THE SEX-RATIO AND THE PRODUCTION OF THE MALLARD, ANAS PLATYRHYNCHOS L.

by

J. A. EYGENRAAM

INSTITUUT VOOR TOEGEPAST
BIOLOGISCH ONDERZOEK IN DE NATUUR (ITBON)
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(Institute for Biological Field Research, Arnhem, Holland)

I. THE SEX-RATIO

a. For a proper management of the Mallard population a knowledge of the sex-ratio is of primary importance. Without this it is impossible to study the effect of reproduction rates and mortality on the population density by shooting and decoying.

For this reason, assisted by voluntary helpers, the author made a study of the sex-ratio of the Mallard in the field and in duck decoys.

By means of periodic counts made from the end of July to the beginning of June in various habitats it was possible to obtain a picture of the apparent and actual fluctuations in the sex-ratio of the Mallard. Moreover, this investigation was carried out at the request of the International Waterfowl Research Bureau, London and organised in the Netherlands by the author.

For the purpose of making a study of the sex-ratio among duck decoy-catches, the help was obtained of a number of decoymen. During the months of August and September they noted the catches daily, specified according to age and sex. After September, when the distinctive tail-feathers are moulted (WITHERBY and co-workers, 1952), it becomes a very laborious task to distinguish between adult and juvenile ducks, and the specification is limited to sex.

By this method of determining the sex of young ducks only just ready for flight we gained information on what is known as the tertiary sex-ratio, i.e. the sex-ratio on reaching maturity. It should be noted that no study was made of the primary and secondary sex-ratios, i.e. those respectively before and after the eggs are hatched.

The results of the counts and decoy catches will now be discussed in succession.

b. In order to rule out the possibility of faulty conclusions arising

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[1]) Verschijnt tevens als Mededeling No. 34 van het Instituut voor Toegepast Biologisch Onderzoek in de Natuur.

from a sexual difference in habitat preference, the counts were made in different localities.

The observation areas are shown in Fig. 1.

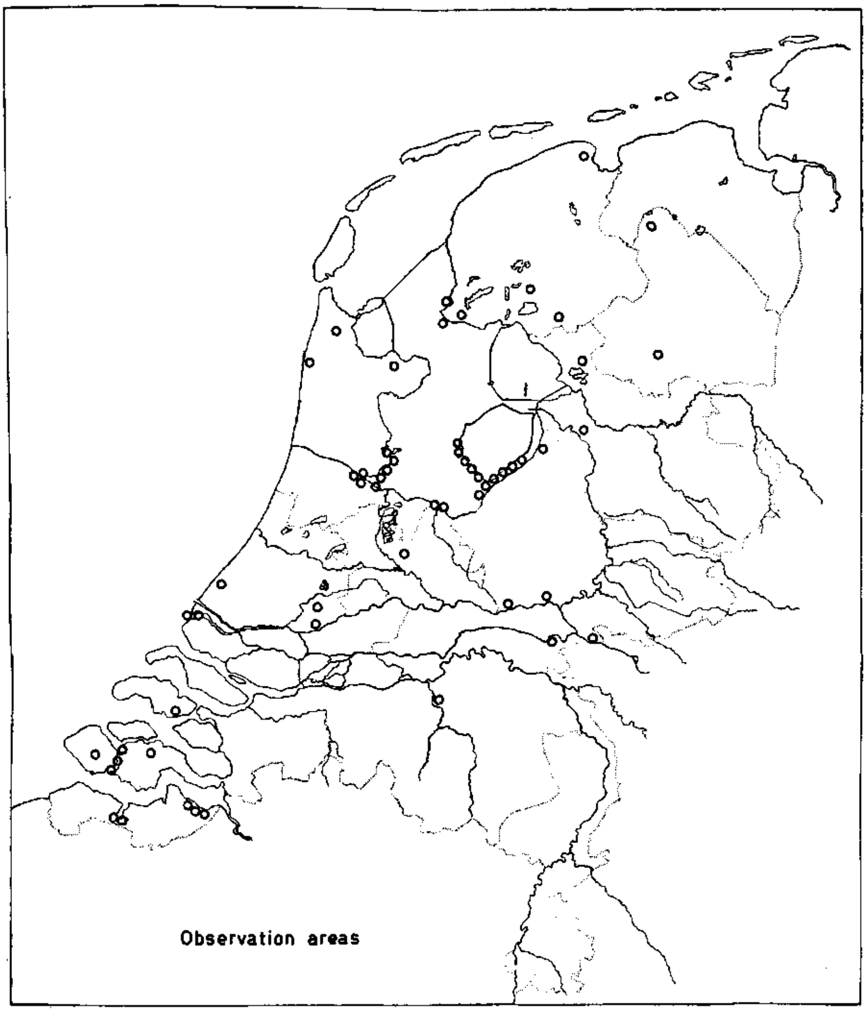

Fig. 1

Observations were usually made twice a month, over the period 1948-1954. All round-figure estimates were excluded from the material collected, only actual counts being employed.

A total of 865 counts were worked out, divided into two groups, viz.

city parks and canals (441 observations), and more natural environments such as lakes, pools and rivers (424 observations).

The division was made throughout because in the towns the Mallard is to some extent fairly tame, occasionally domesticated, and during the winter months its numbers are scarcely or not at all reinforced by migratory Mallard.

In natural surroundings it is mainly the true wild Mallard that is encountered. Should there be any question of a separate migration of the sexes, this could be more clearly demonstrated in the latter localities than in the former, and might affect the result when the data are combined.

In both cases, however (Tables 1 and 2 respectively) the seasonal fluctuations show the same trend.

TABLE 1

Sex Ratio in Mallard 1948/1954

In City parks and canals

Month	Number of observations	Drakes	Ducks	♂♂ : 100 ♀♀
Aug.	7	397	232	171
Sept.	23	2229	1624	137
Oct.	64	5432	4317	126
Nov.	58	5314	4616	115
Dec.	44	4824	4362	111
Jan.	53	4730	4486	105
Feb.	73	5995	5478	109
Mrch	84	4303	3915	110
Apr.	12	523	267	196
May	6	34	9	378
June	17	2091	632	331
Total	441	35872	29938	
		65810		

From August to January there is first a large, and afterwards a gradually decreasing majority of drakes. From March onwards there is again a rapid increase in the excess of drakes over ducks, reaching its highest point in June.

Since the fluctuation trends in Tables 1 and 2 are in agreement there is no harm in combining data from all areas and calculating the averages from these figures (Table 3, Fig. 2). Let us now consider these averages more fully.

TABLE 2

Sex ratio in Mallard 1948/1954

On pools, lakes and rivers

Month	Number of observations	Drakes	Ducks	♂♂ : 100♀♀
Aug.	5	539	363	148
Sept.	23	1919	1358	141
Oct.	45	5010	4180	120
Nov.	35	3326	2937	113
Dec.	40	3961	3776	105
Jan.	37	1672	1565	107
Feb.	57	2933	2755	106
March	90	2439	2341	104
April	66	1237	886	140
May	9	126	41	307
June	17	621	141	440
Total	424	23783	20343	
		44126		

TABLE 3

Sex ratio in Mallard 1948/1954

Total average

Month	Number of observations	Drakes	Ducks	♂♂ : 100♀♀
Aug.	12	936	595	157
Sept.	46	4148	2982	139
Oct.	109	10442	8497	123
Nov.	93	8640	7553	114
Dec.	84	8785	8138	108
Jan.	90	6402	6051	106
Feb.	130	8928	8233	108
March	174	6742	6256	108
April	78	1760	1153	153
May	15	160	50	320
June	34	2712	773	364
Total	865	59655	50281	
		109936		

It is noticeable that both in spring and autumn the drakes are greatly superior in numbers. The excess number of drakes in the autumn may be accounted for by the fact that the wing moult, which makes the adult Mallard for some time incapable of flight, begins earlier in the male and is thus also completed earlier than in the female.

During this "flightless" period most Mallards live at least a month in localities affording a good deal of cover which they generally only leave in the evening in order to go foraging on foot or swimming.

