GROWTH AND MORTALITY OF MALE AND FEMALE NESTLING HOUSE SPARROW *PASSER DOMESTICUS* IN ENGLAND

Luc SCHIFFERLI

ABSTRACT - To find out whether the surplus of males found in various adult populations of House Sparrow is the result of an unbalanced sex ratio at fledging, the author studied the sex ratio of nestlings and growth and mortality of males and females in 397 chicks. There was no evidence for an unbalanced sex ratio and no sexual differences in growth or morality were found. However, the sample to establish the sex ratio is much smaller than the ones of adult populations in which an unequal ratio was established by others. Sex ratio and competition of nestlings in various species of birds are reviewed and discussed. It is suggested that an unbalanced sex ratio in House Sparrow fledglings would occur only if food is abnormally poor. Then females which are smaller in size might be at a disadvantage in competition with their male siblings.

KEY WORDS - Sex ratio, *Passer domesticus*, nestling mortality, growth.

Several studies on the sex-ratio of adult House Sparrows in Germany show a slight surplus of males in the winter population (Niethammer 1953, Piechocki 1954, Löhrl & Böhringer 1957). The data seem representative, since they are based on large samples found dead after extensive poisoning which affected up to 95% of the populations (Niethammer 1953). However, some bias cannot be ruled out, e.g. the more colourful males might have been found more easily (Löhrl & Böhringer 1957). Other authors confirm the results from Germany but their methods of estimating the sex-ratio seem more open to bias. Dawson (1967) reports a slight proponderance of males in adult House Sparrows found dead under a roost after a heavy rain storm in New Zealand; however, some females might have been mistaken for juveniles, while others could have been roosting with their broods. Nichols (1934) censused the sexes in New York from November to May by direct observations which showed a surplus of males, as did field observations by Mansfeld (1950) and by Pfeiffer & Keil (1962) in Germany shortly before breeding started.

If there is a slight surplus of males in the House Sparrow when breeding

Schweizerische Vogelwarte
6204 Sempach CH

settembre 1980 AVOCETTA 4: 49-62

begins the question arises whether this is (1) the result of an unbalanced sex -ratio already present at fledging or whether it is (2) caused by differential mortality of the sexes after fledging, or (3) a combination of the two.

The aim of the present study was to investigate the sex-ratio at hatching and at fledging and to test whether the sex-ratio changes during the nestling period through a sex differential in mortality. Such mortality might occur if the slightly smaller females were at a disadvantage in competing for food with their male siblings. Some aspects of growth in relation to the sex of the ne - stling were also examined.

METHODS

Over the summers of 1972-74 a total of 397 nestlings from 133 different broods were col - lected throughout the breeding season and at all nestling ages. They were taken from a population of House Sparrows near Oxford, England, breeding in nest-boxes that were checked at regular intervals. The chicks were sexed by inspection of the gonads under a binocular microscope. In most males the testis could be seen by the naked eye. They varied in size about between 1-2 mm depending on age. In the females the ovary was somewhat larger (1.5-3 mm) and flatter. As found by others (Williams 1940, Kessel 1957, Bösenberg 1958) sexing was possible at all ages . However, the dissection had to be done very carefully as the testis tended to be attached to the liver and intestine and could accidentally be removed with these organs. Despite this the sex of 98% of the specimens was established beyond any doubt.

All nestlings were dissected and the gizzard, alimentary canal, liver and carcass processed separately. The food was removed from the gizzard and alimentary canal and the components dried to constant weight in a over at about 85 °C, weighed, and the fat extracted in a Soxhlet apparatus using chloroform as a solvent. The chloroform remaining on the specimens was evaporated and the fat content of the nestling obtained by subtracting the lean dry weight from the dry weight. Chicks older than seven days were plucked.

RESULTS

The sex-ratio of nestlings

The sex of 397 nestlings and 11 chicks that died, presumably from starvation, is shown in Table I, where the broods are divided according to their previous nest history. Overall, there is a remarkably well balanced sex-ratio amongst nestlings (50.5% males).

