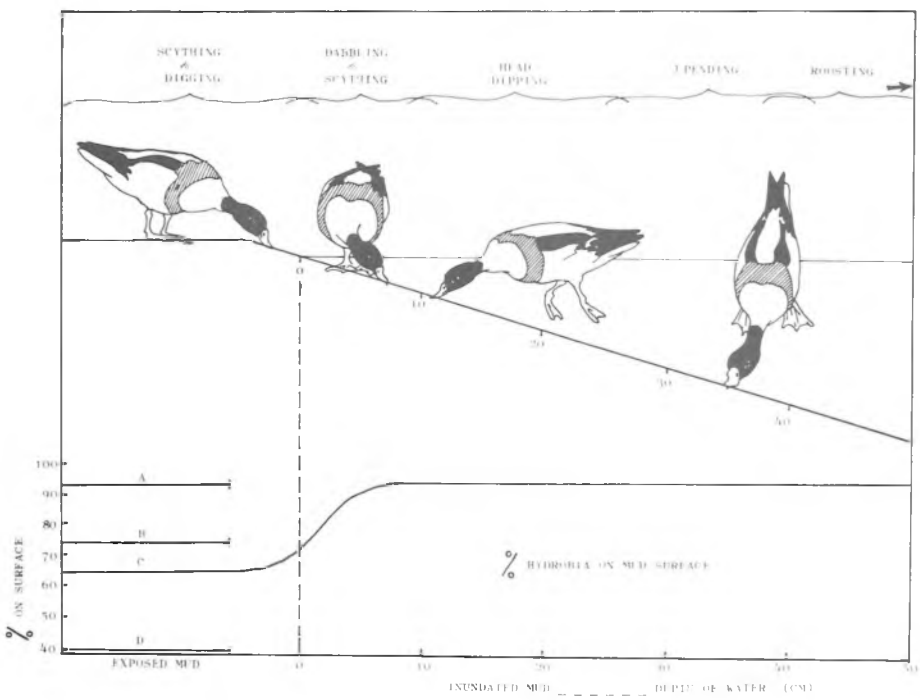

Figure 4. Summary of Shelduck feeding methods showing relationships between the different methods used and (1) water depth and (2) the proportion of the *Hydrobia ulvae* population at the mud surface (*Hydrobia* data from Vader, 1964). A.—Percentage of *Hydrobia* population remaining on surface of mud at night at low tide. B.—Maximum daytime percentage of *Hydrobia* on mud surface at low tide. C.—Percentage of Hydrobia on exposed mud surface under experimental laboratory conditions. D.—Minimum daytime percentage of Hydrobia on mud surface at low tide. See text for description of feeding methods.

The activity of Shelduck

Feeding occurred mainly on the flow tide and around high water, while non-feeding periods (called roosting here) predominated on the ebb tide and at low water (Table 1). Feeding can be categorized into five methods: (1) Surface digging for *Hydrobia* burrowed in exposed mud, mentioned by Olney, 1965; (2) The scything action or, less common, dabbling, by birds feeding on exposed mud with a moist surface, as described by Swennen & van der Baan (1959). This method intergrades with (3) which involves dabbling and also scything in shallow water (1 to 10 cm) at the tide fringe or in pools, from a standing position. (4) Head dipping in deeper water (10 to 25 cm) from a swimming position. (5) Upending in yet deeper water (25 to 40 cm) (Figure 4). During all these feeding methods except (1) *Hydrobia* are known or thought to be taken from the mud surface. The frequency of use of each feeding method was related to the tide state (Table 1). Head dipping (4) was much the commonest method used at Skinflats, being at a peak shortly after the mid flow tide. Upending was common around high water. As the tide fell the total feeding activity was much reduced, and many birds gathered in non-feeding groups, most birds standing well out on the mud flats. The birds that continued to feed however, adopted predominately the scything and dabbling methods, (2) and (3), either at the tidal fringe or in the wetter areas of exposed mud. The feeding bouts of these birds were usually of short duration, and they would then fly or walk back to the receding tidal fringe and recommence feeding.

The pattern of tidal movement

Tidal movement at Skinflats is generally in a north-westerly direction on the flow tide and towards the southeast on the ebb, rather than directly inshore and offshore. An inert floating body, will thus move in the same direction in the absence of strong winds and many Shelduck could be seen to be passively moved this way, in and out with the tide. The lowest sector of the study area lies in the southeast and this floods early and rapidly. At high water on neap tides some of the flats remain exposed though on springs the entire area of mud is inundated (Figure 1).

