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TIME-BUDGETS OF CAMARGUE HORSES

II. TIME-BUDGETS OF ADULT HORSES AND WEANED SUB-ADULTS

by

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(With 5 Figures)
(Acc. 10-IV-1979)

INTRODUCTION

It has been shown in paper I of this series (BOY & DUNCAN, 1979) that the time-budgets of foals become similar to those of the age-class above, the sub-adults, soon after weaning. In this paper the time-budgets of adults and weaned sub-adults will be described. An analysis of the differences between the time-budgets of these age classes, and of the two sexes, is a necessary prelude to studies of variations between seasons and populations; the analysis also has heuristic value since little is known about the effects of the different reproductive strategies of mammals on the use of time. GADGIL & BOSSERT (1970) have pointed out that animals will need to make compromises in their use of time (or energy) between reproductive and maintenance activities.

Maintenance activities are those concerned with feeding, movement and rest and it is clear that the nature and duration of an animal's reproductive activities will depend on the flexibility of its requirements of time for the maintenance activities. Thus if an animal exploits food resources which require a great deal of time to harvest, then they may be "obliged" to adopt a social system which requires only a small investment of time per day in social interactions. This kind of argument has been put forward to account for the unusual harem-based social system of baboons such as the gelada (DUNBAR, 1978). Unfortunately, as pointed out by DUNBAR (1978) much

1) This study was funded by the Fondation Tour du Valat, and I am grateful to Dr L. HOFFMANN for his consistent encouragement and support.

Warm thanks go to all the "horse-people" who made this study possible by their willingness and resistance to the often tiresome environment that we and the horses lived in. Particular thanks to C. FEH, J.-C. GLEIZE, and S. M. WELLS who, with the author, made most of the observations.

Vincent BOY did the programming and made many helpful suggestions in discussions on the analysis, and Bettina HUGHES on the methods and results. My thanks to them both.

of the critical evidence is missing and what little is available suggests that when males increase the time spent in reproductive activities, then it is time spent feeding which decreases, while time spent resting does not change (cf. Waterbuck, SPINAGE, 1968; Impala, JARMAN & JARMAN, 1973). Territorial Impala lose condition, and their status, quite rapidly, presumably at least in part as a consequence of this loss of food (JARMAN & JARMAN, 1973). These results suggest that there must be rather strong constraints on the time required for resting. Particular attention was therefore paid to resting by horses in this study.

The social system of free-living horses (KLINGEL, 1967; FEIST & MCCULLOUGH, 1976) differs from those of these territorial ruminants in that the horses' system is based on long lasting relationships between a male and the females of his harem. There have been very few previous studies of the time-budgets of free-living horses, and unfortunately KLINGEL (1967) and GOGAN (1973) did not distinguish between age- or sex-classes in their studies.

The horses studied here cannot be considered as wild, since one year before this study they were being managed to produce foals (WELLS, 1978). However, during the study they were subject to little interference by man (see Materials and Methods), and the social structure underwent considerable changes. Initially the structure was largely determined, as in other domestic herds, by relations between the females and their offspring, and with eachother (WELLS, 1978); males played insignificant roles compared to those reported for feral populations (FEIST & MCCULLOUGH, 1976) or wild ones (KLINGEL, 1967). Three years later the social system showed strong similarities to those of wild and feral equids: males herded their breeding units about twice per hour (C. FEH, pers. comm.), and displays, fights and chases by males were commonly seen. The changes in the frequency of fights are shown in Table 1a and changes in the composition of the social units are shown in Table 1b.

Although little work has been done on the time-budgets of free-living horses, a great deal has been done on domestic horses, using automatic recording devices (RUCKEBUSCH, BARBEY & GUILLEMOT, 1970; RUCKEBUSCH, 1972; DALLAIRE & RUCKEBUSCH, 1974; RUCKEBUSCH, 1975). These studies not only provide extremely useful data for comparison with those presented here, but they have also clarified our understanding of resting and sleep in horses. As in other higher mammals, horses have four states of alertness, which can be recognised by characteristic patterns of cortical electrical activity and associated motor patterns: wakefulness, drowsiness, slow-waves sleep and paradoxical sleep (RUCKEBUSCH, BARBEY & GUILLEMOT, 1970). In this study of Camargue horses it was not possible to determine the time

TABLE 1

Some changes in the behaviour and social structure of the horses during this study

Year	1975														
Month	J	F	M	A	M	J	J	A	S	O	N	D			
No. fights			0	1	0	5	1	0	0	0	2	0			
No. hours observed			192	192	192	192	150	192	132	162	240	156			
Year	1976												1977		1978
Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	July
No. fights	0	0	3	2	1	1	3	1	0	0	0	2	24	17	1
No. hours observed	192	192	136	132	65	64	50	50	50	50	50	50	283	227	30

a.