For this reason they escape observation. By August most drakes have

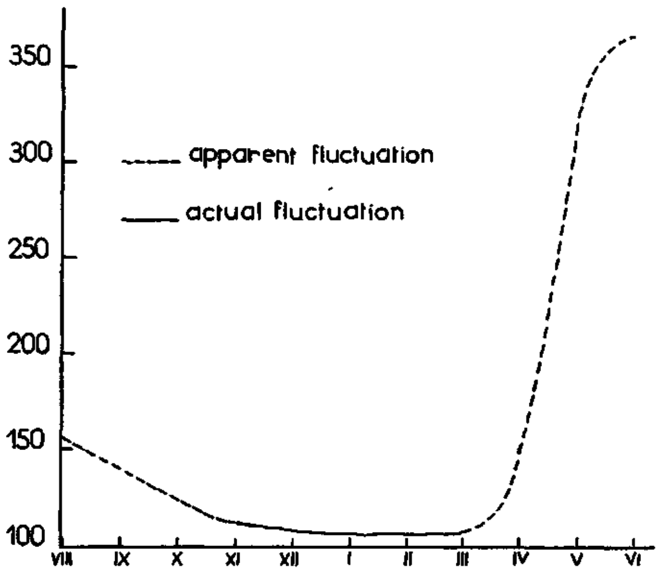

Fig. 2

completed moulting their wing-feathers, whereas the ducks have only just begun (LEBRET 1949). Hence the ducks being less in evidence, the drakes are only apparently very much in the majority. The ducks disappear again in the spring, but this time in order to lay and incubate the eggs. Afterwards they rear their broods and live separated from the drakes.

It is therefore impossible to arrive at a correct estimate of the sex-ratio of the Mallard from the beginning of the breeding season until the end of the moulting season.

The latest date on which an exceptional female Mallard was encountered without its wing-feathers is the middle of October (communicated by MAEBE and VAN DER VLOET).

The difficulty in calculating the real sex-ratio in the field, caused by the factors mentioned, ceases after October.

The only factor which could then have a disturbing effect would be a sexually differentiated migration. Should this phenomenon be present to a high degree among Mallard from northern Europe it is conceivable that one sex may cross or winter in our latitude in greater numbers than the other. This would also make it difficult to discover the real sex-ratio during the winter months, the Dutch Mallard beïng predominantly of a resident nature (LEBRET 1956).

The question as to whether there is a sexually-differentiated migration of Mallard may best be studied from the daily catches in duck decoys. During the period from 1950-1955 rushes of the northern Mallard were repeatedly caused by the division 'of temperature in western Europe, viz. from mid-December 1950 to the beginning of January 1951; in november 1953 and January 1954; in November 1954 and January 1955.

At these times there were sudden increases in the catches, followed by a gradual falling-off. During these periods of rush-migration, which comprise a total of 85 days, 9725 Mallard were caught in certain decoys in a ratio of 95 to 96 drakes: 100 ducks. Outside these migration periods 14377 Mallard were caught in the same decoys in the months of November, December and January in a ratio of 119 drakes: 100 ducks.

It is clear that during the rushes the females are in a slight majority, and at other times the drakes. The females are apparently more sensitive to frost which causes them to start migrating somewhat earlier, but it is obvious that the drakes follow soon after.

This can be shown by the average sex-ratio of all of the catches during the months of November, December and January over the years 1950-1954 as compared with the average sex-ratio in the field.

In the decoy catches this average is 108 to 109 drakes: 100 ducks. The average of the field counts over the same period is 109 to 110 drakes: 100 ducks. This striking agreement shows that the duck decoys do not trap selectively during this period, and also that the differentiation in migration only results in a very temporary disturbance of the sex-ratio. Hence it has no visible effect on the periodic counts.

From the decoy catches we may assume that the sex-ratio among young birds August-September is 113:100 (Table 4). It is worth noting that this figure is reliable because juvenile ducks do not moult their wing feathers

TABLE 4

Sex-Ratio in Mallards Caught in Duck Decoys 1950-1954

		♂♂ ad.	♀♀ ad.	♂♂ juv.	♀♀ juv.	Total
1950	Aug.	768	608	2388	1847	
	Sept.	490	408	1158	980	
	Total	1258	1016	3546	2827	8647
	Sex ratio	124 : 100		125 : 100		
1951	Aug.	529	449	2505	2234	
	Sept.	333	160	1000	952	
	Total	862	609	3505	3186	8162
	Sex ratio	142 : 100	110 : 100			
1952	Aug.	921	820	3651	3048	
	Sept.	577	301	1079	1005	
	Total	1498	1121	4730	4053	11402
	Sex ratio	134 : 100		117 : 100		
1953	Aug.	149	103	1066	1161	
	Sept.	361	106	752	818	
	Total	510	209	1818	1979	4516
	Sex ratio	244 : 100		92 : 100		
1954	Aug.	567	393	2856	2447	
	Sept.	490	425	768	702	
	Total	1057	818	3624	3149	8648
	Sex ratio	129 : 100		115 : 100		
Total general		5185	3873	17223	15194	41475
Average sex ratio		134 : 100		113 : 100		

in the first year and duck decoys do not catch selectively drakes or ducks.

Among the total Mallard population (juveniles and adult birds) the ratio is 114 in November (Table 3). Later it gradually falls off to about 106:100 in January. After this month investigation of the decoy catches cannot be continued because the close season begins on the first day of February.

The indications are that in this case we are concerned with a real fluctuation, since neither the moulting of the wing-feathers nor the differentiated migration can affect the result. Nor are the decoy catches a factor as they do not work selectively after October. They are, however, selective before November for the adult birds (Tables 4 and 5) as the females moult during the hunting season, unlike the drakes, and cannot be caught.

TABLE 5

Sex Ratio in Mallards Caught in Duck Decoys 1950-1954

Males : 100 females				
	Oct.	Nov.	Dec.	Jan.
1950/51	142	129	117	122
1951/52	141	132	108	150
1952/53	154	119	134	132
1953/54	166	85	92	112
1954/55	139	101	120	88
Average	147	107	111	106
Numbers of ducks inv.	12037	11165	6499	6217
	35918			

There is thus a shorter period in which they are liable to be captured and as a result they pay a lesser toll. But this is reflected in the catches up to and including October, and not in those from November to January.

As shooting of ducks during the wingmoult is forbidden in our country it is likely that during the period of August to November sportsmen will shoot more drakes than females. It is possible that the gradual falling-off from 114 in November to 106 in January is also caused by selective shooting during these last months of the hunting season (BOYD 1954). This is a matter for further investigation.

Summary and conclusions

1. An investigation was made into the sex-ratio of the Mallard in the Netherlands by means of simultaneous field counts and duck decoy catches.

2. Since the period of the wing-moult does not coincide in the drake and the duck it is practically impossible to carry out an investigation into the sex-ratio before November.

3. From July to November hunting (including decoying), which is the chief mortality factor, has a more marked effect on the drakes than on the ducks, the latter being less vulnerable for a time.

4. The sex-ratio in November is 114 : 100. In summer it will therefore probably be higher among adult birds as by selective shooting and decoying in the autumn it has been forced down to this figure.

5. During the winter there is a further, albeit small decline which is possible caused by selective shooting alone, decoy captures being not selective in winter.

6. Immediately prior to the breeding season the sex-ratio is approximately 106 : 100.

7. It follows that the sex-ratio is not static (LEBRET 1949) but dynamic and varies in the course of the year between 106 and an unknown figure exceeding 114.

Samenvatting

Om de populatiedichtheid van een vogelsoort te kunnen beheersen is o.m. kennis omtrent de geslachtsverhouding noodzakelijk. Voor de Wilde Eend is deze bestudeerd aan de hand van een groot aantal waarnemingen in verschillende biotopen. Ook kon de geslachtsverhouding in de vangsten van eendenkooien worden vergeleken met die in het veld.