Feeding intensity in relation to food supply

Feeding Shelduck usually associated with regions of abundant *Hydrobia* (Figures 2 and 5), although were concentrated slightly inshore of the highest *Hydrobia* populations. Feeding also occurred however towards the northern end of Skinflats, mainly around high water, even when *Hydrobia* was scarce in that area, late in winter. Part of the southern sector also had many *Hydrobia* but was little used for feeding by Shelduck.

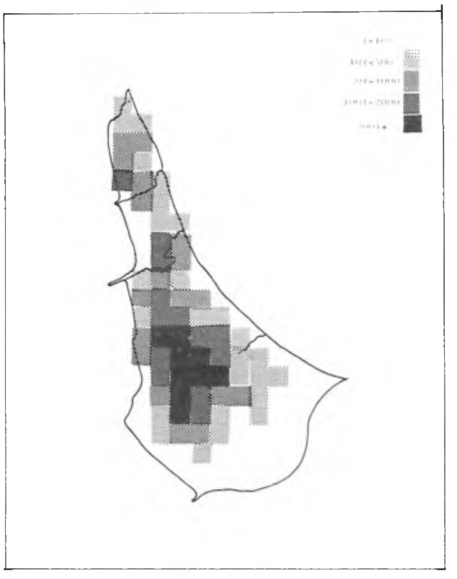

Figure 5. Distribution of Shelduck feeding during the winter (1st October to 31st March). The total 'Shelduck × feeding hours' in each grid square, is calculated from field observations of 7 hours per day on 3 or 4 days each month (see text). No allowance is made for days when frost was severe (see text).

The reaction of Shelduck to severe frost was apparently not consistent. In November and January the birds had moved away from Skinflats following overnight minimum temperatures of −2·0°C and −3·5°C respectively. However in December and March many birds remained following overnight minima of −2·8°C and −4·5°C. It is therefore not easy to ascertain from temperature records, in the absence of field observations, on which days the feeding birds moved elsewhere. If a threshold temperature of −3·0°C minimum overnight temperature is assumed to be the level which usually inhibits feeding, a total of 19 days during the study period would have been without feeding Shelduck at Skinflats. It is almost certain that the frost was sufficiently severe on 13 of these days to prevent feeding, these comprising

6·1% of the daylight feeding periods from October to March.

Disturbance

On each observation day, all disturbance was recorded, divided into two categories, that causing (1) a cessation of feeding or (2) flushing. Humans walking across Kincardine Bridge or along the seawall caused the former up to a maximum distance of 0·5 km and the latter up to 0·25 km. The sound of a shot had a variable influence, possibly depending on the amount of recent disturbance, though the situation was generally similar to that of a moving person. Industrial sounds arising from the adjacent Grangemouth area were mostly ignored as were aircraft and helicopters at normal operational height. The occasional passage of boats caused localized disturbance close to the L.W.M. After flushing the movement of birds was generally downstream in a south-easterly direction. Disturbance was in practice probably sufficiently infrequent, brief and localized not to substantially influence the pattern of feeding. However it could be hypothesized that the absence of more feeding birds in the northern sector of the study area could be partly due to disturbance outside the observation periods. It is also possible that Shelduck would have fed more extensively in the south of the area if disturbance from shooting and construction work was reduced. This suggestion is supported by the observation that Shelduck were rather closer inshore in March after the shooting season, than in January when foreshore shooting was particularly prevalent in that area.

Discussion

In view of the general predominance of *Hydrobia ulvae* in the Shelducks' diet elsewhere (Campbell, 1947; Goethe, 1961; Olney, 1965a, b), this snail is likely to be the principal food item at Skinflats and the main causal factor in the distribution of Shelduck feeding. Observations of Shelduck feeding methods at Skinflats and the high relative abundance of *Hydrobia* (numerically and in dry flesh weight m^{-2}) add further support to this suggestion. However the main source of dietary energy could not be positively identified in the absence of food samples from gut analysis; faecal samples would inevitably be biased against soft bodied food items. It must be recognized therefore that organisms apart from *Hydrobia* may influence feeding patterns. Thus the precise feeding site may have depended both on the density and behaviour of *Hydrobia* and the availability of alternative foods.

