Sexual differences in migration and winter quarters of ducks ringed in the Netherlands

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Introduction

Wigeon *Anas penelope*, Pintail *Anas acuta*, Shoveler *Anas clypeata*, Teal *Anas crecca*, and Mallard *Anas platyrhynchos* have been ringed in great numbers in the Netherlands and as a result there are many recoveries of these species. A comparative analysis of the migration patterns in which greater details of materials and methods are given has been published (Perdeck and Clason 1982). A fairly large number of the ringed ducks were sexed, and the recoveries of these have been used to analyse differences between males and females with regard to migration to and the position of the winter quarters. The influence of the winter temperatures on the different areas taken up by male and female Teal, Pintail and Wigeon were also studied. Only recoveries of birds shot after the first March following ringing were used. The overall sample size for the species is given in Table 1 (bottom). Since the recoveries in July are very biassed by regional variation in the start of the hunting seasons, they were excluded.

Differential migration according to sex

For each species the median position of males and females was calculated for May and June combined (representative of breeding area), August, September, October, November, December, January and February. These positions are shown in Figure 1, where the male and female medians for a month are connected by a line.

For each period the difference between the individual recovery-scatters of males and females was tested with the two-sample uniform scores test (Mardia 1972). Significant differences (indicated by asterisks in Figure 1) were found during the autumn (Mallard, Teal, Wigeon) and the winter (Pintail, Wigeon). Apart from these significant differences, there seems to be a trend for males to be migrating ahead of the females during the autumn. However, the females catch up, during November, and even overtake the males in winter.

To test this further, the main axis or first principal component (on the map) was calculated from the 16 median positions (8 for each sex). These positions were then projected on this axis and the value for the female subtracted from that of the male. Since the value on the axis increases from wintering area to breeding quarters, a negative difference means that

Table 1. Difference between monthly median positions of males and females on the main axis (kilometres). Values between parentheses are rank numbers.

	Wigeon	Pintail	Shoveler	Teal	Mallard	Mean rankings
May & June	−137 (2)	−54 (3)	−258 (2)	−350 (8)	−296 (3)	(4)
August	−14 (5)	−53 (4)	−543 (1)	−210 (2)	−353 (2)	(2)
September	−135 (3)	−378 (1)	−81 (4)	−231 (1)	−447 (1)	(1)
October	−1119 (1)	−176 (2)	+36 (6)	−58 (3)	−247 (4)	(3)
November	+42 (8)	+9 (5)	+198 (8)	+55 (4)	−9 (5)	(6)
December	−74 (4)	+432 (8)	+133 (7)	+65 (5)	+27 (7)	(7)
January	+17 (7)	+351 (7)	−98 (3)	+85 (6)	+10 (6)	(5)
February	0 (2)	+192 (6)	−3 (5)	+144 (7)	+44 (8)	(8)
Number males	581	559	114	1247	522	
Number females	420	479	110	840	816	

The periods of ringing are from July to March inclusive (Shoveler), October to March inclusive (Mallard), and August to March inclusive (Wigeon, Pintail, Teal).