There is no evidence for an unbalanced ratio at hatching in broods where all eggs hatched and survived, or in nests where some eggs failed to hatch. In addition, there is no indication of a sex differential in nestling mortality , as no sex prodominates either in chicks which died in the nest or in the survivors of broods that suffered mortality. Hence, the sex-ratio in nestlings seems to be close to 1:1, regardless of the previous nest history. Nevertheless, it should be noted that some of the sub-samples are rather small.

TABLE I - Sex-ratio of nestling House Sparrows. Data from 1972, 1973 and 1974. No ratio differs significantly from 1:1 (chi-square tests).

	males	females	% males	broods
All eggs hatched and survived	76	73	51.0	36
Some eggs failed to hatch, but all hatching chicks survived	49	47	51.0	36
Some chicks died	29	34	46.0	25
Unknown	48	41	53.9	26
Total	202	195	50.9	133
Chicks that died in the nest	5	6	45.5	11

Sex differences in nestling weights

Although there is apparently no sex-linked mortality in the nest, one or the other sex might be more successful in competing for food within the brood. This would not necessarily lead to mortality but would cause differences in nestling weights. To find out whether such differences exist, the siblings were ranked according to their live weight. The results are shown in Table II, where the sex-ratio for the two heaviest chicks within a brood is compared with that of the lighter siblings. A proponderance of males (54.5%) was found in the group of heavier chicks and a slight surplus of females (51.2%) in the lower weight class. This might have been expected as fully grown males are slightly larger and usually heavier than females. However, if the chicks are ranked according to their fat reserves we find an opposite trend. As both comparisons show only a slight and statistically non-significant deviation from an equal sex-ratio, there is no conclusive evidence that either sex is at a comparative disadvantage.

TABLE II - Order of male and female nestlings within a brood, ranked according to fresh weight (a), and fat reserves (b) in 69 broods. Only broods of three or more chicks older than two days were included.

	males	%	females	chi-square
Ranked order				
(a) ranked by life weight				
first & second	75	54.3	63	0.81 n.s.
third - fifth	60	48.8	63	
(b) ranked by fat reserves				
first & second	68	49.3	70	0.20 n.s.
third - fifth	64	52.0	59	

Nestling growth and post-fledging survival in relation to sex

The growth of nestling House Sparrows has been studied in detail (Summers-Smith 1963, Seel 1970, Dawson 1972, O'Connor 1973, 1975), but no information on growth in relation to the nestlings' sex is available. In Fig. 1 the means of body wet weights, of fat reserves, and of the lean dry carcass weights throughout the nestling period are illustrated for each sex. The increase with age in all components was very similar in both sexes and none of the paired mean values differed significantly.

Dawson (1972) has shown that 11 day old nestling House Sparrows which survived for at least 10 days after fledging were significantly heavier (24.0 g, s.e. 0.42, n = 44) than those that died within this period (20.1 g, s.e. 0.91, n = 10). To test wether one sex might suffer higher mortality before reaching independence, the nestling analysed in this study were grouped according to their weight when 11 days old. As my sample was rather small (n = 24), chicks collected when 10 days old were added to the sample. Dawson's data showed a mean weight increase of 0.5 g during the 11 th day and for the present comparison this amount was added to the weights of 10 day old chicks. Table III shows the sex-ratio in heavy chicks with good chances of survival to independence ('survivors') and that of youngs with a much lower survival chance ('non-survivors'). The ratios in both groups were, again, not significantly different from 1:1, providing no evidence for a sex-linked mortality before the fledglings reach independence. To summarise the results of this study, I was unable to detect any sex differences in mortality, in growth or survival chances in nestling House Sparrows.