Vader (1964) investigated the tidal cycle of *Hydrobia* in the field and under laboratory conditions. He reported that during the day (in winter) the percentage of *Hydrobia* on the mud surface declines throughout the low tide period to a level of about 40% of the total population just before immersion. Very close to the point of reimmersion the population tends to rise to the mud surface once again. Thereafter as the water deepens the proportion on the surface increases until at 5 to 10 cm water depth 90% to 95% are at the surface, and this level remains through the high water period. At the time of emersion a proportion of the population once again moves beneath the mud surface, and this process continues through the ebb period. This pattern of tidal movements was also qualitatively observed at Skinflats though very few *Hydrobia* were visible in midwinter on the mud surface at low tide, probably partly associated with low temperatures (Figure 6). Two further behavioural aspects of *Hydrobia* probably have important consequences for feeding Shelduck. Firstly, in summer almost the entire population burrows beneath the mud surface at low water probably because of the dry state of the mud surface. This also occurs in winter in areas such as Skinflats which drain rapidly on a falling tide. Secondly Anderson (1971) has shown that it is only between March and November that a proportion of the snails float in with the tide; usually with a peak in June. At Skinflats floating *Hydrobia* were seen in very small numbers in September and October and not at all in the rest of the winter. This aspect of the behaviour of *Hydrobia* therefore has little significance for Shelduck feeding ecology during most of the winter, at least in northern Britain. Shelduck were observed to feed in areas of high food density (dominated *by Hydrobia*) on the flow tide, when they were covered by water to a depth of at least 5 cm. Under these conditions a very large percentage of the *Hydrobia* would have been at the mud surface and thus most available to the feeding birds (Figure 4). The Shelduck. However the presence of large quantities of shell debris in the form of a raised bank, made the substrate coarse and towards the shore and on neap tides continued to feed throughout much of the high tide period in water of 10 to 25 cm depth adopting mostly the same method of feeding

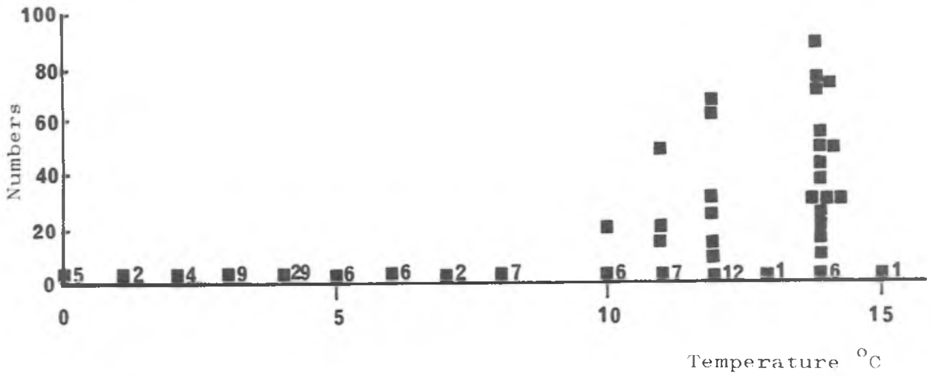

Figure 6. Number of *Hydrobia* observed on the mud surface in relation to mud surface temperature. *Hydrobia* numbers recorded at low tide within 100 cm² plots; temperature recorded at a depth of 2 cm. Figures beside points (■) indicate number of observations where no *Hydrobia* were on mud surface.

as described above (Figure 7a). However on spring tides and at other times close to high water (H.W.N.) the regions of high food density were often covered by water of too great a depth for the head dipping method of feeding. Upending then became commoner (Figure 7b) taking place in water of 20 to 40 cm. The extent of upending was greater on spring tides because of the greater duration and depth of coverage of the better feeding areas. At high water, particularly on spring tides many Shelduck moved towards the northern end of Skinflats. Here the water was shallower and feeding could continue even at high tide (H.W.S.). It appears that when feeding in the main *Hydrobia* area was prevented by too great a water depth, the Shelduck moved to an area with poor *Hydrobia* resources. At such times alternative foods may be taken preferentially and have a dominant influence on feeding distribution. A return movement to the main *Hydrobia* area occurred when the water fell. Shelduck thus tended to concentrate for feeding in the sites of the highest *Hydrobia* density only when the tidal state allowed. It was probably those Shelduck which remained inadequately nourished, by the time the tide had started to recede, that continued to feed on the recently exposed flats and in shallow water, for as long as surface *Hydrobia* were abundant. A rapid draining of surface waters at Skinflats possibly discouraged feeding on the ebb tide. In other areas the drainage may be less rapid and therefore *Hydrobia* remains available at the mud surface for rather longer. It could be this factor which resulted in more extensive feeding on the ebb tide on the Thames Estuary (Olney, 1964) than was observed in the present study. Because the rate of tide fall on neaps is slower than on springs, the main *Hydrobia* areas would be in shallow water for longer, thus encouraging rather more extensive feeding. (Figures 8a, b). Anomalously an area of abundant *Hydrobia* in the low south eastern sector was little used by feeding Shelduck. However the presence of large quantities of shell debris in the form of a raised bank, made the substrate coarse and probably unsuitable for feeding. Furthermore this area was covered too rapidly by the flow tide to allow much use at this time. Disturbance from shooting and construction work possibly further discouraged Shelduck from using this part of Skinflats. It is clear that the use of a variety of feeding methods, including head dipping and upending on the flow tide and at high water, and the scything and dabbling methods on the ebb tide, enables the high availability of *Hydrobia* at certain tide levels, to be exploited for a great proportion of the tide cycle than if a single feeding method was employed.

