Sex ratio in mice of some strains of the dd group

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Summary. Sex ratios were studied in 13,280 young of four strains of mice. All the strains belonged to the dd group. The results obtained are summarized as follows.

A shift of total sex ratio to male was observed in one strain. There was no shift of sex ratio when the four strains were examined as a whole. In each of the four strains, the rate of paternal and maternal individuals which showed a shift of sex ratio to either sex was in a range of 1.4 to 4.5 and 3.7 to 6.0 per cent, respectively. With regard to generation, a shift of sex ratio was recognized in one strain. In litter series and litter size, a shift of sex ratio was noticed in two strains. It was concluded that there might be no changes of sex ratio parallel with litter series or litter size.

A seasonal shift of sex ratio was seen in two strains. There were differences in sex ratio among the seasons in one strain. It cannot be said, however, that there is any relationship between sex ratio and season.

With regard to parental age, a shift of sex ratio was observed in two strains (paternal age only in the ddY strain). It was to male in the DDY strain and to female in the ddY strain. With regard to the parental age difference, no shift of sex ratio was seen in the DDY strain. With regard to maternal age at the time of first mating, no shift of sex ratio was recorded in any strain.

A shift of annual sex ratio was observed in two strains. It was to male in all the strains. (*Japan. J. Anim. Reprod.* 24 105~109, 1978)

There are many reports to assert that the sex ratio can be altered genetically. On the other hand, many contradictory papers are also seen. The authors (1974)¹⁾ reported the sex ratios of ten strains of mice and the pedigree of individuals which showed a shift of sex ratio to either sex. There are several strains of mice forming the so-called dd group and derived from a common ancestor. These mice have been bred in Japan. Of these strains, the DDK strain was mentioned in the previous report.¹⁾ This report deals with the sex ratios of the four strains belonging to the dd group and results of comparison of the sex ratio between these strains and the DDK strain.

Materials and Methods

Four strains, DDD, DDY, ddY, and DSD, of mice were used in the present study. All the strains, except the ddY strain, had been maintained by sib-mating at the National Institute of Animal Health. The ddY strain had been maintained by rotation-mating and 1:1 (male: female) mating.

The number of offspring of each strain was as follows: 4,740 for DDD, 1,784 for DDY, 1,978 for ddY, 4,778 for DSD, and 13,280 for the four strains as a whole. All the mice were raised in an air-conditioned and light-controlled room, and allowed to have mixed feed and water *ad libitum*.

Analysis of sex ratio and a survey on the pedigree were performed by the same methods as described by NISHIDA *et al.* (1967)²⁾ to determine the sex ratio in swine. The classes which showed a shift of sex ratio to either

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Table 1. Total sex ratio

Strain of mice	n	S. R.	S. D.	No. of litters	Litter size	Differences in sex ratio among four strains			
						DDD	DDY	ddY	DSD
DDD	4,740	51.4	0.7	609	7.8				
DDY	1,784	53.4**	1.1	284	6.3	*			
ddY	1,978	49.5	1.1	166	11.9	*	*		
DSD	4,778	49.5	0.7	889	5.3	ns	ns	ns	
Total	13,280	50.7	0.4	1,958	6.8				

Remarks for all tables:

ns...not significant.

n...total number of offspring, except Table 2.

S. R....sex ratio expressed by percentage of males.

S. R. and S. D....a fraction of 0.05 or over counted as a unit, and a fraction of less than 0.05 discarded (S. D., Table 1 only).

*...significant at 5% level.

***...significant at 1% level.

Table 2. Parental individuals showing shift of sex ratio to either sex

	Strain of mice	Shift to				Total	%	Parental number
		#5%	male 1%	female 5%	1%			
Paternal	DDD	1	2	1	0	4	4.3	93
	DDY	2	0	1	0	3	4.5	66
	ddY	1	0	0	0	1	1.4	70
	DSD	2	0	3	1	6	3.4	176
Maternal	DDD	6	2	6	0	14	4.9	283
	DDY	5	0	2	2	9	6.0	150
	DSD	4	0	8	3	15	3.7	406

Parents were the same as those of the ddY strain, because 1:1 mating was performed.

Maternal data of the ddY strain was discarded from the table.

#...significance level.

sex are cited mainly in tables. The standard deviation, the number of litters, and litter size have been discarded from all the tables, except a table on the total sex ratio.

Results and Discussion

Reports on the sex ratio in mice will be cited in the discussion.

Total sex ratio (Table 1): A significant shift of sex ratio was observed only in the DDY strain. No shift of sex ratio was found in any other strain or in the four strains as a whole. A significant difference in sex ratio was seen between the DDD and DDY or ddY

strains, between the DDY and ddY strains, and between the DSD and DDK strains when each of the four strains was compared with the DDK strain.¹⁾ Mean litter size was the largest in the ddY strain and the smallest in the DSD strain. A significant difference in litter size was noticed between these two strains.

Parental individuals (Table 2): Distribution of parental individuals showing a shift of sex ratio of their offspring to either sex was between 1.4 and 4.5 per cent in paternal individuals, and between 3.7 and 6.0 per cent in maternal ones. In a survey on the pedigree of individuals which had shown a shift of sex

ratio to either sex, both positive and negative evidences, which were the same as described in the previous paper,²⁾ were observed in the present study.