Year	Breeding units	Bachelor group
1974	1. 1 ad ♂ ; 7 ad ♀ ♀ ; 9 sub-ads	1 sub-ad ♂
1075	1. 1 ad ♂ ; 7 ad ♀ ♀ ; 16 sub-ads	2 ad ♂ ♂
1976	1. 1 ad ♂ ; 9 ad ♀ ♀ ; 16 sub-ads	4 ad ♂ ♂ ; 5 sub-ad ♂ ♂
1977	1. 1 ad ♂ ♂ ; 8 ad ♀ ♀ ; 20 sub-ads 2. 3 ad ♂ ♂ ; 2 ad ♀ ♀ ; 4 sub-ads 3. 2 ad ♂ ♂ ; 1 ad ♀ ; 2 sub-ads	2 ad ♂ ♂ ; 1 sub-ad ♂
1978	1. 1 ad ♂ ; 2 ad ♀ ♀ ; 5 sub-ads 2. 1 ad ♂ ; 3 ad ♀ ♀ ; 4 sub-ads 3. 1 ad ♂ ; 3 ad ♀ ♀ ; 4 sub-ads 4. 2 ad ♂ ; 7 ad ♀ ♀ ; 11 sub-ads 5. 1 ad ♂ ; 1 ad ♀ ; 2 sub-ads 6. 1 ad ♂ ; 2 ad ♀ ♀ ; 2 sub-ads	2 ad ♂ ♂ ; 1 sub-ad ♀

b.

a. Changes in the frequency of fights in the breeding herd.
b. Composition of the social groups at the end of the foaling season (1st Sept.) at various stages in the study. Horses considered adult at 3 years, or at the birth of her first foal for a female younger than 3 years. Membership determined from nearest-neighbour records.

spent in different states, but since horses have preferred postures for these states (DALLAIRE, 1974), it was possible to interpret some inter-individual differences of the time-budgets of these horses in the light of general principles of mammalian sleep.

The categories of maintenance activities studied were chosen so as to represent the typical postures and gaits of horses as they satisfied their basic

requirements of foraging, moving and resting. "Resting" was subdivided into three postures, standing, resting, and sternal and lateral recumbency (the preferred postures drowsiness, slow-waves sleep and paradoxical sleep respectively, DALLAIRE, 1974) and "moving" was subdivided into walking, trotting and galloping.

MATERIAL AND METHODS

These have been described fully in paper I of this series; a brief account will be given here.

a. *Study area.*

This was located on the Tour du Valat estate in the south-east of the Camargue, 13-Bouches du Rhône, France. The climate in most years was sub-humid with cool winters and hot, dry summers.

The area available was 300 ha, extended to 335 ha in 1976, of basically halophytic vegetation of poor nutrient value during the winter. In the growing season the horses fed largely on the emergent plants of marshes (SKELTON, 1978). The vegetation of the area was typical of the Camargue and has been fully described by BASSETT (1978).

b. *Horses.*

The herd consisted of horses of the Camargue breed, which measures some 140 cm at the shoulder and weighs 350-450 kg when fully grown. Before the study began the herd had been maintained on the estate for at least 30 years, for the production of foals. No animals were added except for stallions which were introduced each spring for breeding purposes. The brood mares were not handled and were given supplementary fodder only occasionally.

For the purposes of research into the behaviour and ecology of horses in this environment the herd was reduced to 14 animals and released with a stallion onto the study area at the end of 1973. The horses were left without human interference and during the following five years the density increased considerably from 0.046 to 0.167 horses/ha. Since the increase continued, it may be assumed that throughout the study the density was below the carrying capacity. The age and sex composition is given in Table 2.

TABLE 2

The composition of the study population by age and by sex at the end of the foaling seasons, 1975-8

Sex	Age	Number of horses			
		1975	1976	1977	1978
Males	5 + yrs	1	1	2	4
	4 yrs		2	2	4
	3 yrs	2	2	4	1
	2 yrs	2	4	1	4
	1 yr	4	1	4	6
	foals	1	4	6	8
	3 + yrs	7	8	10	16
	2 yrs	2	2	6	5
Females	1 yr	2	6	5	3
	foals	6	5	3	5
Total		27	35	43	56

In the Results and Discussion, it was found convenient to distinguish between three classes of sub-adults, yearlings (*i.e.* horses in their second year), young males (males in their third year) and young, pregnant females. The last class included both yearlings and two-year-olds, and females were allocated to this class if they foaled for the first time in the year which followed the observations.

