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DEMOGRAPHIC ANALYSIS OF A SYNTHETIC POPULATION , SELECTED FOR THE GLOBAL OBJECTIVE OF LITTER WEIGHT AT 60 DAYS OLD THROUGH OVERLAPPING GENERATIONS

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ABSTRACT

The demographic analysis of a population of rabbits, selected for a global objective through overlapping generations from the year 1983 until the year 1999, is described. Distribution by ages of breeding rabbits is shown in the pyramid of ages, and the greatest frequency of these is found at ages younger than 4.5 months (37.8% of the bucks and 46,7% of the does). The productive life has been 7.3 months for the bucks and 5.3 for the does. The elimination of the breeding rabbits has been 62.4% for the bucks and 16.6% for the does during the replacement stage. The death-rate table shows the breeders survival percentage after the first mating. The interval between generations has been 10.6 months. From the total of the animals that were replaced, only 43.6% of the bucks and 65.8% of the does have been effective, and 33.5% of the bucks and 28.3% of the does have been useful. The interval between parturitions has decreased from 50.82 days during the year 1983 to 43.3 days during the year 1990. In order to evaluate the efficiency in resources utilisation, the occupancy of the cages has been studied, which has been 96.89% for the bucks and 94.24% for the does.

INTRODUCTION

The objective of the current work is to carry out a demographic analysis of a population of rabbits. It consists of a description of the population's condition according to its size, its composition and the different phenomenons that explain its evolution throughout time: reproduction, death rate, eliminations. (Vu Tien, 1983).

Owing to the fact that selection experiments with rabbits are generally carried out in separated generations, it is interesting to achieve a demographic analyisis in a population that has been selected in overlapping generations, similar at the work presented by ROCHAMBEAU et al. (1992) in this congress.

In the current work, the results of the demographic analysis from the year 1983 until the year 1990 are shown.

This work has been realized in the frame ef the scientific cooperation with the INRA (France) SAGA ,Toulouse and IRTA and the agreement IRTA and Diputacio of Barcelona.

1.- MATERIAL AND METHODS

1.1.- POPULATION

The population under study has been selected since the year 1983 with the global objective of litter weight at 60 days old (Rafel et al., 1988). One of the objectives of this selection experiment is the study of the feasibility of a selection model in overlapping generations and the optimizing of managemental practices to guarantee a maximum occupancy of the cages and the attainment of correct intervals between generations.

1.2.- FARM MANAGEMENT

The climatic and managemental characteristics under which the experiment is realised were described by Rafel et al. (1980) and Rafel et al. (1990). They can be reduced to: Mediterranean climate with a continental trend. Animals housed in pens with a controlled environment and divided into three cells (maternity, fattening, replacement), in metal wire cages alloted to only one flat, fitted with an automatic waterer and a chute for the distribution of commercial type feed.

The population for selection consists of 96 does and 30 bucks, divided into 6 breeding groups of 16 does and 5 bucks each.

The breeding management is organizaded into fortnightly bands. First week groups basically gather matings, palpations and parturitions. The second one gathers weanings and weight individual controls in order to rationalize the breeding managenment and to dispose of a maximum number of contemporary breeders in each indexation. The matings are carried out throughout the whole week and the weanings only during one day. This kind of management means that the weaning of the young rabbits has to be done at 32 days old, with a difference of ± 2 days in relation to the mean.

The fattening period lasts 4 weeks, which is enough time for the young rabbits to reach 1.8 - 2 kg of live weight, the commercial weight at slaughter in Spain.

The replacement of bucks is carried out inside their breeding group: generally, the buck is replaced by its son.

Whereas the does replacement is carried out outside the reproduction group where they were born. Does achieve a maximum of five parturitions. Litters are reduced to a maximum of 8 young rabbits after the first parturition and to a maximum of 10 after the following ones.