There are many affirmative and contradictory reports on the existence of genetical factors altering the sex ratio in man and other mammals. In mice, MAKINO and YOSHIDA (1951)³⁾, WEIR (1955 a, b)^{4,5)}, and COOK and VLČEK (1961)⁶⁾ presented positive reports. FALCONER (1954)⁷⁾, HOWARD *et al.* (1955)⁸⁾, and NISHIDA *et al.* (1974)¹⁾ expressed negative opinions. From the above-mentioned results of this study, it is assumed that there may be no genetical factors altering sex ratio in mice. It is, however, impossible to deny the existence of genetical factors, since data were not collected from all the strains belonging to the dd group in this study.

Generation: Generations which showed a shift of sex ratio was noticed only in one strain (in the 41st generation of the DDD strain, the sex ratio was 58.2**). No alterations with generations were observed in sex ratios in this study.

There are two opposite reports that sex ratio became higher⁹⁾ or lower¹⁰⁾ with the advance in generation of mice. NISHIDA *et al.* (1974)¹⁾ observed no such progressive changes of sex ratio in mice. The results of the present study agree with those reported

previously by the authors.

Litter series: A shift of sex ratio to male was recognized in the DSD strain (sex ratio was 72.7* in the 5th order of litter series), and a shift to female in the ddY strain (43.5* in the 3rd order). No parallel change of sex ratio to either sex with litter series was noted in any strain.

PARKES (1924)¹¹⁾ reported that the sex ratio became higher with the litter series in mice. The results of the present study were the same as those reported by NISHIDA *et al.* (1974)¹⁾.

Litter size: Each of two strains, DDY, and ddY, showed a shift of sex ratio in one class. The shift was to male in all those strains. The sex ratio was 56.1* and 78.9* in the DDY and ddY strain, respectively. No alteration, however, with litter size to either sex was recognized in this study.

The results of this study agree with those previously mentioned by MAKINO and YOSHIDA (1951)³⁾ and NISHIDA *et al.* (1974)¹⁾.

Season (Table 3): A season in which was shown a shift of sex ratio was noticed in two strains, DDD, and DDY. It was not the same in these strains. Therefore, it cannot be concluded that there is a relationship between season and sex ratio.

Some authors^{8,11)} observed the relationship between season and sex ratio in mice. NISHIDA

Table 3. Season and sex ratio

Strain of mice	Spring		Summer		Autumn		Winter	
	n	S. R.	n	S. R.	n	S. R.	n	S. R.
DDD	1,029	51.0	1,023	53.0*	1,031	51.9	1,509	49.9
DDY	529	50.4	431	51.5	396	56.8**	431	55.9*
ddY	415	40.0	455	49.0	862	50.7	646	48.6
DSD	1,139	47.7	1,089	50.3	1,029	50.1	1,338	49.9

Differences among seasons

DDY Spring-Autumn.*

Table 4. Parental age in months and sex ratio

Strain of mice	Age	n	S. R.	Range of age		
DDD	—	—	—	1~8		
DDY	4	388	56.7**	1~8		
ddY	4	523	44.7 #P	—#M	#P 2~5, 10	#M 2~4, 10
DSD	—	—	—	1~10		

#P and #M: paternal and maternal age, respectively.

et al. (1474)¹⁾ have had doubts about such relationship. The results of the present study agree with those reported by NISHIDA *et al.* (1974)¹⁾.

Parental age (Table 4): A shift of sex ratio was seen in two strains, DDY, and ddY. It was to male in the DDY strain, and to female in the ddY strain. No consistent changes of sex ratio with parental age were observed in any strain. No shift of sex ratio was noted in relation to the parental age difference in the ddY strain. The parents were of the same age in any other strain, since they were maintained by sib-mating.

NISHIDA *et al.*¹⁾ stated that the presence of relationship between sex ratio and parental age difference was doubtful. The results of the present study are in agreement with their statement.

Maternal age at the time of first mating: No shift of sex ratio was observed in the present study. NISHIDA *et al.*¹⁾ reported that there was no relationship between sex ratio and maternal age at the time of first mating in mice. The same conclusions as those of their report can be drawn from the results of the present study.

Annual sex ratio: A shift of sex ratio was

recognized in two strains, DDD, and DDY. It was higher than fifty per cent in all strains (53.7* in DDD, 1970, and 54.0* in DDY, 1971). It cannot be assumed, however, that there may be a particular relationship between sex ratio and calendar year. These results agree with those given by NISHIDA *et al.* (1974)¹⁾.

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dd グループ数系統のマウスの性比について

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著者ら (1974)¹⁾は 10 系統のマウスの第二次性比について報告した。これに続くものとして、今回は dd グループに属する 4 系統 (DDD, DDY, ddY, DSD) の総子数 13,280 頭について性比をしらべた。その結果は次のようである。

総性比においては、1 系統で雄へのかたよりがみられた。4 系統合計では、性比のかたよりはみられなかった。産子性比のかたより (以下単に“かたより”とする) を示す個体の率は、父親では 1.4~4.5%, 母親では 3.3~6.0% であった。世代では、1 系統でかたよりがみられた。産次及び一腹子数では、2 系統でかたよりがみられ

た。しかし、従来報告されているような、産次や一腹子数と平行する性比の変化はみられなかった。

季節におけるかたよりは 2 系統でみられ、1 系統では季節の性比間に有意差がみられたが、季節と性比との間に特殊な関連があるとはいえない。

両親の月齢についてみると、2 系統でかたよりがみられた (ddY 系統では父月齢のみ)。ddY 系統以外の系統では、全部雄へかたよった。両親の月齢差では、かたよりはみられなかった (ddY 系統)。初交配時の母月齢でも、かたよりはみられなかった。年度におけるかたより (雄へ) は 2 系統でみられた。

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