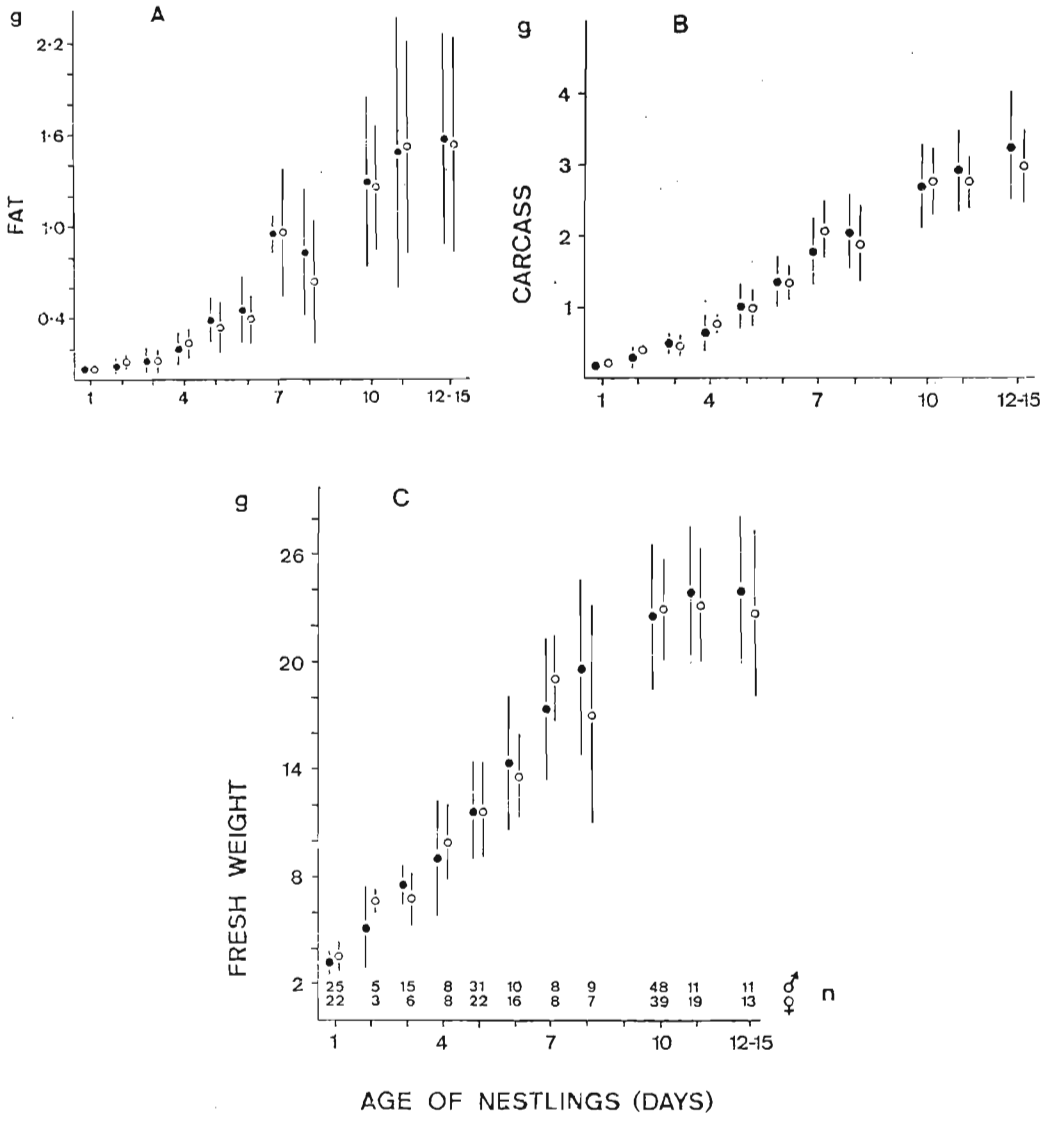

FIGURE 1 - Changes in the fat weight (A), the lean dry carcass weight (B) and the fresh body weight (C) in male (dots) and female (open circles) nestlings. The means ± 1 standard deviation (vertical bars) are given. The sample-sizes are indicated in C. The means of males and females do not differ significantly (t-tests) at any age and there is no significant difference in the total sample of males compared with females (matched pairs t-tests) in any of the three examples.

TABLE III - Male and female nestlings grouped according to their fresh weight when 10-11 days of age. 'Survivors': chicks weighing 24.0 g or more when 11 days or 23.5 g or more when 10 days old. 'Non-survivors': chicks of 20.1 g or less when 11 days or 19.6 g or less when 10 days old. See text for explanation.