De periode, waarin deze studie kan worden uitgevoerd, wordt door verschillende factoren beperkt. Doordat de slagpenrui bij woerden en eenden niet gelijk plaats vindt, vallen de perioden, waarin de woerden en de eenden zich weinig vertonen, niet samen.

Tijdens het broedseizoen, dat in maart begint, vertonen de wijfjes zich minder dan de woerden. In verband met deze beide verschijnselen kan de werkelijke geslachtsverhouding bij de Wilde Eend in het veld slechts worden bepaald van november tot en met februari. Het resultaat zou ook dan nog niet betrouwbaar kunnen zijn, indien de Wilde Eend een geslachtelijk gedifferentieerde trek zou vertonen. Dit verschijnsel is er inderdaad, zoals uit de kooivangsten kan worden duidelijk gemaakt. Bij „rush"-trek komen de wijfjes voorop, maar doordat de woerden weldra volgen, is de verstoring van de geslachtsverhouding van zo korte duur, dat de gevolgen in de veldtellingen niet werden waargenomen.

Bij de Wilde Eend wordt steeds een kleine meerderheid van woerden vastgesteld. In november bedraagt deze 114 ♂♂ tegen 100 ♀♀, in februari nog 106 : 100. Deze vermindering zou kunnen worden veroorzaakt door selectief afschot, wat nog nader zal worden onderzocht. Het is niet waarschijnlijk, dat de eendenkooien selectief vangen, omdat de verhouding woerden : eenden in de kooivangsten gedurende de genoemde periode gelijk was met die in het veld.

Tussen februari en november is de geslachtsverhouding slechts bij benadering te schatten. Uit de omstandigheid, dat in november, d.i. na een periode van drie maanden waarin de druk van jacht en kooivangst op de woerden groter is dan op de eenden, de verhouding woer-

den : eenden nog 114 is, moet worden afgeleid, dat deze vóór de opening van de jacht nog hoger is geweest en door het eenzijdig schieten en vangen van woerden tot deze waarden is teruggebracht. In februari zijn er slechts 106 woerden per 100 wijfjes en dit suggereert, dat tengevolge van een grotere sterfte onder de wijfjes gedurende het broedseizoen de sekseverhouding oploopt tot boven 114.

In verband met het feit, dat de woerden de gehele zomer gescheiden leven van het overgrote deel der wijfjes, n.l. van de wijfjes die jongen hebben, zal de dynamiek in de geslachtsverhouding zeer moeilijk in cijfers kunnen worden bestudeerd.

Het is waarschijnlijk, dat de geslachtsverhouding zich in de loop van de tijd beweegt van 106 : 100 in februari via een waarde hoger dan 114 naar 114 : 100 in november.

Het onderzoek was mogelijk door de zeer gewaardeerde medewerking van een aantal waarnemers, welker namen hier met erkentelijkheid worden genoemd.

Mej. G. v. d. Baan, mej. A. Koeten en de heren J. Albers, P. Annema, O. Bajema, A. v. d. Berg, R. v. d. Berg, A. Berkouwer, A. M. Blokland, Sj. Braaksma, P. W. Brander, Ph. G. Goossen, G. Gooyer, C. Groot, C. Hoogerheide, A. de Kleuver, J. A. F. Koridon, T. Lebret, J. Maebe, J. G. M. Marquenie, H. T. v. d. Meulen, H. P. Misset, J. G. J. M. Mooyman, M. F. Mörzer Bruyns, G. Nooter, K. Postma, M. W. Struycken, G. Sukkel, C. Swennen, A. Timmerman, A. A. Tjittes, J. Viergever, H. v. d. Vloet, J. W. de Vries, J. Walters en een aantal kooilieden.

Literature cited

Boyd, H., 1954: Some Results of recent British Mallard Ringing. The sixth Annual Report of the Wildfowl Trust 1952-1953. London.

Frieling, H., 1934: Statistische Untersuchungen über das Geschlechtsverhältnis der Enten zur Zugzeit. Der Vogelzug 5, pp. 109-115.

Lebret, T., 1949: Eenden tellen. De Nederlandse Jager 54, pp. 4-5; 26, pp. 36-37.

Lebret, T., 1956: De Wilde Eend, *Anas platyrhynchos* (L.), als Nederlandse standvogel. Ardea 44, pp. 281-283.

Mc Ilhenny, A., 1940: Sex ratio in Wild Birds. The Auk 57, pp. 85-93.

Witherby, H. F. c.s., 1952: The Handbook of British Birds. Vol. III, p. 238.

II. THE PRODUCTION

The commonest method of determining the reproductive success of a duck species is actually to keep a number of individual birds under observation for an entire breeding season in a compact and well-defined area (BENNETT 1938, EARL 1950, SMITH 1953). On the basis of the results obtained in the observational area the increase in population is estimated in a much larger area, and possibly over an entire state. The reliability

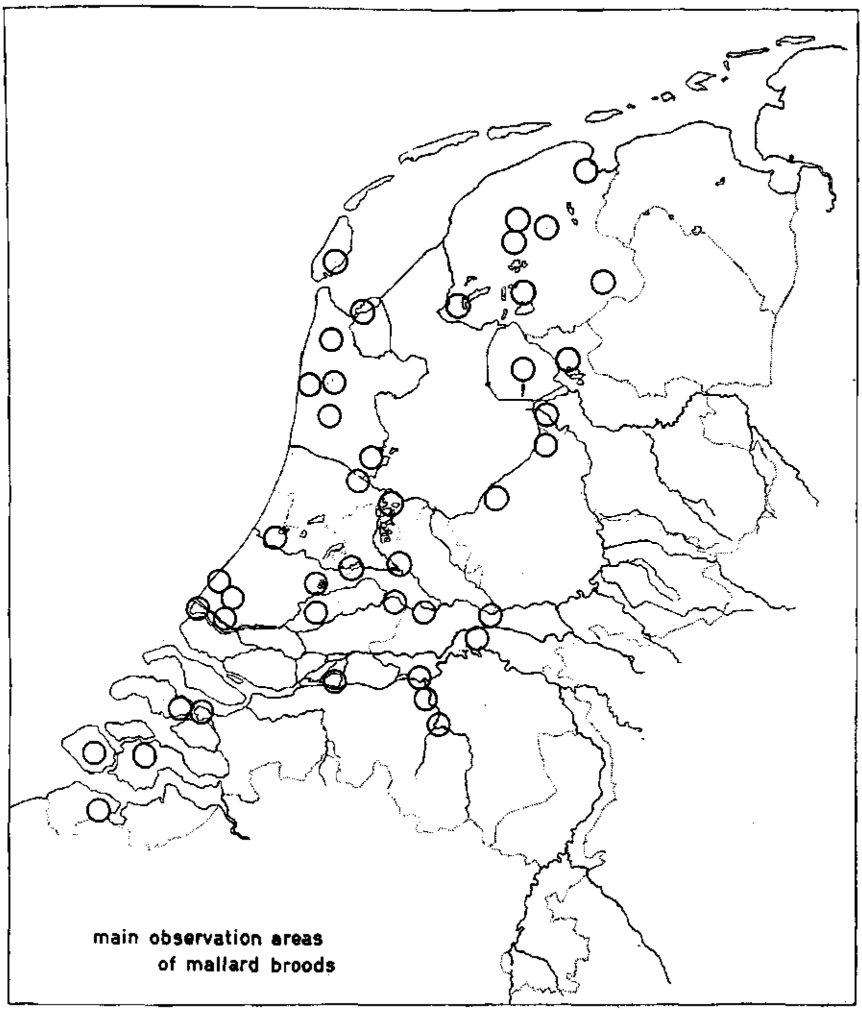

Fig. 3

of this method will wholly depend on whether the observational area is a representative one.

The author's main reason for adopting a different method of studying the production of the Mallard was that no observational area can be found in Holland that may be considered representative of the country as a whole.