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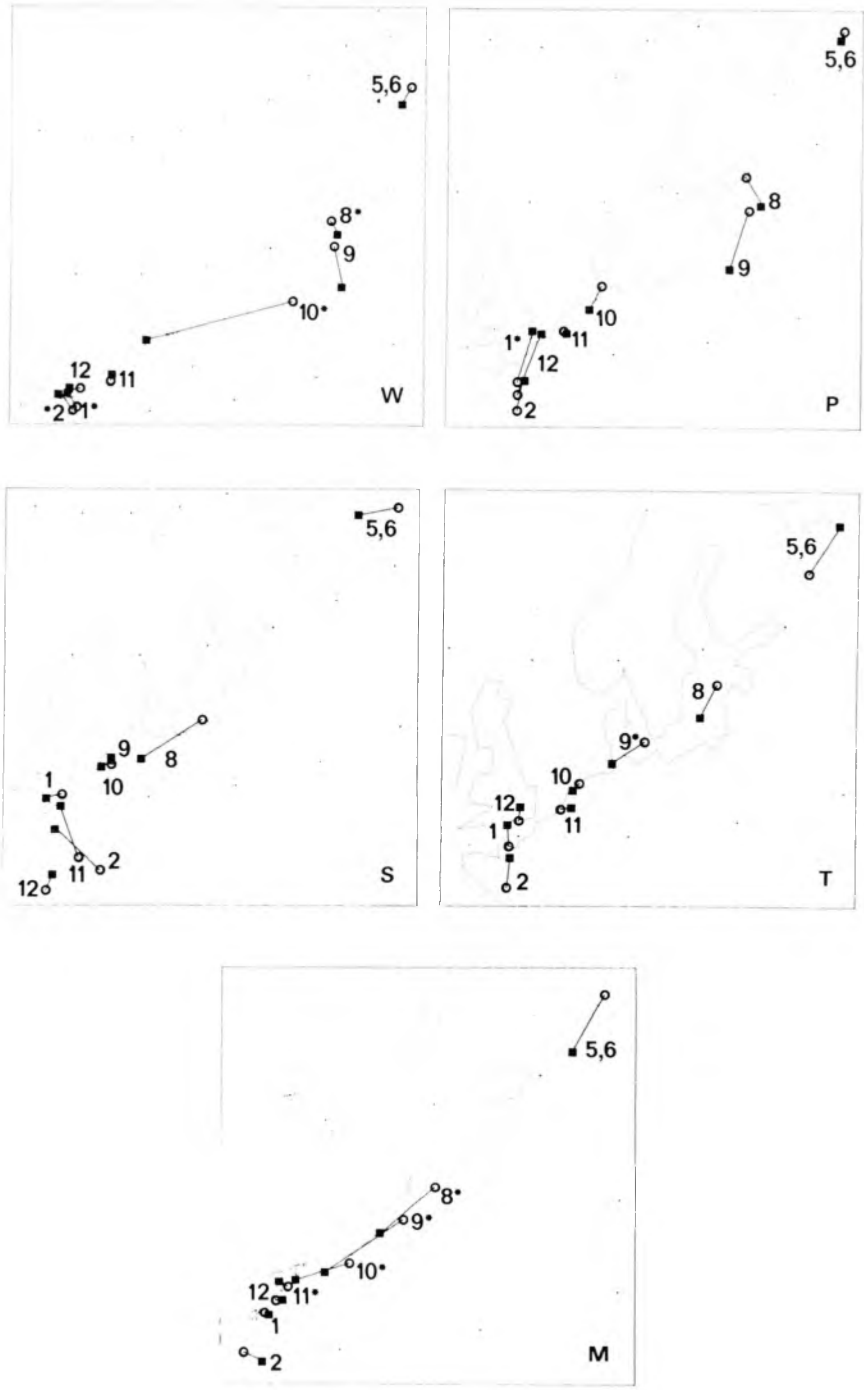

Figure 1. Average position of males (squares) and females (circles) in the various months (numbers). Asterisks indicate a significant different between males and females.

W = Wigeon, P = Pintail, S = Shoveler, T = Teal, M = Mallard.

the females are closer to the breeding area, a positive one that the males were. The result is given in Table 1. The species form a concordant group (Kendall's coefficient of concordance = 0.53, $P < 0.01$), and the mean ranking can be used to correlate male-female differences with the time of the year. If the eight periods are numbered from 1 (May, June) to 8 (February), this sequence correlates with the mean rankings ($r_s = 0.76; P < 0.05$).

It is therefore concluded that females do tend to lag behind the males during the autumn, catch up with them in the winter, and then generally take up more southerly positions than the males (sexual allohiemy).

Sexual allohiemy and winter temperature

If females were more sensitive than males to cold weather and responded to it by moving away, a relationship, especially in females, between temperature and position could be expected. Teal, Pintail and Wigeon were chosen for this analysis, since these species showed distinct differences in the winter position of males and females. These differences are north-south in Teal and Pintail, and approximately northwest-southeast in the Wigeon (Figure 1).

The influence of temperature was studied by comparing the positions of males and females in winters of different severity. Recoveries from the British Isles, the Netherlands, Belgium, France, Spain and Portugal were divided into two categories. For the Wigeon the categories are 1) British Isles, 2) Continent; for the Pintail 1) north of 48°N, 2) south of 48°N. Teal present a problem, as both males and females shift their position to the south during the winter as shown in Figure 1. It appeared that especially the recoveries in February deviate from those in December and January. A satisfactory homogeneous north-south distribution could be obtained by defining the two categories of recovery place as follows: 1) north of the Belgium-French border (Dec., Jan.) and north of 48°N (Feb.), and 2) south of the Belgium-French border (Dec., Jan.) and south of 48°N (Feb.).

As it is not known to which regional temperatures the birds react, within the range of the winter distribution, six places (Netherlands, Central England, Shannon, Brest, Paris, Bordeaux) were selected, and for each place the winters of 1950-1977 were arranged according to the mean temperature in Dec., Jan., Feb. (K.N.M.I.; Frith 1974; U.S. Dept. of Commerce). Then for each year the average of the six rank numbers was calculated and the years were arranged using this average rank number (Table 2). This procedure is justified since the separate rankings are concordant (Kendall's coefficient of concordance = 0.73, $P < 0.01$). The relative rankings of the temperature of the six places indicate the degree to which warmth/coldness is widespread. Thus the winter 1962/63 ranks coldest in all six places, while 1974/75 ranks warmest in five places and second warmest in the sixth.