2. DATA STRUCTURE

The analyzed data correspond to 2788 animals chosen for reposition and born between the years 1983 and 1990, among which

323 bucks and 1709 does, as a minimum, have reached the time of the first mating. The current study includes 4930 parturitions where 1 young rabbit at least is born alive (table 1).

3.- ANALYSIS OF THE DATA

For the demographic study of the population we refer to the methods proposed by Vu Tien (1983), the calculations being carried out with the statistical package SAS/STAT (1988),

We have followed these guide lines:

Pyramid of ages: The animals have been classified in 7 age groups, in order to separate the different conditions of the population. The results are expressed in natural years, for the whole period under study.

Productive life: It has been calculated as the difference in days between the first mating and the exit of each breeder. Results are expressed by the bereeder's year of birth, considering the period 1984-1989. The year 1990 has been omitted, because some of the animals born during this year were still alive at the moment of the study.

Reasons for exit: These are the reasons for the elimination of the breeders:

- technical, which include problems dealing with breeding (non acceptannce of mating, consecutive palpations with negative result...).
- sanitary (nasal secretion, foot disease,mamitis...).
- death
- end of productive life, which in bucks results from the production start in their offspring and in does results from the fifth parturition.

The results are expressed as a percentage over the total of eliminated individuals. The results given by the number of parturition include the whole of the reference file that has been under study; in the study by sex, reason and condition, the breeders born before 1988 have been omitted because of incomplete data.

Death rate table: it has been carried out from a study of all the animals that have reached their first mating, and through the study of the percentage of surviving animals after each consecutive birthday (months). The word death rate is used in a broad sense, as a synonymous of loss.

Interval between generations: it has been calculated separately for each of the four ways as a function of the age of the offspring chosen as the future breeder. The results are expressed in the breeder's year of birth, considering the period 1983-1989 for the same reason as the one previously mentionned in the productive life.

Needs of breeders: They have been calculated as consecutive percentages over the total of animals entered into replacement in different conditions:

- total entered into replacement.
- with a minimum of one mating
- with a minimum of one gestation with a young rabbit born alive.

- Effective: with a minimum of a weaned offspring.
-Userful: with a minimum of a an efficient offspring.

The whole reference file has been used to make the calculations.

Interval between parturitions: it has been calculated as a function of the days of difference between two consecutive gestations of a same doe.

Occupancy of the cages: it has been calculated as the percentage expressed by the days of occupancy of the cages, over the total of days of the year. Results are expressed in natural years.

2.- RESULTS AND DISCUSSION

PYRAMID OF AGES

Both table 2 and figure 1 show the distribution of animals by sex, age and year. It cn be observed that the larger group is always the first one, that corresponds to the replacement animals. For the bucks we find 37.8% and for the does 48.7%. We should mention the fact that the number of replaced animals has been increasing throughout the years, which confirms the importance of the replacement in overlapping generations.

The high number of bucks in this group is related to the strict system of substitution of these, which compels the selection system to keep at least two brothers or half brothers, even knowing that only one will take the place of the father and that the other will be eliminated during the replacement.

Within the three following groups of ages, 41.4% of the bucks and 41.9% of the does can be found.

In the group 4.5-6 months there are less animals than in the group 6-8 months, because the former corresponds to a shorter period.

We should also mention that there is a larger proportion of bucks in the population, at the older ages.

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PRODUCTIVE LIFE

A proper management of the breeders is all important to guarantee the proper intervals between generations.

Table 3 shows how the does suffered a decrease in their productive life: it decreased from 175 days during the year 1980 to 150 days during the year 1989. Among the two factors that exert an influence on the duration of the animals' productive life, the one that has exerted the strongest influence in the case of does has been the age of exit, which decreased from 321 days during the year 1984 to 287 during the year 1989, with a mean value of 299 days, whereas the age of the first mating was holding to the same position.

The decrease of the productive life of the females is not necessarily negative, even if the average productive life of 159 days (5.3 months) only permits an achievement of 3.7 parturitions. The highest pressure exerted on the sanitary and productive condition of the population reduces the number of animals remaining in maternity to only those which give good technical results and are in a faultless sanitary condition.