Individuals were referenced by a letter-number combination (*e.g.* H2) and were easily recognisable, by differences in colour, shape, etc. The only major clinical event during this period of the study in these age/sex classes was a still-born foal of one of the young mares (H2) during spring 1975.

Births of foals, and oestrus in the females occurred between December and June each year.

c. *Field observations.*

The animals had been habituated to observation during 1974 and could be followed easily by observers on foot. Special precautions were necessary to avoid disturbing the herds when the observers changed (every 3 or 4 hours). An image-intensifyer was used at night and a portable radio allowed the observer to request help if, for instance, the herd split up.

Most of the data were collected in the year March 1975-February 1976 and referred to as "1975": the breeding herd was observed for two days (24 hrs) in two weeks of each month except early August and January when only one complete watch was made. During the following year, referred to as "1976", four days were studied during the seasons spring, summer, autumn and winter (defined from the data of the previous year, see paper III). Finally, in 1978, when the social system had ceased changing rapidly a sample of horses was studied over two days for comparison with the results obtained previously. This sample included the principal stallion of each breeding unit and the dominant lactating female; in addition three other lactating females, three two-year-old females, three two-year-old males and four yearlings were selected at random.

Nine activities were distinguished:

Sleep and Drowsiness	1. Lying flat: lateral recumbency, lying laterally with the head immobile on the ground and the legs extended.
	2. Lying up: sternal recumbency, lying with the sternum on the ground and legs folded under the body.
	3. Standing resting: standing immobile. Usually with one hind-leg relaxed and the weight carried by the other; eyes partly or wholly closed, head held low, ears pointing in different directions. Ears and tail may move.
	4. Foraging: biting, chewing or swallowing food. Foraging overrides walking if both occur simultaneously.
Orientation and Movement	5. Standing alert: standing with head raised or moving, ears oriented in the same direction and eyes fully open. Drinking was included in this activity for this analysis.
	6. 7. 8. Walking, Trotting and Galloping (including cantering) - self explanatory.
	9. Rolling: retained separately because of its high energy cost.

d. *Analysis.*

The time-budget of each horse was calculated for each week by summing the number of records obtained for each activity over the two days observed.

The approach adopted in this analysis was first to establish, for each year, whether or not the inter-individual differences were constant. This was done by a three-dimensional classification technique (STATIS) whose mathematical basis is analogous to principal component analysis (L'Hermier des Plantes, 1976). The "interstructure" of

the weeks is expressed as an angle such that weeks in which the same individuals differed with respect to the same activities are allocated the same angle, and the distance from the origin of the point representing the week expresses the size of the differences. In this way the years could be subdivided into periods in which interindividual differences were relatively homogeneous.

For each period, the average time budget was then calculated for each horse and the resulting, two-dimensional, matrix of horses × activities was subjected to correspondance analysis (HILL, 1974). This analysis identified the main sources of variation between the individuals: these factors were then studied further by reference to the original data.

At various points it was useful to calculate a measure of dissimilarity ("distance") between two time-budgets in isolation from the rest. The areas we used was the "X^2-distance" (CAILLIEZ & PAGÈS, 1976).

Non-parametric statistical tests (SIEGEL, 1956) were generally preferred since the distributions of much of the data were non-normal.

Isolated cases of missing data (0.02% of the data set) were replaced by the most probable values; in case where data were missing for a horse over a whole day in any period, such an animal was eliminated from the analysis of that period.

RESULTS AND DISCUSSION

a. Grouping the weeks.

The polar coordinates for the weeks in the first year (1975) are shown in Table 3. There were no obvious groupings, but it seemed that the autumn and winter months were rather separate from spring and summer, so the two groups were divided arbitrarily at the origin of the x-axis and analysed separately. The late September and October weeks were treated with the spring and summer weeks.

The results for 1976 are shown in Table 4. The same procedure was used here and it resulted in two groups, a winter (and early spring) one and a larger group comprising the results from the rest of the year.

b. Representation of the difference between the individuals using correspondance analysis.

The first two axes of the analyses accounted for large proportions of the variance in the data sets for the periods studied, Table 5. The subsequent axes were not easily interpretable and are therefore ignored.