Since there are not enough recoveries for each separate winter, they have been grouped into four classes. Class 1 ('very low temperature') contains only the winter 63 (that is 1962/63). This exceptionally cold winter produced 30% of all recoveries.

Class 2 ('low temperature') contains the 9 winters with rank numbers 2-10, (56, 65, 53, 64, 51, 69, 70, 68, 54, respectively), class 3 ('intermediate temperature') those 9 with rank numbers 11-19 (52, 71, 59, 55, 62, 58, 77, 73, 76, respectively), and class 4 ('high temperature') 9 with rank numbers 20-28 (72, 60, 61, 50, 66, 67, 57, 74, 75, respectively).

For each species a contingency table was set up with the variables being temperature, recovery place and sex (Tables 3-5). A loginear analysis was applied to these 4 x 2 x 2 tables (Fienberg 1970, 1977). The best models according to fit and simplicity criteria are the ones that include a dependency between temperature and recovery place only (Teal) or a dependency both between winter and recovery place and between sex and recovery place. In neither case does the difference between male and female widen significantly with decreasing temperature. From the percentage column in Tables 3-5 it can be concluded that with higher temperatures Teal and Pintail stayed further to the

Table 2. Mean water temperature (Dec., Jan., Feb.) for six places in Western Europe and average rank number for each winter.

	A	B	C	D	E	F	Av. RANK No.*
1949/50	7°	7°	5°	4°	5°	6°	24
1950/51	4°	6°	3°	3°	4°	6°	11
1951/52	5°	6°	4°	4°	3°	6°	22
1952/53	6°	5°	3°	2°	2°	4°	6
1953/54	5°	7°	4°	2°	3°	6°	7
1954/55	5°	7°	4°	2°	4°	7°	8
1955/56	5°	6°	3°	1°	2°	4°	3
1956/57	6°	8°	6°	5°	6°	7°	27
1957/58	6°	7°	4°	3°	4°	6°	16
1958/59	5°	7°	4°	3°	4°	6°	13
1959/60	5°	7°	5°	4°	5°	7°	20
1960/61	6°	7°	5°	4°	5°	6°	23
1961/62	5°	6°	4°	3°	5°	7°	12
1962/63	3°	3°	0°	−3°	−1°	2°	1
1963/64	6°	5°	4°	1°	2°	4°	4
1964/65	4°	5°	3°	3°	3°	4°	10
1965/66	6°	8°	4°	3°	5°	8°	15
1966/67	6°	7°	5°	4°	5°	7°	25
1967/68	5°	7°	4°	2°	4°	6°	9
1968/69	5°	6°	3°	2°	3°	6°	5
1969/70	5°	7°	3°	0°	3°	6°	2
1970/71	6°	6°	4°	3°	3°	5°	17
1971/72	6°	7°	5°	3°	4°	6°	18
1972/73	7°	7°	5°	3°	4°	5°	19
1973/74	7°	7°	5°	4°	6°	7°	26
1974/75	8°	8°	6°	6°	7°	8°	28
1975/76	7°	7°	5°	4°	4°	5°	21
1976/77	5°	6°	6°	3°	5°	7°	14

A Shannon, Ireland, B Brest, C Central England, D Netherlands, E Paris, F Bordeaux
* ranking within each place based on temperatures measured up to first decimal (°C).

Table 3. Teal: distribution of recoveries according to winter temperature, recovery place and sex.

	Male			Female		
Winter temperature	North	South	% north*	North	South	% north*
Very low	42	102	29	17	65	21
Low	41	45	48	24	28	46
Intermediate	70	43	62	41	37	53
High	44	15	75	26	14	65
All winters	197	205	49	108	144	43

* north of Belgium-French border (Dec., Jan.)
north of 48°N (Feb.)

north. In the Pintail this relation is due solely to the difference between the 1962/63 and the other winters: without 1962/63 the dependency between temperature and recovery place is insignificant. In the Teal the relation holds for the other groups of winters as well.

In the Wigeon the situation is more complicated. From the percentage recovered in the British Isles (Table 5) it can be seen that when the winter 1962/63 ('very low') is excluded there is a tendency to winter less in the British Isles with increasing temperatures. Although this tendency is not significant, one would not expect, seeing these figures, such a very low number recovered in the British Isles in 1962/63 as is the case. Had the birds given up the British Isles as a place to winter since under

Table 4. Pintail: distribution of recoveries according to winter temperature, recovery place and sex.