The evolution of the bucks has been much more complex, as a result of the strict standard of substitutions. Because some of the males were lacking offspring, the year of exit was increased to 447 days during the year 1987.

REASONS FOR EXIT

Table 4 shows that the highest percentage of elimination of bucks (62.4%) is obtained during the replacement, because of the strict standard followed for their substitution. On the contrary, only 15.6% of the does are eliminated during the replacement.

The main cause of elimination of bucks is the technical reason, as much in the maternity stage (58.2%) as in the replacement one (59.6%), followed by the end of productive life during maternity and the sanitary reason during the replacement. Death amounts for only 4 to 4.4% of losses.

The case of does is a different one: of those who are in the replacement stage, 51.1% are eliminated for a sanitary reason and 38.6% for a technical reason. In the maternity stage the main causes of loss are, in decreasing order of magnitude, end of productive life, technical and sanitary reason. Death among does is about 10%.

The study of the reasons for exit per number of parturition of the females into maternity (table 5) shows that 36.5% of the does are eliminated after the fifth parturition, mainly because they reach the end of productive life. After the first parturition, 18.47% is eliminated, and after the fourth one the number of

eliminated females reaches a minimum: 8.34%.

The separation into type of reason shows how, with zero parturitions, the main reason for the elimination (52.27%) is a technical one. After the following parturitions, the main reason is a sanitary one (47.83% after the first, 52.53% after the second, and 50% after the third). The eliminations brought about by the second parturition are less important, globally speaking, being the most important both the technical (40.74%) and the sanitary reason (42.96%).

DEATH RATE TABLE

Both table 6 and figure 2 show the survival rate of breeders after the first mating.

The first thing that stands out is the higher survival rate of the males as related to the one of the females. After the tenth month, the survival rate of the bucks is 17.64% whereas the survival rate of the does is 1.73%.

The evolution of the does' death rate until the seventh month is regular. After this moment, which is coincident with the average length of the productive life, the death rate increases quickly.

The bucks show a different evolution from that of the does. Until the ninth month, the losses are regular and after this point the mortality percentages become lower each month, although they last longer than those of the females.

A population of the Rex breed studied by de Rochambeau (1982) shows a high death rate until the seventh month. From the seventh to the eleventh, the losses are lower, and almost the totality of the population's members has desappeared.

We should also mention the fact that 50% of the males disappears between the 6th and the 7th month after the first mating, and that 50% of the females is lost between the 5th and the 6th month.

INTERVAL BETWEEN GENERATIONS

The interval between generations (Table 7) through the ways female-female (F-F) and female-male (F-M) shows a slight tendency towards decreasing: it goes down from 10.6 months to 9.8 months in the first case, and from 10.4 to 9.9 months in the second; and it decreases every year except for the last one.

Through the ways male-male (M-M) and male-female (M-F), on the other hand, the interval between generations keeps its position until the year 87, which shows a big increase because of the difficulties in replacing some of the males. The increase through the ways M-M and M-F was such that, during this year, the maximum

intervals were obtained: 11.3 and 13.0 months, respectively. After these maximums, there is a tendency towards decreasing, and in 1989 the smaller intervals since the beginning if the experiment are obtained: 9.5 for the way M-M and 10.3 for the M-F.

The average lengths of interval per way are 10.2 months for the ways M-M, F-M and F-F, and 11.3 for the way M-F.

The mean value of the intererval between generations for the four ways, from the year 1984 to the year 1990 is 10.6 months, a satisfactory value if we compare it with the 8-10 months suggested as desirable in the works carried out by Matheron and Bouvier (1977) in overlapping generations and with a maximum of three parturitions per female. In overlapping generations, the real intervals between generations fall between 6.6 and 9 (Rouvier et al., 1980) or they are even higher (9.6 in Matheron and Poujardieu, 1984).