The ordination for the period spring and summer 1975 will be considered first. Axis 1 was bipolar, with large contributions from some of the lactating mares and from an adult male and a yearling (Table 6, Fig. 1). Axis 2 had a large contribution from the same adult male only, Table 7.

These two axes separated three groups of horses, Fig. 1, adult females, yearlings, and adult males. The young females (H2 and I1) were associated with the yearlings and the young males (H1 and H4) with the adult males.

For the activities, large contributions to Axis 1 were provided by Standing

TABLE 3

The results of a 'three-dimensional' classification analysis (STATIS, see Methods c.) on the results from the 22 weeks for which two days' data were available in the year 1975

Week	Polar co-ordinates x - axis	y - axis	Period
December 2	— 46951	300055	
December 1	— 36104	220219	
March 1	— 19219	182968	
October 1	— 19073	225295	1975
January 2	— 18006	220158	Autumn
February 1	— 12681	222390	+
November 2	— 2293	273811	Winter
September 1	— 1028	156997	
July 1	4380	262764	
October 2	5247	223812	
March 2	5807	134673	1975
May 1	7534	174673	Spring
August 2	7995	199325	+
July 2	8373	268680	Summer
February 2	9592	227637	
June 1	13751	292032	
May 2	15015	223373	
April 2	15686	177179	
September 2	16540	247610	
April 1	17095	161816	
June 2	32478	363192	

resting (Table 8) associated with the adult females (Fig. 1), and by the two lying postures which were associated with the males and young horses. This axis will be referred to as the "Mare axis" in the remainder of this paper. The two lying postures also provided large contributions to Axis 2, Table 8, Lying flat being associated with the males and Lying up with the young horses, Fig. 1. Axis 2 will be referred to subsequently as the "Stallion axis".

The main differences between the individuals were thus related to their age and sex. Average time-budgets were calculated for five classes; though so large a number of classes was perhaps not warranted, this procedure had the advantage of clarifying the intermediate position of the young males and females. The results are shown in Table 9a. The significance of differences between the time-budgets of the three groups identified on the ordination (adult females, yearlings and young females, and males) were tested using the "runs" test (SOKAL & ROHLF, 1972); significant differences were found for all activities except Rolling, Walking and Foraging. Rolling was observed rarely, and Walking tended to occur for the whole herd together as the horses