	Male			Female		
Winter temperature	North	South	% north*	North	South	% north*
Very low	13	18	42	4	19	17
Low	28	14	67	19	13	59
Intermediate	35	5	88	16	11	59
High	25	8	76	9	4	69
All winters	101	45	69	48	47	51

* north of 48^{o}N

Table 5. Wigeon: distribution of recoveries according to winter temperature, recovery place and sex.

	Male			Female		
Winter temperature	Br. Isles	Continent	% Br. Is.	Br. Isles	Continent	% Br. Is.
Very low	9	25	26	4	19	17
Low	29	26	53	8	20	29
Intermediate	15	24	38	4	13	24
High	9	21	30	5	14	26
All winters	62	96	39	21	66	24

these extreme circumstances even here the temperatures were too low? Then one would expect that the Wigeon moved more to the south on the continent than in less extreme winters. This is not the case (19% recovered south of 48^{o}N in 1962/63 and 17% in the remaining winters). Another explanation of the low numbers recovered in the British Isles in 1962/63 might be that the British hunters curtailed shooting for the benefit of the birds, while this was not done to such a degree on the continent. This in spite of the fact that in many European countries, including France and Italy, shooting was forbidden by statute in February 1963, while such legal prohibition was not then possible in Britain.

Discussion

Figure 1 shows that the early migration of the males is sometimes directed toward the winter quarters (Mallard) and sometimes more to the south (Wigeon, Pintail), indicating migration to moulting areas.

From the maps it can be seen that differences in winter between males and females are most pronounced and consistent in Teal, Pintail and Wigeon. This accords with field observations and duck-wing studies. Thus during the winter a preponderance of male Teal and Pintail were observed in the Netherlands (Lebret 1950), whereas the midwinter sex ratio of the Mallard is practically equal (Eygenraam 1957). Boyd, Harrison and Allison (1975), Harrison and Allison (1977), and Harrison (1977) published the results of the analysis of duck wings collected from hunters in Great Britain. The adult male/adult female numbers were: Wigeon 2273/993; Teal 1106/757; Pintail: 33/20; Shoveler: 18/4; and Mallard: 725/841. The clear excess of males in the Wigeon led Harrison (1977) to suggest that 'the adult females have winter quarters elsewhere, quite possibly in France or further south'. This is confirmed by our analysis.

All the available evidence indicates that there is no difference in wintering area between the sexes in the Mallard. This lack of divergence might be explained by the early pair-formation of this species. According to Bezzel (1959), 80% of the individuals have already paired at the end of October. Teal, on the other hand, do not pair before the end of February.

Sexual allohiemy has been found in other duck species (Goldeneye *Bucephala clangula:* Nilsson 1969; Pochard *Aythya* *ferina* and Tufted Duck *A. fuligula:* Salomonsen 1968; Canvasback *A. valisineria:* Nichols & Haramis 1980).

Goldeneye, Pochard and Teal females feed in shallower water than males, and during cold periods leave the area (Nilsson 1979; Willi 1970). This seemed to be connected with sexual differences in feeding behaviour. Pochard females have shorter diving times than the males, while in the Teal the method of feeding with the front of the body submerged is almost exclusive to the males (Willi 1970). Both their smaller size, and such behaviour, make the females more sensitive to cold weather than males. If their reaction to cold is to move further on, a segregation of the sexes in the winter quarters would be expected. The present analysis shows, however, that male and female ducks react in much the same way to temperature.

Salomonsen (1968) suggests that the males, arriving first in the winter quarters, occupy all available space within the specific niches and pre-empt the food reserves. The females (and juveniles) are thus forced to migrate further.

In the Canvasback, Nichols & Haramis (1980) found that birds trapped during the winter on smaller bodies of water tended to have higher proportion of females and weigh less than birds trapped on large open bodies of water. Further, there was a pattern of intersexual segregation, with females being found more frequently on the periphery of roosting flocks. These observations suggested that intersexual competition could be an important cause of the latitudinal differences (females more to the south) in the wintering areas of the sexes.

It is clear that more studies are needed to clarify the basis of sexual allohiemy in the species examined.

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Summary

Recoveries during May to February of Wigeon *Anas penelope*, Pintail *A. acuta*, Shoveler *A. clypeata*, Teal *A. crecca* and Mallard *A. platyrhynchos*, ringed in the Netherlands were analysed for migrational differences between the sexes. The results showed that the females tended to lag behind the males during the autumn, catch up with them before the winter, and winter in more southerly positions.

This allohiemic behaviour of the sexes was related to winter temperatures taken at six places in western Europe. In Teal, Pintail and Wigeon a more or less pronounced relationship between temperature and recovery place was found, but differences between sexes are not significantly increased in cold winters. This makes it unlikely that allohiemy is caused by a different reaction of males and females to low temperatures.

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