This method consisted in carrying out observations with the aid of a number of voluntary helpers into Mallard broods at many places from April to August. The observational areas were spread over all parts of the country suitable for Mallards (Fig. 3). The number of samples and the places where they were taken are a sufficient guarantee of the material being representative. In this way 268 different Mallard broods were counted in 1950; 662 in 1951; 620 in 1952; 990 in 1953 and 1177 in 1954. a total of 3717 different Mallard broods. Each year some tens of broods were seen by the same observer more than once with intervals of at least a week, thus increasing the number of data to 4658. There is no indication that reports made by different assistants relate to the same broods. The date, location, number of ducklings and their age were noted in the case of every Mallard brood observed. For estimating the age criteria were given which were even more extensive than those employed by Southwick (1953), so that in the case of very small ducklings the age could be estimated in days, and in the case of all other ducklings in weeks. With the use of the information regarding date of observation and age it was possible to calculate the approximate date of hatching in the case of each brood. The average size of brood per age-group could be calculated from the information on the number of chicks per brood and the estimated age. The production was calculated from the entire material in combination with the sex-ratio and the percentage of unproductive ducks.

Distrubution of the hatching dates

The Mallard is able to start laying from February to September. The incubation period is 28 days and it takes 12 days to produce a full clutch of 12 eggs, so that the Mallard chicks may hatch about 40 days after the first egg has been laid. In some years the first ducklings appear before 1st April. During this month the numbers increase steadily until in the first decade of May a climax is reached which occurs year after year, but is more marked in some years (1951 and 1954) than others (Table 6).

Table 6

Distribution of hatching dates on a percentage basis [1])

Year	Apr. I	Apr. II	Apr. III	May I	May II	May III	June I	June II	June III
1950	4	11	10	17	17	17	12	5	3
1951	2	4	11	25	19	15	10	4	4
1952	3	13	17	20	19	18	5	3	1
1953	1	7	16	25	21	16	7	5	2
1954	—	4	16	26	18	14	8	7	4

[1]) The very early and the very late broods have been omitted.

Second broods are very exceptional, but having regard to the many broods that are still found after 31st May there must be many cases of repeat clutches. The latter generally number from 7 to 11 eggs.

Hence the June broods are smaller than the April and May ones (Table 7). Mallard ducklings may also be born as late as July, August

TABLE 7

Relation between brood-size and hatching period

	Average brood size of ducklings one day old			Ditto on the age of 5 weeks and older		
Hatched in:	April	May	June	April	May	June
1951	11.14	11.03	9.91	5.13	7.27	5.18
1952	11.37	10.95	8.71	7.97	6.49	5.33
1953	9.85	10.11	9.00	6.50	6.60	5.41
1954	10.00	9.61	8.06	8.37	6.41	6.33
Average	10.59	10.42	8.92	6.99	6.99	5.56

or even September, but the very early and very late broods are of little importance for the maintenance of the species. In 1950 the number of broods hatched before 1st April and after 30th June was 4% of the total, in 1951 6%, in 1952 1%, in 1953 0%. Consequently at least 94% of the Mallard ducklings are hatched during April, May and June (Table 6).

The average brood-size

During the first few days of its life a brood averages nearly 11 chickens. The April and May broods may have a rather higher average and the June [and July] broods a rather lower one (Table 7). The mortality during the first week as a result of insufficient vitability, unfavourable weather conditions and predation causes a rapid decline in this number to the averages of between 7.44 and 9.49 as shown in table 8.

TABLE 8

Average brood-size per age group

Year	0-1 wk.	1-2 wk.	2-3 wk.	3-4 wk.	4-5 wk.	5-6 wk.	6-7 wk.	7-8 wk.
1950	7.44	6.33	6.10	6.20	5.95	5.81	5.85	6.02
1951	9.65	7.34	6.85	5.75	5.83	6.50	6.29	6.05
1952	9.49	7.52	7.24	8.24	7.00	6.75	6.94	6.91
1953	8.88	6.48	6.42	5.92	5.96	6.15	6.63	6.61
1954	8.66	7.17	6.97	7.03	6.76	6.69	6.76	6.42

From the first to the second week of life there is a further significant drop, but subsequent losses are apparently slight (Table 9). Actually

TABLE 9

Numbers of broods from which the data were calculated

Year	1 wk.	2 wk.	3 wk.	4 wk.	5 wk.	6 wk.	7 wk.	8 wk.	Total
1950	127	111	88	85	57	48	48	44	608
1951	367	151	86	76	46	36	31	37	830
1952	326	165	151	83	30	24	33	24	836
1953	601	146	78	61	51	41	67	41	1086
1954	777	170	118	71	42	42	38	40	1298
Total	2198	743	521	376	226	191	217	186	4658

they are more considerable than might be inferred from the consecutive columns. This is owing to the fact that a number of broods perish altogether and are not allowed for in the averages; they will nevertheless have to be included in one way or another in the final result. This is done by estimating the percentage of unsuccessful females (p. 47-48).

There are indications that very small broods of one to two ducklings occur to a comparatively less extent in the older age groups than in the younger ones. It seems, therefore, that broods reduced to less than three have less chance of survival. The probability of this can be demonstrated by analysing the numerical frequency of the broods in the various age groups.

It was found that in the age group 1 (0 - 1-week-old ducklings) the number of ducklings varied from one to 19 per brood and that the most frequently occurring number was ten (Fig. 4). In the age group 2 (1 - 2-week-old ducklings) the brood-size varied from one to 15, seven being the number occurring most frequently (Fig. 5). The variation and frequency trend in the other groups can be seen from Figs. 6-11. To facilitate a study of the distribution of brood-sizes varying from one to 12 in all eight age groups this is summarised in Figs. 12-14. The large broods, i.e. those comprizing 9, 10, 11 and 12 ducklings, are, on a percentage basis, considerably more numerous in the younger age groups than in the older ones: the graph shows a steeply downward trend (Fig. 12). The middle groups (broods of 5, 6, 7 or 8 ducklings) show a proportionate increase in numbers, which is very understandable when one considers their continual reinforcement from originally larger broods reduced by mortality to broods of 5-8 (Fig. 13). The small broods of 3-4 also