	Males	%	Females
'Survivors'	29	48.3	31
'Non-survivors'	10	55.6	8

DISCUSSION

Sex ratio at hatching

The sex-ratio at hatching reflects the proportion of males and female at the time of fertilisation ('primary sex-ratio', Mayr 1939), unless one sex has a higher embryonic mortality. There are, however, few data on the sex of avian embryos that fail to hatch. In the Domestic Chicken *Gallus domesticus* (Byerly & Jull 1935), the Ring-necked Pheasant *Phasianus colchicus* (Latham 1947) and the Canvasback *Nyroca valisineria* (Hochbaum 1944) embryonic mortality was slightly higher in females than males. In an attempt to establish the ratio at fertilisation, some authors sexed chicks from clutches where all eggs hatched (Table IV). Two of the species show an excess of males, three a proponderance of females. However, only the sex-ratio for the Domestic Chicken mentioned above and the Starling (Table IV A) differ significantly from 1:1. Hence there is little conclusive evidence for an unbalanced primary sex-ratio or an unequal embryonic morality.

It seems biologically more meaningful to determine the sex-ratio including the broods with 'infertile' eggs ('secondary sex-ratio', Mayr 1939), as this reflects the natural situation. Such data are presented in Table IV B. The males seem to outnumber the females in most cases, including the House Sparrow, but the surplus of females in the Starling is the only statistically significant example. In general, the results in Table IV suggest a fairly well balanced proportion of the two sexes at hatching and hence the sex-ratio at fledging will usually be close to 1:1, except where sex-dependent nestling mortality is present (see below).

TABLE IV - The sex-ratio at hatching in different species.
A) broods where all eggs hatched only
B) including broods with eggs failing to hatch
* artificially incubated eggs

	% males	n	Author
A) Herring Gull *Larus argentatus*	51.6	64	Goethe 1937
Eastern Redwing *Agelaius phoeniceus*	47.9	119	Williams 1940
Domestic Pigeon *Columba livia*	49.8	3,488	Levi 1945; Cole & Kirkpatrick 1915, combined
Starling *Sturnus vulgaris*	41.0	117	Kessel
House Sparrow *Passer domesticus*	51.0	149	this study
B) Red-billed Quelea *Quelea quelea*	52.6	948	Morel & Bourlière 1955; Ward 1965, combined
Spanish Sparrow *Passer hispaniolensis*	50.3	56	Gavrilov 1968
Ring-necked Pheasant *Phasianus colchicus*	50.3	1,020	Latham 1947
Turkey *Meleagris gallopavo*	50.2	19,446	Asmundson 1941
Canvasback *Nyroca valisineria*	50.8*	524	Hochbaum 1944
Redhead *Nyroca americana*	53.2*	412	
Mallard *Anas platyrhynchos*	52.7*	630	
Pintail *Anas acuta*	53.2*	519	
Starling *Sturnus vulgaris*	41.8	165	Kessel 1957
House Sparrow *Passer domesticus*	51.0	245	this study

The effect of nestling competition on the chicks by the time of fledging

During periods of food shortage, competition amongst the siblings of a brood can lead to retarded growth in some chicks and eventually to nestling mortality. In House Sparrow nestlings such evidence of inadequate food supplies are quite common and mortality caused by starvation is at times 30% or more (Mackowicz *et al.* 1970, Seel 1970, Dawson 1972). It might be expected that under such severe competition one sex or the other could be at a relative disadvantage and hence suffer heavier mortality than the other. It is usually assumed that the males, being slightly larger in most passerines (Witherby *et al.* 1943), would be favoured. However, it has been shown that females succumb less easily to physical stress (Latham 1947) and that males of some species have higher metabolic

rates (Riddle *et al.* 1930). Hence it is not necessarily the females that should suffer more under the competition for food amongst nestlings.

The results of the present study did not reveal any evidence for sex-differential nestling mortality in the House Sparrow. Neither sex predominated amongst the starved chicks nor amongst the survivors of broods in which some chicks died. As the sex-ratio is apparently well balanced at hatching (Table I) there is no reason to believe that it should deviate substantially from 1:1 at fledging.