NEEDS OF BREEDERS

In the table 8 we show the percentages of animals needed for the accomplishment of the experiment. It can be oserved that only 44.1% of the males entered into replacement reach the day of the first mating, that 43.6% are effective breeders and that 33.5% are useful breeders.

The females have another behaviour: 65.8% of the does entered into replacement become effective breeders and 28.3% of them become useful breeders.

After carrying out an experiment to select for growth traits in separated generations, de Rochambeau (1989) finds that, among the starting breeders, 27% of the bucks and 28.9% of the does are effective.

Among the effective bucks (table 9), 84.2% have had male sons and 93.6% have had daugthers. On the other hand, 44.4% of the effective females have had male sons and 89.4% have had daugthers.

INTERVAL BETWEEN PARTURITIONS

The analyisis of parturitions as related to the days elapsed since the previous gestation (figure 3) clearly shows a mating system with a semi-intensive rythm of 10-12 days and a management with fortnightly bands.

70.9% of the parturitions occur between 39 and 45 days after the previous gestation, being the day 45 the one with the highest number of parturitions (20.6%). 12.3% of the parturitions concentartes between the days 54 and 59, 14 days after the first band, being day 56 the one with a higher frequency (3%).

The third band, 28 days after the first one, gathers 4.7% of the parturitions.

Table 10 shows the evolution of the interval between parturitions throughout the years: from the year 1984, wih an interval of 50.82 days, the length of the interval goes down to 43.3o days during the year 1990. This decrease is attained between the years 85 and 87, clearly showing the effort made to optimize the whole management system.

No important differences are found among the intervals between gestations corresponding to a different number of parturition.

The effect of the season is clear, and it can be observed that some stations have a shorter interval - autumn with 45.13 days and winter with 45.42 days -, while others have a longer one: spring with 46.12 days and summer with 47.2 days. Even so, the difference between the most advantageous station and the least one is only about 2 days.

The full occupancy of the resources (cages) is one of the main advantages of the work in overlapping generations.

Table 11 shows how the mean values of occupancy have been 96.89% for the bucks and 94.14% for the does.

The evolution throughout the years has been ascending in the case of the does, whose occupancy increased from 90.86% during the year 1984 to 97.43% during the year 1990, although there was a decrease during the year 1987.

In the case of the bucks, on the other hand, the level of occupancy holds on around 96%, except for the year 87 when there is an decrease in the occupancy rate.

In an experiment of this type it is necessary to emphasize the importance of the full occupancy and of keeping the population size to its level, because any decrease im the occupancy level could induce a decrease in the intensity of selection to get back to the optimum levels of occupancy.

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TABLE 1.

POPULATION NUMBERS AND AVERAGE PRODUCTIVE PARAMETERS OF THE POPULATION. YEARS 1983-1990.

- Number of bucks entered into maternity	323
- Number of does entered into maternity	1.709
- Number of does that have had a minimum of one parturition with one young rabbit B.A.	1.487
- Number of litters with, at least, an alive young rabbit.	4.930
- Number of litters with, at least, a weaned rabbit.	4.603
- Rabbits born per parturition, total.	9,41
- Rabbits born alive per parturition.	8,87
- Mean value of interval between parturitions	46 days
- Average age of young rabbits at weaning.	32 days
- Individual weight of young rabbits at weaning.	765 gr.
- Mean weight of litter at weaning.	5.841 gr.
- Age young rabbits at II control.	60 days
- Individual weight of young rabbits at II control.	1.896 gr.
- Litter weight at II control.	13.405 gr.
- Post-weaning growth (32-60 days)	41.07 gr.

TABLE 2

PYRAMID OF AGES. PERCENTAGES PER CLASSES OF AGES AND YEARS.