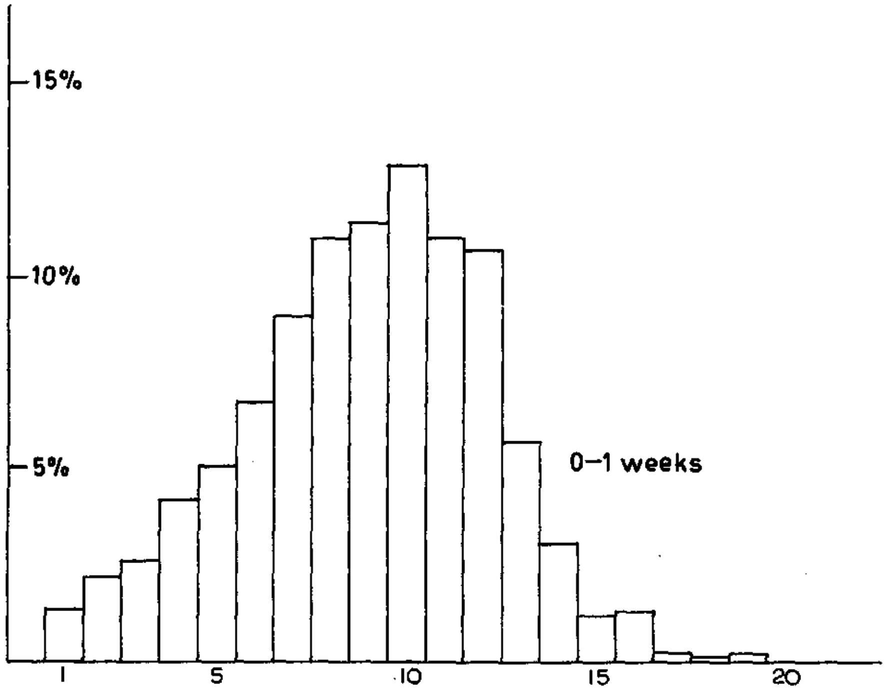

Fig. 4

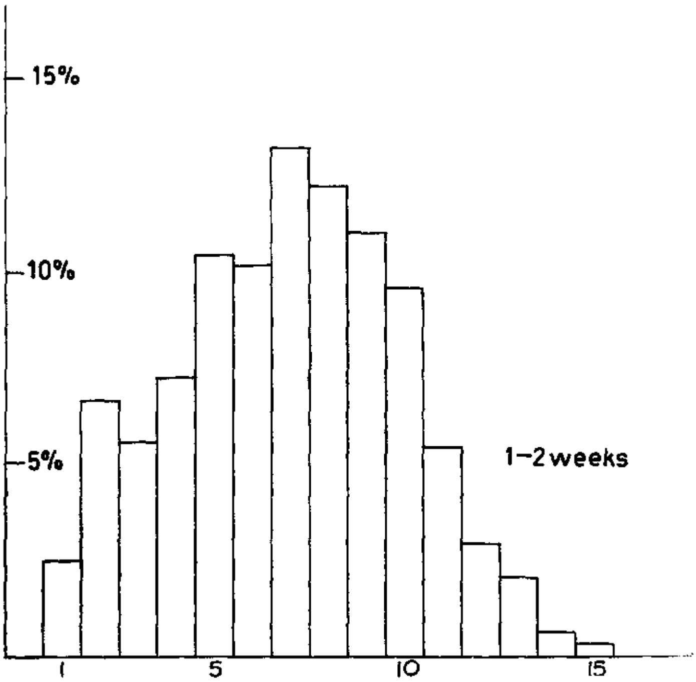

Fig. 5

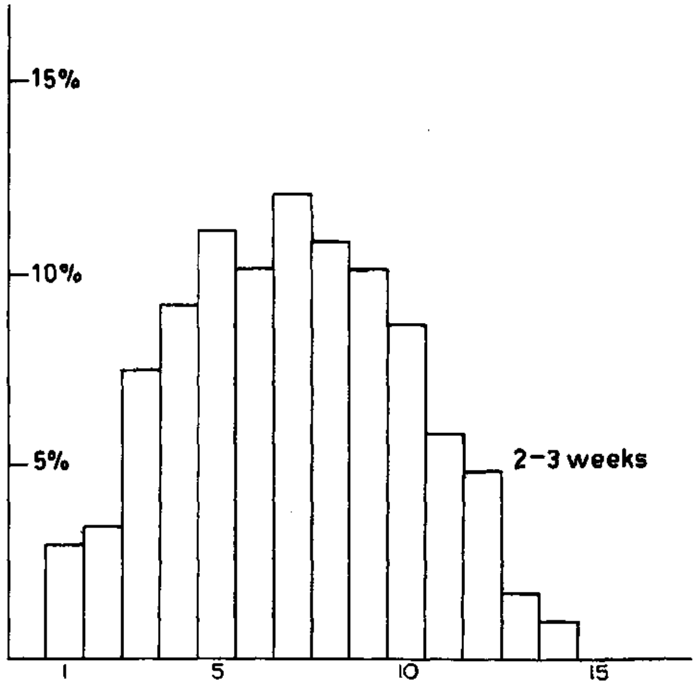

Fig. 6

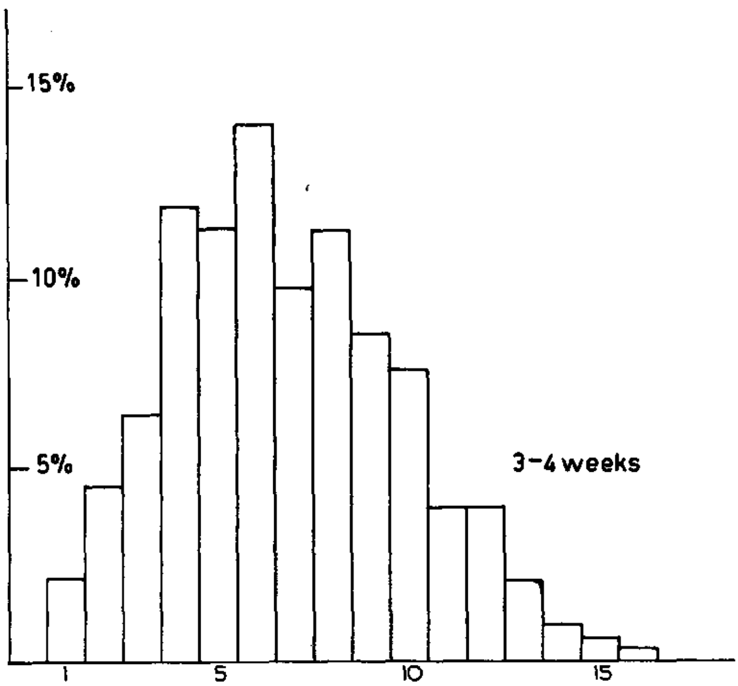

Fig. 7

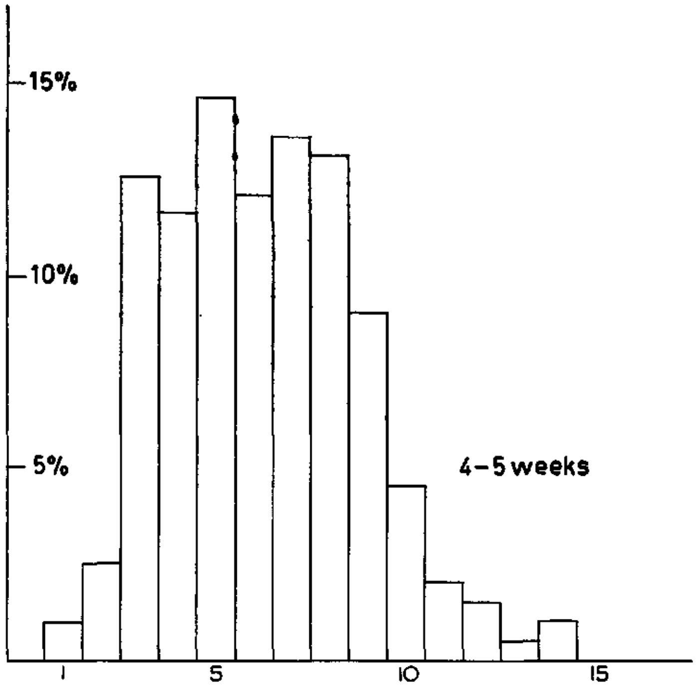

Fig. 8

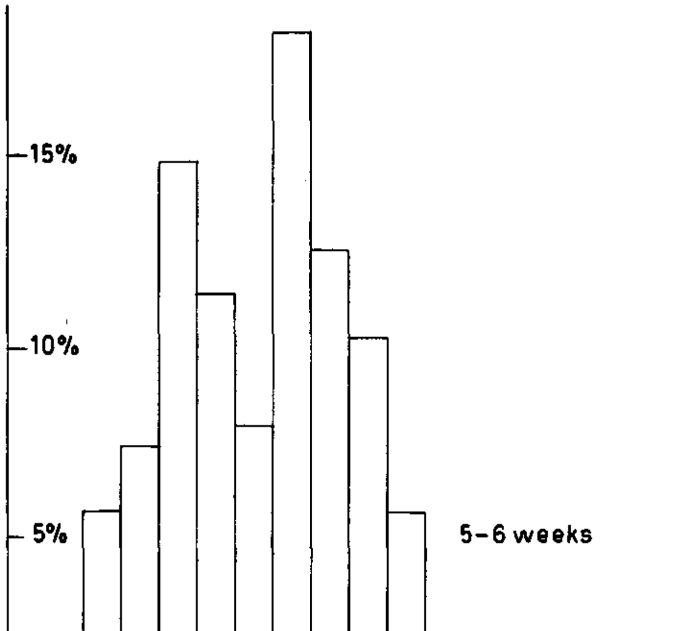

Fig. 9

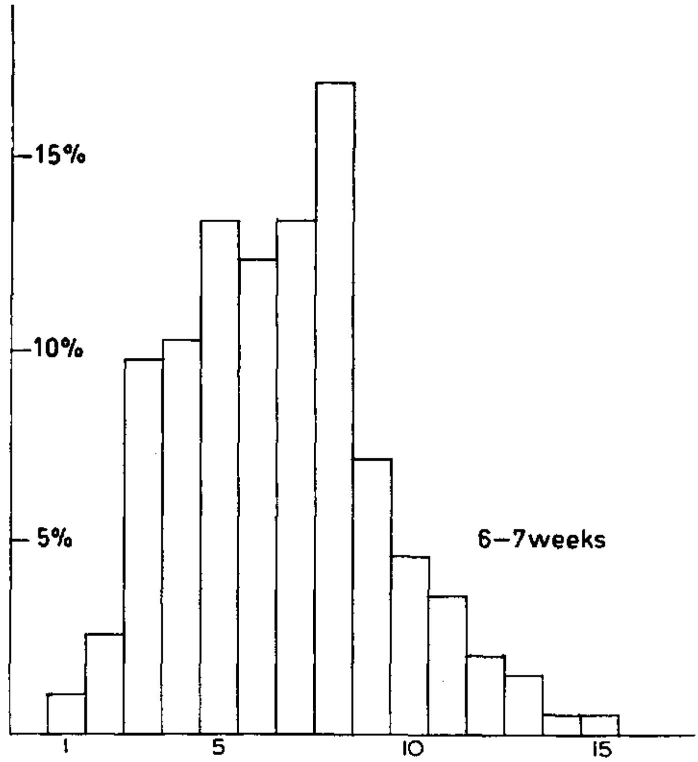

Fig. 10

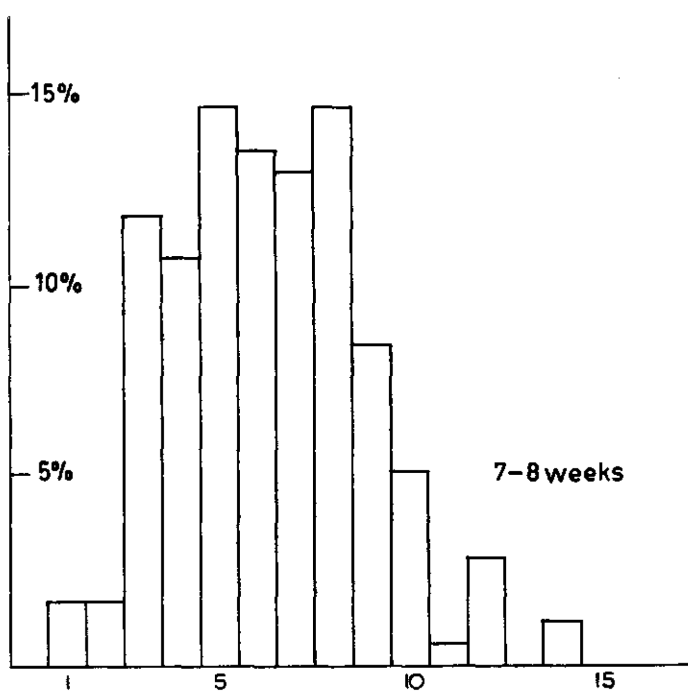

Fig. 11

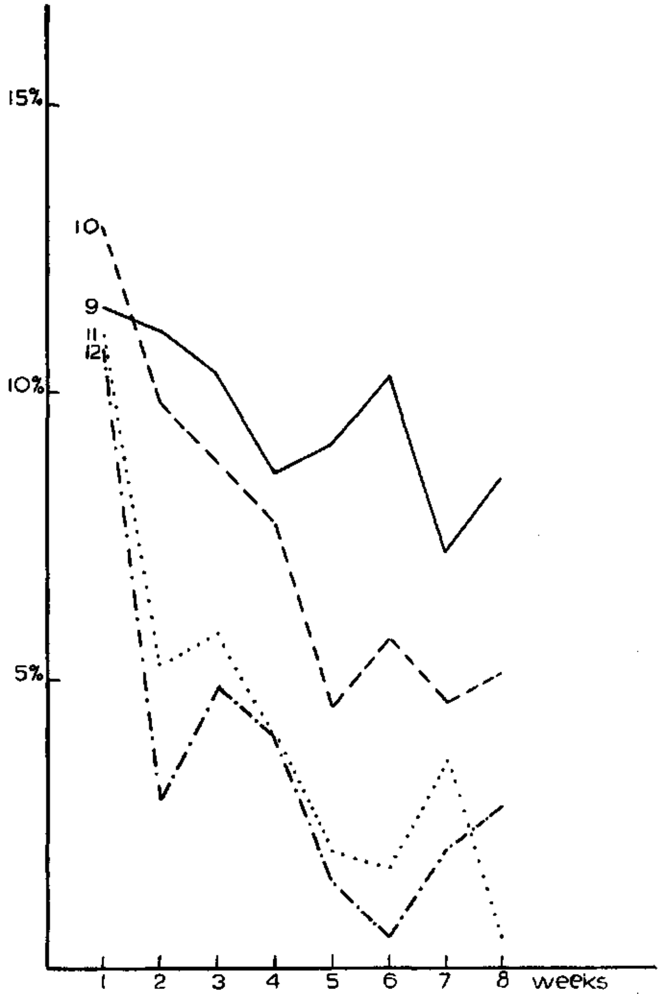

Fig. 12

show an upward trend, and this is to be explained in the same way as in the case of the medium-size broods. But in the case of the very small broods of 1 and 2 we again notice a downward trend, which means that on a percentage basis the latter occur less frequently