The results of most studies on the sex-ratio of nestlings are based on small samples (see below). The sex-ratio of adult populations, however, usually differs only slightly from 1:1 (e.g. in the House Sparrow in Germany 52.3% males ; combined data from Niethammer 1953, Piechocki 1954, Löhrl & Böhringer 1957. n = 30,319 sexed birds). To show a statistically significant proponderance of one sex either a massive sample or a marked surplus of one sex is required. A surplus of 52% males, as in the adult populations mentioned above, can only be proved statistically with a sample of 2438 or more birds of known sex (chi-square = 3.9, 1 d.f., p = 0.05). My total sample of 397 nestlings (Table I) is therefore too small; it would provide a significantly unbalanced sex-ratio only if there were 55% males. Hence it is inadequate to decide whether the surplus of 52% males in adult populations is already apparent at fledging. There is, however , strong evidence from other studies and the breeding biology of the House Sparrow discussed below to suggest that nestling death is not sex-linked under 'normal' environmental conditions.

The sex-ratio at fledging in different species is documented in Table V. In the Red-billed Quelea the sex-ratio is close to unity (Morel & Bourlière 1955, Ward 1965). Bösenberg (1958), working on the House Sparrow suggested a sex-linked nestling morality as the proportion of males to females changed in favour of the males with increasing age; however, his results are not statistically significant (Dawson 1972). There are, however, two passerine species where females show a significantly heavier mortality. Gavrilov (1968) concluded this for the Spanish Sparrow, as the sex-ratio of fledgings differed significantly from 1:1 in spite of an equal ratio at hatching. His interpretation is supported by a surplus of females in 14 chicks that died in the nest (11 females). Nevertheless, the sex-ratio of fledglings seems to vary and is usually near unity at times when chick mortality is not abnormally high. Similarly, in a detailed analysis of the biology of the Great Tit, Dhondt (1970) found a significant proponderance of males in broods reared under unfavourable food conditions (and consequently of heavy nestling mortality). Urban areas with a chick loss of over 40% produced nestlings, 54.6% of which were males, in contrast to non-urban areas (35% mortality, 47% males). Moreover, non-urban areas, suffering highest mortality in June (40%) produced the largest surplus of males in this area (54%). Hence, in both species females seem to be at a disadvantage in competing for

food if the supply is unusually unfavourable.

TABLE V - Sex-ratio at fledging in different species.

	% males	n	Author
Red-winged Blackbird *Agelaius phoeniceus*	42	230	Williams 1940, Holcomb 1966, Holcomb & Tweist 1970, combined
Common Grack *Quiscalus quiscula*	39	61	Howe 1976
Starling *Sturnus vulgaris*	44	260	Kessel 1957
Great Tit *Parus major*, urban areas	55	207	Dhondt 1970
non-urban areas	47	1446	
Red-billed Quelea *Quelea quelea*	50	948	Morel & Bourlière 1955, Ward 1965, combined
Spanish Sparrow *Passer hispaniolensis*	58	383	Gavrilov 1968
House Sparrow *Passer domesticus*	51	397	this study

The question arises as to why females should suffer particularly under poor food conditions whereas the sex-ratio seems almost equal if mortality is average. It has been pointed out by Lack (1954) that bird species, including the House Sparrow, depending on a fluctuating food supply when rearing their young often start incubation before the clutch is complete. As result some chicks hatch and are fed well before the others. If food supply is rich all chicks can be fed adequately, but if food is scarce the earlier hatched and more advanced nestlings get virtually all the food brought to the nest and the later hatched young die quickly without significantly affecting the survival of their sibling. This adjusts the family size quickly to the actual food situation. It seems reasonable to suggest that the hatching order is primarily a function of the staggered start of incubation (Howe 1976) and not of the sex of the developing embryo. The sex-ratio in the last chicks to hatch is likely to be 1:1, assuming that it is balanced at hatching. Unless food supply is abnormally poor, only these late hatched chicks will die and the sex-ratio at fledging will be balanced (Gavrilov 1968, Dhondt 1970). Nevertheless, if brood-size does not match the food supply even after the late hatched chicks have starved then the females which are smaller in size (Perrins 1965, Dawson 1972) are likely to suffer higher mortality in consequence.