MALES								
		Months						
Year	Observ.	<4,5	4,5-6	6-8	8-10	10-12	12-14	>14
84	46	32,61	15,22	30,43	21,74			
85	51	31,37	9,80	13,73	11,76	17,65	9,80	5,88
86	53	37,74	11,32	13,21	15,09	11,32	5,66	5,66
87	66	31,82	31,82	13,64	9,09	4,55	7,58	1,52
88	92	35,87	15,22	15,22	13,04	3,26	3,26	14,13
89	88	40,91	10,23	12,50	12,50	10,23	5,68	7,95
90	94	46,81	5,32	10,64	11,70	7,45	11,70	6,38
84-90	490	37,8	13,7	14,7	13,0	7,6	6,5	6,7

FEMALES							
	Months						
Observ.	<4,5	4,5-6	6-8	8-10	10-12	12-14	>14
153	37,25	18,30	23,53	11,76	9,15		
189	42,33	14,29	15,87	13,23	11,64	2,65	
184	40,76	13,59	16,85	11,96	12,50	3,26	1,09
191	43,98	17,28	16,75	8,90	8,90	4,19	
265	54,72	13,21	12,83	13,21	4,53	1,13	0,38
224	49,11	12,95	12,50	15,18	8,93	1,34	
238	52,81	13,47	10,08	12,18	8,82	2,94	0,42
1.444	46,7	14,5	14,9	12,5	8,9	2,2	0,3

TABLE 3

PRODUCTIVE LIFE. PER AGE OF BIRTH AND SEX.

	MALES				FEMALES			
Year	Observ.	Days 1st mating	Days Exit	Days prod. life.	Observ.	Days 1st mating	Days Exit	Days prod. life.
84	(47)	175	383	208	(173)	146	321	175
85	(48)	183	380	197	(229)	141	311	170
86	(59)	164	335	171	(216)	139	320	181
87	(50)	168	447	279	(215)	167	305	138
88	(38)	211	439	228	(307)	138	267	129
89	(41)	168	410	242	(283)	137	287	150
84-89	(283)	177	396	219	(1423)	140	299	159

TABLE 4

REASONS FOR EXIT PER SEX AND CONDITION. YEARS 88-90.

Sex	Reason	Maternity	Replacement
BUCKS	Total	37,6	62,4
	Technical	58,2	59,6
	Sanitary	7,7	31,8
	Death	4,4	4,0
	End of prod. life	29,7	4,6
DOES	Total	84,4	15,6
	Technical	30,7	38,6
	Sanitary	28,8	51,1
	Death	9,4	10,3
	End of prod. life	31,1	0

TABLE 5

REASONS FOR EXIT.
MATERNITY FEMALES. PER NUMBER OF PARTURITION.

Num. of Partur.	Observ.	Reason				% total
		Technical	Sanitary	Death	E.C.(*)	
0	(220)	52,27	30,00	17,73	0,0	13,59
1	(299)	35,12	47,83	17,06	0,0	18,47
2	(198)	31,82	52,53	15,66	0,0	12,23
3	(170)	35,88	50,00	14,12	0,0	10,50
4	(135)	40,74	42,96	16,30	0,0	8,34
5	(595)	4,37	2,69	0,50	92,44	36,75
Total	(1617)	26,28	29,19	10,51	34,00	

(*) E.C. = End of productive life.

TABLE 6

DEATH RATE TABLE.
% SURVIVAL AFTER THE FIRST MATING.

Months	Num. bucks	Num. does	% Bucks	% Does
1	7	151	2,37	9,33
2	16	151	5,42	9,33
3	16	221	5,42	13,65
4	26	140	8,81	8,65
5	19	108	6,44	6,67
6	27	101	9,15	6,24
7	45	110	15,25	6,79
8	40	300	13,56	18,53
9	28	230	9,49	14,21
10	19	79	6,44	4,88
11	12	24	4,07	1,48
12	9	3	3,05	0,19
13	8	1	2,71	0,06
14	4	–	1,36	–
15	4	–	1,36	–
16	3	–	1,02	–
17	1	–	0,34	–
18	3	–	1,02	–
19	2	–	0,68	–
20	6	–	2,03	–
TOTAL	295	1.619		

TABLE 7

INTERVAL BETWEEN GENERATIONS (MONTHS).