in the older age groups than in the younger ones (Fig. 14). This reduction might be due to the fact that a normal loss is only made good from above to a very slight extent. This would mean that the parental instinct of a duck that has managed to retain three or four young works so effectively that

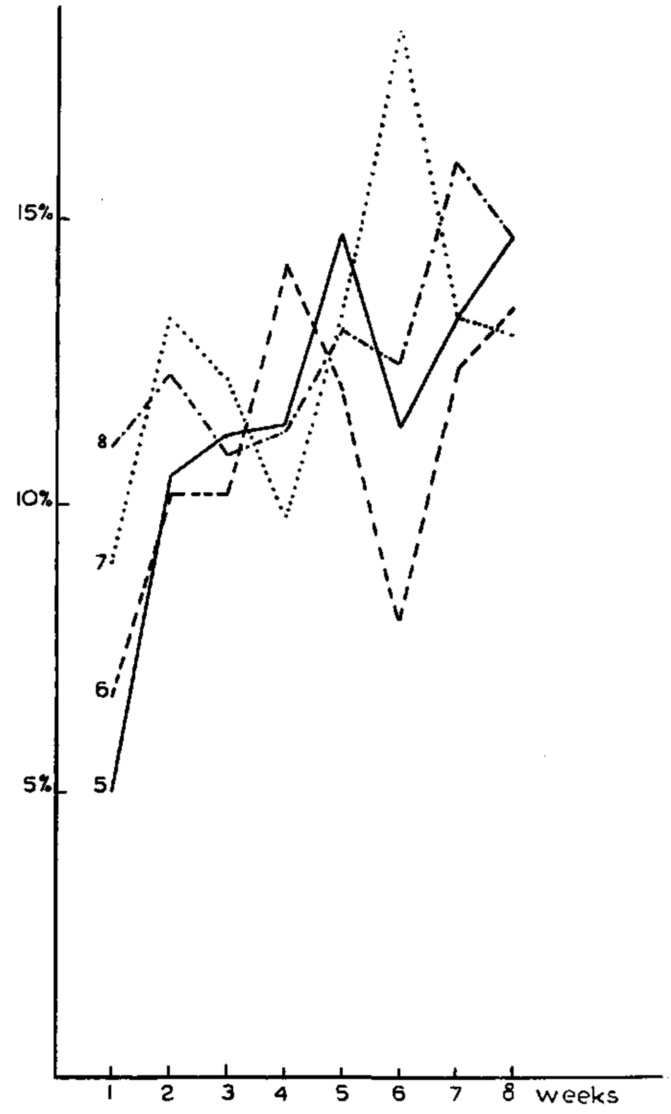

Fig. 13

further losses are an infrequent occurrence. This theory would be supported by Figs. 8, 10 and 11, in which the transition from three to two is very steep. In Figs. 4, 5, 6, 7 and 9 the transition is so gradual, however, that it is unlikely that little mortality occurs in broods of three and four ducklings. It is much easier to assume that in these broods also the