Dawson (1972) has shown that the weight of nestling House Sparrow affects

their chances of survival to independence. The present study provided no evidence for sex-linked differences in growth, fat reserves or body weight (Fig. 1), despite adequate samples. It seems therefore unlikely that the nestlings' chances of survival are influenced by their sex. If the sex-ratio of adult populations differs from 1:1 it seems probable that this is largely an effect of sex-differential mortality after the young have reached independence.

Several studies revealed a surplus of females at fledging. In the Starling (Kessel 1957) 56.5% were females, probably as a result of an unbalanced sex-ratio at hatching (58% females) rather that a higher mortality in males: "the few data available indicate that nest mortality is slightly higher in females than males, the percent of males increasing during the period in the nest" (Kessel 1957). Similarly, the preponderance of females in the Red-winged Blackbird (Williams 1940, Holcomb 1966, Holcomb & Tweist 1970) was possibly already present at hatching, since more females died in the nest than males (Williams 1940). In the Common Grackle (Howe 1976) hatching asynchrony is usual in large clutches and as in other species the last hatching chicks suffer highest mortality. At fledging, males are 22% heavier than females (compared with 6% in the House Sparrow, Fig. 1), although there is no such sexual dimorphism at hatching. Thus, males presumably need more food to attain their fledging weight than females. Consequently, in the last hatching chicks the males are more likely to die than females, resulting in a surplus of females. When Howe experimentally minimised the hatching asynchrony he found a sex-ratio close to 1:1 in fledglings.

ACKNOWLEDGEMENTS

The material for this paper was collected whilst I was writing for a D.Phil. at the Edward Grey Institute, Oxford, under the supervision of Drs. C.M. Perrins and E.K. Dunn. They and Dr. R.J. O'Connor read the manuscript. I wish to thank them for their constructive criticism.

RIASSUNTO

Popolazioni di passero domestico adulti hanno una leggera preponderanza di maschi sulle femmine. Questo ineguale rapporto sessi può essere originato da: 1) ineguaglianza già presente all'involo dei giovani dal nido, 2) mortalità differenziale tra i sessi dopo l'involo, 3) combinazione dei due fattori precedenti.

Scopo del presente studio è indagare se alla nascita o durante l'accrescimento dei pulcini di Passero domestico vi è mortalità differenziale tra i

sessi.

Dal 1972 al 1974 sono stati raccolti 397 nidiacei da 133 covate, presso Oxford (GB), sono stati sessati, sezionati e carcasse e grasso sono stati pesati.

Non è risultata nessuna differenza statisticamente significativa nel rapporto sessi alla nascita (Tab. I. Rapporto sessi alla nascita, covate suddivise in base alla storia del nido. Colonne da destra: maschi, femmine, % maschi, no. covate); righe dall'alto: tutte le uova schiuse, alcune uova non schiuse, alcuni pulcini morti, sconosciuto, totale pulcini morti nel nido). E' risultato che i pulcini maschi hanno peso leggermente maggiore, ma hanno meno grasso delle femmine. Ciò non conforta l'ipotesi che le femmine, più piccole, siano in svantaggio nella competizione per il cibo (Tab. II. Classi di maschi e femmine in ordine di peso vivo (a) e di riserve di grasso (b)). L'accrescimento dei due sessi è simile (Fig. 1. Accrescimento del peso di grasso (A), del peso secco della carcassa sventrata (B), del peso corporeo fresco (C)). Nemmeno la percentuale dei due sessi che a 10 giorni di età ha raggiunto un peso sufficiente a garantire elevate probabilità di sopravvivenza, è differente (Tab. III).

In conclusione, non è stato possibile evidenziare alcuna differenza nella mortalità, crescita e probabilità di sopravvivenza dei pulcini di Passero domestico.