		YEARS						
WAY	Observ.	84	85	86	87	88	89	84-89
MALE MALE	(456)	9,7	9,7	9,9	11,3	10,4	9,5	10,2
MALE FEMALE	(1640)	10,7	10,6	10,4	13,0	11,2	10,3	11,3
FEMALE MALE	(458)	10,4	10,7	10,4	10,1	9,7	9,9	10,2
FEMALE FEMALE	(1625)	10,6	10,4	10,3	10,3	9,6	9,8	10,2
TOTAL		10,6	10,5	10,3	11,7	10,2	10,0	10,6

TABLE 8

NEEDS OF BREEDERS.
Years 1983-1990.

	MALES	FEMALES
Chosen animals (%)	100	100
Animals 1st. mating (%)	44,1	83,5
Animals 1st. parturition (B.A.=0) (%)	43,9	72,7
Effective (%)	43,6	65,8
Useful (%)	33,5	28,3

TABLE 9

EFFECTIVE ANIMALS.
% ANIMALS CHOSEN FOR REPLACEMENT.

	Breeder	
Offspring	Male	Female
Male	84,2	44,4
Female	93,6	89,4

TABLE 10

INTERVAL BETWEEN PARTURITIONS.

	Y E A R						
	84	85	86	87	88	89	90
Observations	473	469	505	504	524	574	508
Days	50,82	46,63	47,72	46,24	44,44	43,41	43,30

	NUMBER OF PARTURITION			
	1	2	3	4
Observations	1173	974	784	623
Days	45,32	46,10	46,59	46,25

	SEASONS			
	Winter	Spring	Summer	Fall
Observations	944	858	900	855
Days	45,42	46,12	47,20	45,13

TABLE 11

PERCENTAGE OF OCCUPANCY OF THE CAGE.

	SEX	
YEAR	Males	Females
84	96,31	90,86
85	97,42	90,64
86	97,91	94,68
87	92,97	93,31
88	98,70	95,02
89	98,80	97,06
90	96,12	97,43
84-90	96,89	94,14