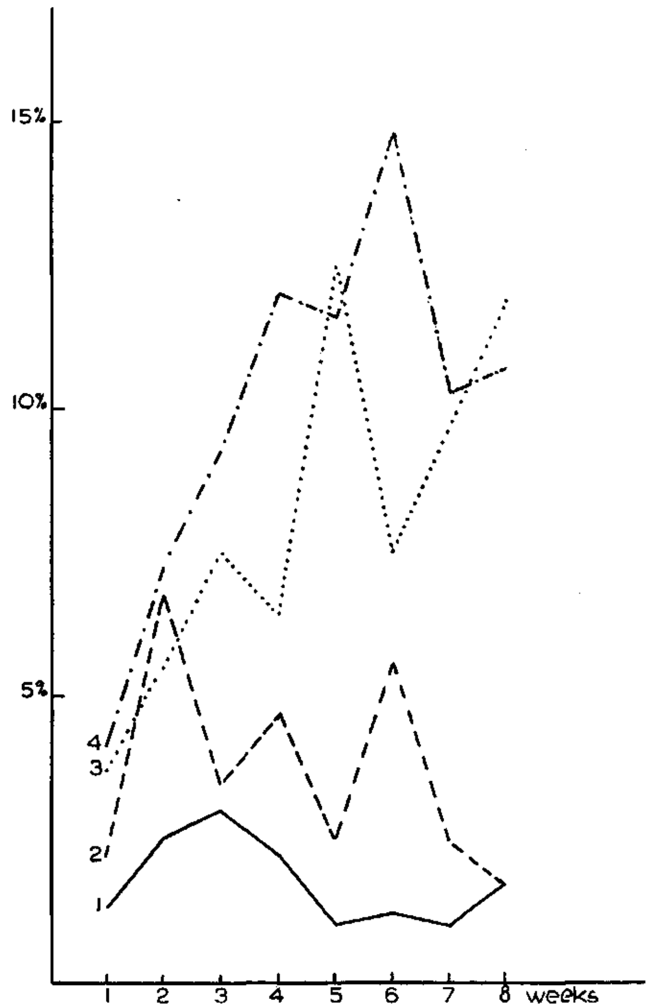

Fig. 14

mortality is such that the numbers of broods with one and two chicks are regularly reinforced.

Should they nevertheless decline in number, the losses are bound to exceed the gains. In this case the chances of very small broods surviving must be small.

The disappearance might be caused by the ducklings leaving the mother to join other broods, or by the mother abandoning her chicks. The first assumption is improbable, firstly because out of the 3717 broods on which we have information only in 0.1% of the cases it was reported that the brood consisted of chicks of varying ages. Field observations also show that there are practically no cases of adoption after the first day of life. Both the mother duck and the young are hostile to ducklings from another brood.

What presumably happens in these cases is that the ducks forsake the chicks as soon as only one or two are left and the latter soon perish. If the season is still not too far advanced and a number of sexually potent drakes remain in the vicinity, a duck of this kind might start producing a repeat clutch, and this would serve the species better than tending a few chicks. However, the accuracy of this explanation needs to be tested by experiment.

Whatever the cause may be, the numbers of broods consisting of one and two ducklings are relatively smaller in the older age groups than in the younger ones and therefore the averages calculated from the observed broods of older age are too high and have to be corrected in order to determine the production. In other words we have to know the percentage of unproductive females.

Reproductive success

It can be seen from the last column in Table 5 that the number of ducklings per successful duck reaching maturity in the five years of the investigation is practically the same. The difference between the extremes (6.02 and 6.91) is not significant. Where the number of fully-grown young per successful duck is constant, good and bad breeding years must be determined by means of three factors: —

1. The number of nesting birds;
2. the annual differences in mortality shortly after attaining to maturity.
3. the percentage of unproductive females.

These factors will now be discussed in turn.

1. No exact data are in hand concerning annual fluctuations in the number of nesting Mallards in the Netherlands. On the basis of widespread counts, the nesting bird population in 1956 was estimated at 180.000 (Over en Mörzer Bruyns 1956) [1]), less than half this number being females. It is likely that this number fluctuates to a certain extent.

2. The period between being old enough to fly and the opening of the shooting season on 24th July is short. There were no signs of any

[1]) In the duck decoys another 120000 Mallards were present at that time (Author).

catastrophic mortality in July and August of the years covered by the investigation, so that this possibility may be disregarded.

3. The percentage of unproductive females may vary, although it is true that no such difference can be shown in the two years in which we have sufficient relevant information.

To obtain some idea of this percentage it is necessary to determine the sex-ratio at a period in which the successful females still accompany their chicks and the ducks that have lost their eggs or young do not subsequently begin on a repeat clutch, i.e. the first decade of June.

Strictly speaking this is not quite correct for the following reasons: a. Mallard chicks are seen as early as the third decade of March. They are ready to fly after 56 days, and within a further fortnight the parent duck is able to leave them. During the first decade of June the first successful females of the season are able to join the drakes living a social life. b. A female that begins to lay on 15th June may still have chicks 25th July, and since ducks with newly hatched ducklings are still seen in August, or even later, the ducks counted between 1st and 10th June may include individual birds that are still beginning a repeat clutch. There is thus an overlap and the resultant error must be accepted. In practice, however, the drawbacks referred to here are much less serious, firstly because only a small percentage of ducks have chicks even before 1st April and the brood is moreover very liable to perish, and secondly because the June counts are in respect of groups of Mallards that are sexually indifferent. It is not likely that females still ready to pair will seek the society of such drakes. For these reasons it may be assumed that the error is only theoretically possible.

For being able to make an estimate as accurate as possible of the percentage of unproductive females in the first decade of June it is nessesary to know the sex ratio at that time. We only know the sex ratio in February to be 106 males : 100 females and this in November to be 114 : 100.

Presumably in June the drakes outnumber the females even more than in November (see page 124) and therefore a sex ratio of 115 to 125 seems a justified estimate.

The counts discussed here were made with some success in the first half of June 1953 en 1954. In 1953 683 Mallards were counted in 11 locations in a ratio of 577 ♂♂ to 106 ♀♀.

In 1954 in the same 11 locations 1085 Mallards were counted in a ratio of 929 ♂♂ to 156 ♀♀. This time the count was made on a larger scale viz. at 41 locations, giving a total of 4824 Mallards in a ratio of 4059 ♂♂ to 765 ♀♀.

Accepting a sex ratio of 115-125 we might expect for the number of 577 ♂♂ in 1953 a number of 461-501 ♀♀. There were only 106. Hence 20-23% was unproductive.

In 1954 for 929 drakes 156 ♀♀, resp. for 4059 ♂♂ 765 ♀♀ were counted. For these numbers 743-808 ♀♀ resp. 3250-3530 ♀♀ might be expected. There were only 156 resp. 765. So 19-21% or 22-24% was unproductive. The differences are not significant.

The 1953 production was thus 6.61 (Table 5 last column) — 20 to 23% = 5.09 to 5.29. The 1954 production was 6.42-22 to 24% = 4.88 to 5.01. Thus in both years about 5 ducklings per duck reached maturity.