Sono riassunte e discusse le informazioni bibliografiche sul rapporto sessi alla nascita (in genere uguale) e all'involo (in alcuni casi rapporto sbilanciato), in varie specie di uccelli (Tab. IV e V). Poichè il rapporto sessi negli adulti di Passero è stato dimostrato su un campione di migliaia di individui, per evidenziare una mortalità leggermente differente dei pulcini, sarebbe necessario un campione più ampio di quello del presente studio. Una mortalità più elevata dei pulcini femmina è perciò possibile, in particolare in momenti di scarsezza di cibo, quando le femmine, di dimensioni minori, possono trovarsi in svantaggio nella competizione per il cibo con i fratelli.

RESUME

Chez les Moineaux domestiques adultes il y a une légère prédponderance de mâles. Cela peut être expliqué par 1) une proportion inégale des sexes des poussins au nid, 2) des différences dans la mortalité après l'envol, 3) une combinaison de 1 et 2. Le but de ce travail est de tester l'hypothèse d'une mortalité différentielle entre les sexes des Moineaux à l'éclosion ou pendant la croissance des poussins.

Des 1972 à 1974 on a recueilli 397 poussins de 133 nids, près de Oxford(GB),

on a déterminé le sexe et pesé la carcasse et la quantité de graisse de chacun. Aucune différence n'a été trouvée dans la proportion des sexes à l'éclosion (Tab. I. Proportion entre les sexes à l'éclosion. Couvées réparties selon l'histoire du nids). Les poussins mâles ont un poids plus grand mais moins de graisse que les femelles (Tab. II. Classes de mâles et de femelles en ordre de poids (a) et de reserve de graisse (b)). La croissance des sexes est similaire (Fig.1. Croissance pondérale de la graisse (A), de la carcasse sêche (B) et du corp (C)). Il n'y a pas de différence non plus dans la proportion des deux sexes, âgés de 10 jours, qui, si on se base sur leur poids, ont une probabilité élevée de survivre. En conclusion, on n'a trouvé aucune évidence de mortalité, croissance ou probabilité de survivre différentielles entre les poussins des deux sexes.

On résume et discute les informations de la littérature sur la proportion des deux sexes de differentes espèces d'oiseaux à l'éclosion (généralement égale) et à l'envol (inégale dans quelques cas) (Tab. IV et V).

La proportion inégale des sexes des adultes de Moineau domestique a été trouvée dans un échantillon suffisament grand. Notre échantillon de poussins semble trop petit pour mettre en évidence une proportion inégale des sexes des poussins. Une mortalité plus élevée des poussins femelles est possible; dans les saisons de nourriture rare les poussins femelles, de dimensions plus petites, peuvent être handicappés dans la compétition avec leurs frères.

REFERENCES

ASMUNDSON, V.S. 1941. Notes on the sex ratio and mortality of Turkeys. Am. Nat. 75: 389-393.

BOSENBERG, K. 1958. Geschlechtsverhältnis und Sterblichkeit der Nestlinge beim Haussperling (*Passer domesticus* L.). Orn. Mitt. 10: 86-88.

BYERLY, F.C. & JULL, M.A. 1935. Sex ratio and embryonic mortality in the domestic fowl. Poult. Sci. 14: 217-220.

COLE, L.J. & KIRKPATRICK, W.F. 1915. Sex ratio in Pigeons, together with observations on laying, incubation and hatching of the eggs. Proc. Nat. Acad. Sci. 1: 354-356.

DAWSON, D.G. 1967. Roosting Sparrows (*Passer domesticus*) killed by rainstorm, Hawke's Bay, New Zealand. Notornis 14: 208-210.

DAWSON, D.G. 1972. The breeding ecology of the House Sparrow. D. Phil. Thesis, Oxford.

DHONDT, A.A. 1970. The sex ratio of nestling Great Tits. Bird Study 17: 282-286.

GAVRILOV, E.I. 1968. A possible regulation mechanism of the sex ratio in the *Passer hispaniolensis* Temm. Int. Studies on Sparrows 2: 20-24.

GOETHE, F. 1937. Beobachtungen und Untersuchungen zur Biologie der Silbermöwe (*Larus argentatus*) auf der Insel Memmertsand. J. Orn. 85: 1-119.

HOCHBAUM, H.A. 1944. The Canvasback on a Prairie Marsh. Washington D.C.