FIGURE 1

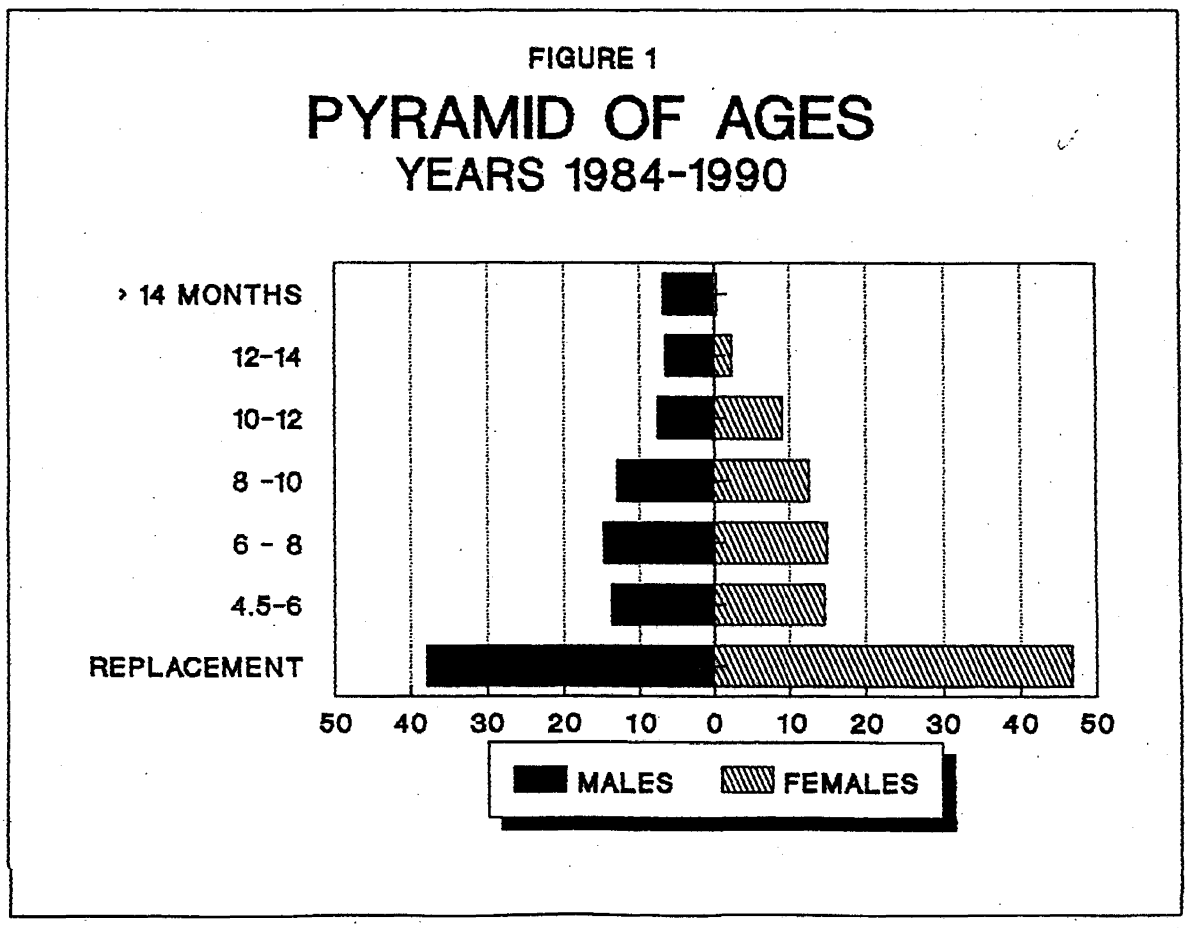

FIGURE 2

DEATH RATE TABLE

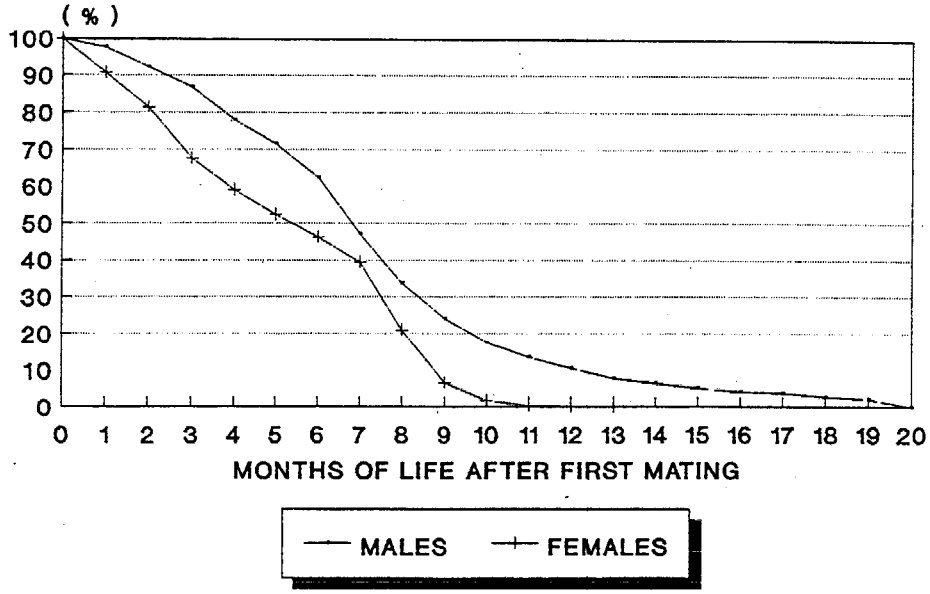

FIGURE 3

INTERVAL BETWEEN PARTURITIONS