The influence of weather conditions is one of extremes; they are either of great importance or almost insignificant. The most striking example occurred when the flats were completely frozen over on two of the sample observation days, and in spite of the tide coming in no birds were seen to feed even after high water. This was because they moved into more saline water downstream, where the effects of the freeze were less severe. They did not return to Skinflats until at least nightfall on the same days. It is therefore not unexpected that extended periods of frost are known to cause extensive mortality in Shelduck (Olney, 1965), probably especially

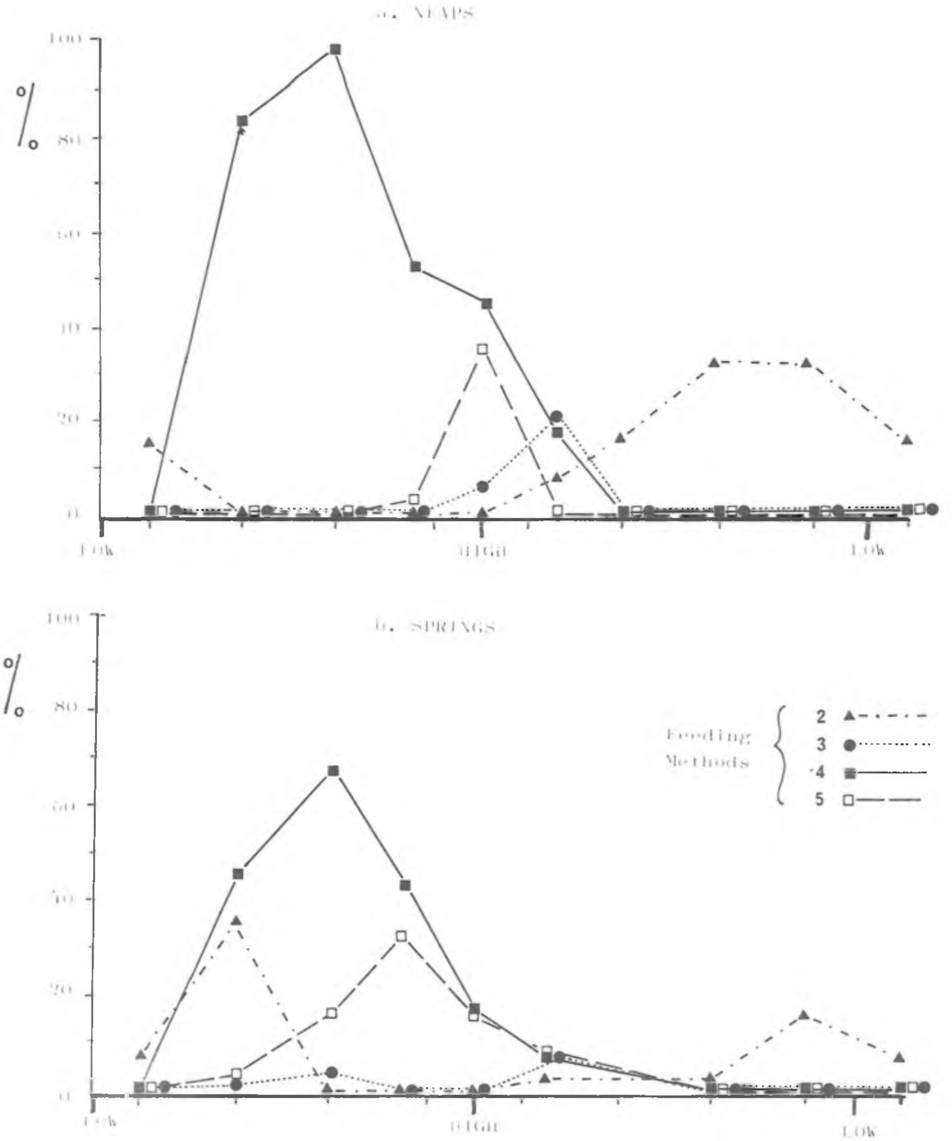

Figure 7. Shelduck feeding activity on neap and spring tides at different tide levels. Feeding methods (1) to (5) are illustrated in Figure 4, and described in the text. (1) Not recorded at Skinflats; (2) – · – · –; (3) . . . .; (4) ———; (5) – – –. The 12 hour tidal cycle is divided into 9 segments of 1 to 1·5 hours (see Table 1).

if alternative feeding areas are restricted. On one day in January during the study, an enormous number of *Hydrobia* were found stranded along the high water mark following a gale. While the measured abundance on the mud flats remained little changed after this event it is possible that the disturbance at the mud-water interface during the very strong gale was sufficient to depress feeding success. A similar relationship between mud station and temperature in *Hydrobia*, probably exists as Goss Custard (1969) demonstrated for *Corophium*. This could influence the availability of *Hydrobia* to feeding Shelduck particularly on the exposed mud towards low water, and would comprise a further factor discouraging feeding on the ebb tide.

Human disturbance was usually fairly light because the glutinous nature of the mud discouraged access, which was thus usually confined to the area of the sea walls. Because the birds were mainly disturbed close to high water on spring tides and as feeding is probably not very efficient at this time the significance for the birds is likely to be slight. The pattern of feeding in darkness was not examined. However because up to 90% of *Hydrobia* may stay at the mud surface throughout the night at both high and low water (Vader, 1964) and they are probably located mainly by tactile clues it could well be that Shelduck feed extensively at night, as do other estuarine birds, and then concentrate less on the recently inundated *Hydrobia* than during the day. The problem deserves further study, because feeding rates of certain estuarine birds seem to be reduced at night (Heppleston, 1971).

The Shelduck and the Dark-bellied Brent Goose *Branta bernicla* (Ogilvie & Matthews, 1969) are the only two Anatidae in north-west Europe which make the estuaries of Britain their main winter headquarters. The Shelduck is consequently likely to be a particularly threatened species of estuarine areas in Britain.