HOLCOMB, L.C. 1966. Red-winged Blackbird nestling development. Wilson Bull. 78: 283-288.

HOLCOMB, L.C. & TWEIST, G. 1970. Growth rates and sex ratio of Red-winged Blanckbird nestlings. Wilson Bull. 82: 294-303.

HOWE, H.F. 1976. Egg size, hatching asynchrony, sex, and brood reduction in the Common Grackle. Ecology 57: 1195-1207.

KESSEL, B. 1957. A study of the breeding biology of the European Starling (*Sturnus vulgaris*) in North America. Am. Nat. 58: 257-331.

LACK, D. 1954. The Natural Regulation of Animal Numbers.Oxford.

LATHAM, R.M. 1947. Differential ability of male and female game birds to withstand starvation and climatic extremes. J. Wildl. Mgmt. 11: 139-149.

LEVI, W.M. 1945. The Pigeon. Columbia S.C.

LOHRL, H. & BOHRINGER, R. 1957. Untersuchungen an einer süddeutschen Population des Haussper - lings (*Passer d.domesticus*). J. Orn. 98: 229-240.

MACKOWICZ, R., PINOWSKI, J. & WIELOCH, M. 1970. Biomass production by House Sparrows (*Passer d. domesticus* L.) and Tree Sparrows (*Passer m.montanus* L.) populations in Poland. Ecol. Pol. 18: 465-501.

MANSFELD, K. 1950. Beiträge zur Erforschung der wissenschaftlichen Grundlagen der Sperlingsbekä mpfung. Nachrichtenblatt f.d. Deutsch. Pflanzenschutzdienst. N.F. 4.

MAYR, E. 1939. The sex ratio in wild birds. Amer. Nat. 73: 156-179.

MOREL, G. & BOURLIERE,F. 1955. Recherches écologiques sur les *Quelea quelea quelea* L. de la bas se vallée du Sénégal. I. Données quantitatives sur le cycle annuel. Bull. I.F.A.N. 17A: 617-663.

NICHOLS, J.T. 1934. Sex ratio in the House Sparrow. Bird Banding 5: 188-189.

NIETHAMMER, G. 1953. Gewicht und Flügellänge beim Haussperling (*Passer d.domesticus*). J. Orn. 94: 282-289.

O'CONNOR, R.J. 1973. Growth and metabolism in some insectivorous birds compared with granivorous species. D. Phil. Thesis, Oxford.

O'CONNOR, R.J. 1975. Initial size and subsequent growth in passerine nestlings. Bird Banding 46: 329-340.

PERRINS, C.M. 1965. Population fluctuations and clutch-size in the Great Tit. J. Anim. Ecol. 34: 601-647.

PFEIFFER, S. & KEIL, W. 1962. Untersuchungen über Populationsdynamik und Ernährungsbiologie des Haussperlings (*Passer domesticus*) in Hessischen Getreideanbaugebieten. Festschr. Vogelschutzwarte f. Hessen, Rheinpfalz und Saarland 122-139.

PIECHOCKI, R. 1954. Statistische Feststellungen an 20'000 Sperlingen (*Passer d.domesticus*). J. Orn. 95: 297-305.

RIDDLE, O., CHRISTMAN, G. & BENEDICT, F.G. 1930. Differential response of the male and female Ring Doves to metabolic measurements at higher and lower temperatures. Amer. J. Physiol. 95: 111-120.

SEEL, D.C. 1970. Nestling survival and nestling weights in the House Sparrow and Tree Sparrow *Passer* spp. at Oxford. Ibis 112: 1-14.

SUMMERS-SMITH, D. 1963. The House Sparrow. London.

WARD, P. 1965. Seasonal changes in the sex ratio of *Quelea quelea* (Ploceidae). Ibis 107: 397-399.

WILLIAMS, F. 1940. The sex ratio in nestling Eastern Redwings. Wilson Bull. 52: 267-277.

WITHERBY, H.F., JOURDAIN, F.C.R., TICEHURST, N.F. & TUCKER, B.W. 1943. The Handbook of British Birds. 5 vols. London.

Ricevuto il 3/3/1980