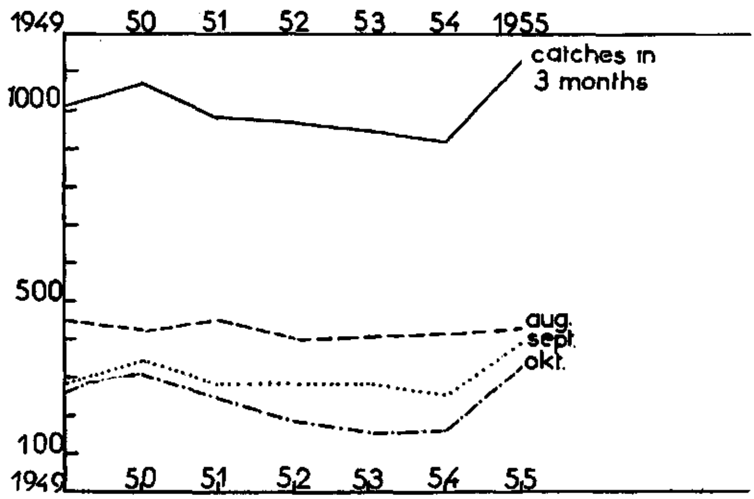

Fig. 15

For a population of 300000 nesting Mallards of which 145000 were females the reproduction for 1953 and 1954 would have been 725000.

Finally, we will also deduce whether these years were good, moderate or poor by analysing the decoy-catches in the months of August, September and October. These figures have been available since 1949, i.e. the year after the waterfowl research was begun. Fig. 15 shows these catches in the form of averages per decoy. On studying the graph we notice at once that the August catches being substantially the same year after year, are unable to provide any information on the success in breeding. There are no appreciable differences until September and October. In view of the fact that in some years migratory Mallards may arrive in numbers as early as October it is better to leave this month out of account. We are thus left with September only. In both years the catches in this month were below the 1949-1955 average, but otherwise show the same amount of agreement as the calculated percentages of unproductive ducks. This suggests that in years of higher September catches (1950 and 1955) either the percentage of unproductive birds was less than 20, or the number of breeding birds was higher than normal.

Summary and conclusions

1. The Mallard's production was investigated by counts of Mallard broods, the location, date, number and age of the ducklings being noted.

2. The hatching dates were inferred from the data, and a maximum for the hatching of young was found in the first decade of May.

3. The average number of ducklings reared by a successful female is fairly constant and amounts to six.

4. The percentage of ducks that are unsuccessful in rearing young is probably variable, and was 23 and 24 in 1953 and 1954 respectively.

5. This percentage must be subtracted from the figure of six in order to arrive at the reproduction figure.

6. Judging from the average decoy catches in September these were by no means favourable years.

7. The nesting population may be estimated at 300000 Mallards, including 145000 females. These rear an average of five ducklings, so that the annual production should be put at 725000.

Samenvatting

Het broedsucces van de Wilde Eend is bestudeerd door het enige jaren volgehouden tellen van eendentomen. Van een groot aantal waarnemers werd hierin medewerking ondervonden. Bij iedere waarneming, werden behalve de plaats, de datum, de leeftijd en het aantal kuikens vastgelegd.

Uit deze gegevens kon de spreiding van de geboortedata, de gemiddelde toomgrootte en in combinatie met de geslachtsverhouding het broedsucces worden berekend.

Ieder jaar werd minstens 94% van de eendenkuikens geboren tussen 1 april en 30 juni, met een min of meer duidelijke climax in de eerste 10 dagen van mei (Tabel 6).

Bij de geboorte tellen april- en mei-tomen gemiddeld ongeveer 11 kuikens, de juni-tomen iets minder, doordat deze meest van vervolglegsels afkomstig zijn (Tabel 7).

De sterfte is in de eerste week het grootst. Ook in de tweede en de derde week zijn de verliezen nog aanzienlijk. Afgaande op de gemiddelden zou men de indruk kunnen verkrijgen, dat er daarna weinig eendenkuikens meer sterven, doordat de gemiddelden nagenoeg gelijk blijven. In werkelijkheid zijn er wel degelijk verliezen, maar doordat het percentage zeer kleine tomen — van 1 en 2 stuks — onder de jongere leeftijdsgroepen hoger ligt dan bij de oudere, worden de laatste gemiddelden minder gedrukt.

De schrijver heeft de indruk gekregen, dat de overlevingskans van tomen die minder dan 3 stuks tellen, geringer is dan van numeriek sterkere tomen. De zeer kleine tomen gaan mogelijk te gronde doordat de moeder hen verlaat. Verlaten jongen worden door andere tomen zeer zelden geadopteerd.

De eenden, die er niet in slagen een broedsel groot te brengen, sluiten zich aan bij de in troepjes levende woerden. In de eerste 10 dagen van juni werden deze geteld. Door de geslachtsverhouding in deze periode te schatten op 115-125 woerden : 100 eenden kon het percentage niet-productieve eenden worden bepaald. In 1953 bleek dit 20-23% te zijn, in 1954 22-24%.

In beide jaren bereikten per eend ongeveer 5 kuikens de volwassen leeftijd. Doordat het gemiddeld aantal volwassen geworden kuikens per eend constant is (tabel 8, laatste kolom), hangt het broedsucces af van de omvang van de broedvogelpopulatie en van het percentage niet-productieve eenden. Het is waarschijnlijk, dat deze beide grootheden van jaar tot jaar wisselen, hoewel het laatste in de onderhavige studie niet het geval was.

Er mag rekening mee worden gehouden, dat in ons land per jaar tenminste 600000 à 700000 jonge Wilde Eenden het vliegvlugge stadium bereiken.

Met erkentelijkheid voor hun medewerking worden hier de namen van de waarnemers vermeld:

Mej. G. v. d. Baan, mej. A. Koeten. J. Albers, P. Annema, F. J. Appelman, O. Bajema, D. Bakker, A. v. d. Berg, R. v. d. Berg, E. Bos, G. Bosch, Th. v. d. Bosch, K. A. Bosma, K. Bosma, P. W. Brander, V. Brandwijk, G. A. Brouwer, J. C. Brusselaars, J. Diender, A. H. v. Dijk, H. Eikelboom, B. Fenthur, M. Geene, J. v. Gemert Smits Jr., W. A. Gunn, N. L. den Haak, G. A. v. Herk, H. W. v. Hoytema, M. Hoogendam, A. J. Hoogland, B. J. Hoogers, Tj. H. Kingma, E. v. Koersveld, W. A. F. L. Koolwijk, J. A. F. Koridon,

J. TEN KLOOSTER, J. L. TEN KLOOSTER, V. LANGENHOFF, R. LATHOUWER, T. LEBRET, M. V. LENT, H. LINDEBOOM, H. T. V. D. MEULEN, G. MOEDERSHEIM, A. K. J. MULDER, J. NOUWEN, P. NIJHOFF, L. J. ODINGA, J. H. PEN, K. POSTMA, A. REUSER, H. ROOK JR., A. SCHOORL, A. A. SCHOUSTRA, D. SCHURER, C. V. D. STARRE, C. SWENNEN, J. R. A. TANGE, A. TAMIS, J. J. C. TANIS, B. TUKKER, B. V. D. VEEN, G. VENEMA. R. VISSER, E. E. V. D. VOO, H. J. H. VOSKUIL, D. M. DE VRIES, K. WALDECK, B. J. J. R. WALRECHT, J. WALTERS, B. WESTERHUIS.

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Literature cited

Bennett, L. J., 1938: The blue-winged teal. Collegiate Press, Ames, Iowa. 144 pp.

Earl, J. P., 1950: Production of Mallards on irrigated land in the Sacramento Valley, California. Jour. Wildl. Mgt. 14, pp. 332-342.

Heinroth, O. und M. Heinroth, 1928: Die Vogel Mitteleuropas. III Band. Hugo Bermühler Verlag, Berlin, p. 286.

Hochbaum, H. A., 1944: The canvasback on a prairie marsh. American Wildl. Inst., Washington, D. C. 201 pp.

Over, H. J. and M. F. Mörzer Bruyns, 1956: Waterwildconcentraties in Nederland in februari 1956. De Levende Natuur 59, 7, pp. 149-155.

Smith, R. H., 1953: A study of waterfowl production on artificial reservoirs in Eastern Montana. Jour. Wildl. Mgt. 17, pp. 276-291.

Southwick, C., 1953: A system of age classification for field studies of waterfowl broods. Jour. Wildl. Mgt. 17, pp. 1-8.