The most straightforward method of assessing the importance of an area for Shelduck is to conduct counts of the birds using the site for feeding. However with the prevailing pressure from government, industrial and agricultural interests to reclaim estuarine areas, it is often important to assess which zones within larger areas are of greatest importance and to make a particular effort to conserve these sites. It is apparent from this study that the birds congregate for feeding where *Hydrobia* is abundant and available to the feeding birds. Any estuarine development such as large scale reclamation which eliminated the feeding grounds would obviously depress the carrying capacity of Britain's estuaries. Reclamation of even small areas where *Hydrobia* is abundant and available or which are used as hard weather refuges could have particularly damaging consequences. Conditions which disturbed local tidal patterns or the configuration of the mud flats may also be important, although the distribution of infaunal organisms might in time adjust to the new conditions and the long term effects would then be slight. Any development which permanently depressed *Hydrobia* stocks could be damaging to Shelduck populations. For example a reduction in salinity through the constriction of flow at the estuary mouth could render conditions unsuitable for *Hydrobia* (Newell, 1964) even though such a development may be quite remote from the site itself. Changes in the import of organic detritus or in sedimentation patterns through canalisation and dredging schemes might also be important, while pollution may have detrimental influences well described elsewhere (Ashby, 1972) or even possibly advantageous influences if it involves compatible quantities of suitable organic material. In conclusion therefore the conservation of Shelduck wintering in Britain, must be based on the ability to predict the impact of development schemes and to resist such schemes where they threaten the integrity of estuarine areas. Such a prediction will require both a knowledge of the number of birds using the area and the potential impact of development proposals on the abundance, distribution and availability of estuarine food organisms.

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Summary

The pattern of Shelduck *Tadorna tadorna* feeding was studied at Skinflats on the Firth of Forth, during the winter of 1972–1973. An association between the intensity of feeding and the distribution and abundance of the main food, *Hydrobia ulvae*, was observed. This association was influenced by tidal movements and weather conditions and possibly by human disturbance. The behaviour of *Hydrobia* in relation to water depth apparently strongly influenced both the spatial distribution of feeding flocks and the feeding method used.

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An alert Ringed Teal *Anar leucophrys* at Slimbridge (*Brian Crosby*).