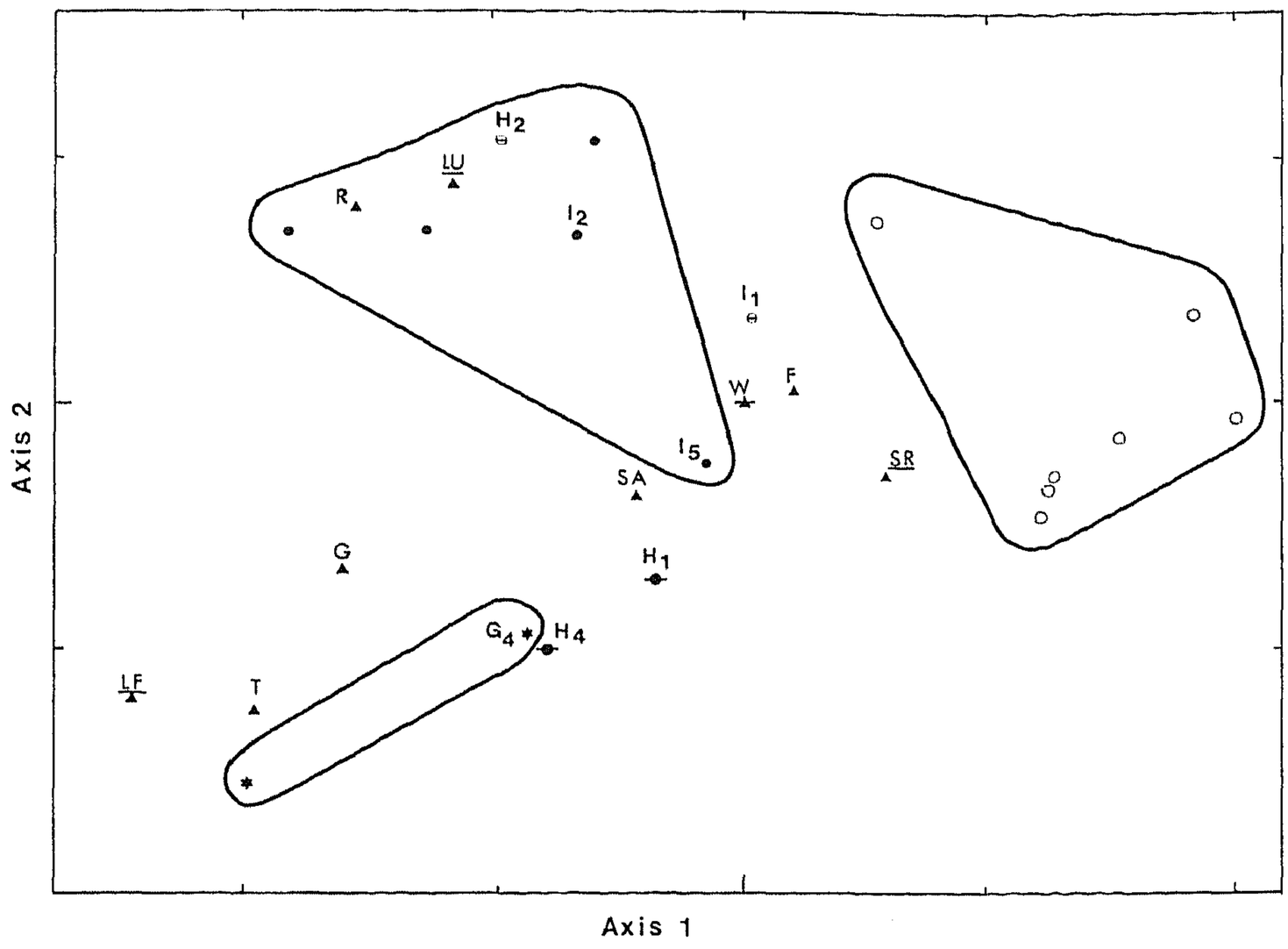

Fig. 1. Ordination of the time-budgets of the weaned horses in the breeding unit, Spring and Summer 1975. ○ = adult females; ⊖ = young females; ● = yearlings; ⊕ = young males; * = adult males; + = origin.
Activities (▲) making large contributions to the axes (see Tables 6, 7) are underlined. Lf = lying flat; Lu = lying up; R = rolling; T = trotting; G = galloping; Sa = standing alert; W = walking; F = foraging; Sr = standing resting. The clouds of points representing adult females, adult males and yearlings are outlined. The scale for the individuals is different from that for activities.

travelled from one part of the pasture to another, so it is perhaps not surprising that no significant differences were found for these activities. To summarise, adult females' time-budgets were characterised by large amounts of time spent Standing resting, yearlings by large amounts of time lying and moving (Trot and Gallop); while males were remarkable for the relatively large amounts of time they spent Standing alert and, like yearlings, lying and moving rapidly.

For the autumn and winter period the axes had similar structures to those obtained from the previous data set, except that the adult stallion (G4 left the herd between these two periods) no longer made a large contribution to the "Mare Axis"; Table 6; and a young male, H4, made a large contribution to the "Stallion Axis", Table 7.

With respect to the activities, the main difference was that Lying up

TABLE 4

Results of a 'three-dimensional' classification analysis (STATIS, see Methods c.) on the results from the 16 days observed in 1976

Week	Polar co-ordinates x - axis	y - axis	Period
January 1	— 5008	37861	
April 1	— 1598	18420	1976
March 1	— 799	11697	Winter
February 1	— 136	12378	
June 1	60	19335	
April 4	349	10698	
June 2	239	28032	1976
April 2	672	17039	Spring
April 3	684	12967	Summer
July 2	834	17349	+
July 1	838	18500	Autumn
December	879	13783	
September 2	915	13198	
September 1	1387	16801	
October 2	3292	17213	
October 1	3711	17385	

TABLE 5

Percentage of the variance in the data accounted for by Axis 1, and by Axis 1 +2, of the ordinations

Period		% variance accounted for by Axis 1	Axis 1 + 2
1975	Spring + Summer	60.8	83.2
	Autumn + Winter	69.3	83.7
1976	Spring, Summer + Autumn	60.4	77.4
	Winter	52.6	71.2
1978	Summer	38.2	68.4

ceased to contribute in a major way to the "Stallion Axis", but Standing alert did, Table 8. The ordination, Fig. 2, shows three groups of similar composition to those of the previous period. The only notable difference being (apart from the absence of G4) that the young females, H2 and I1, were here more closely associated with the adult females. This impression was verified by calculating the χ^2 distance between the average budget for these two age classes in spring and summer (= 4.41) and autumn and winter (= 3.32). This development may have a consequence of their increasing age, but it is more likely to be related to their advanced state of pregnancy. These two both foaled two months after the winter observations,

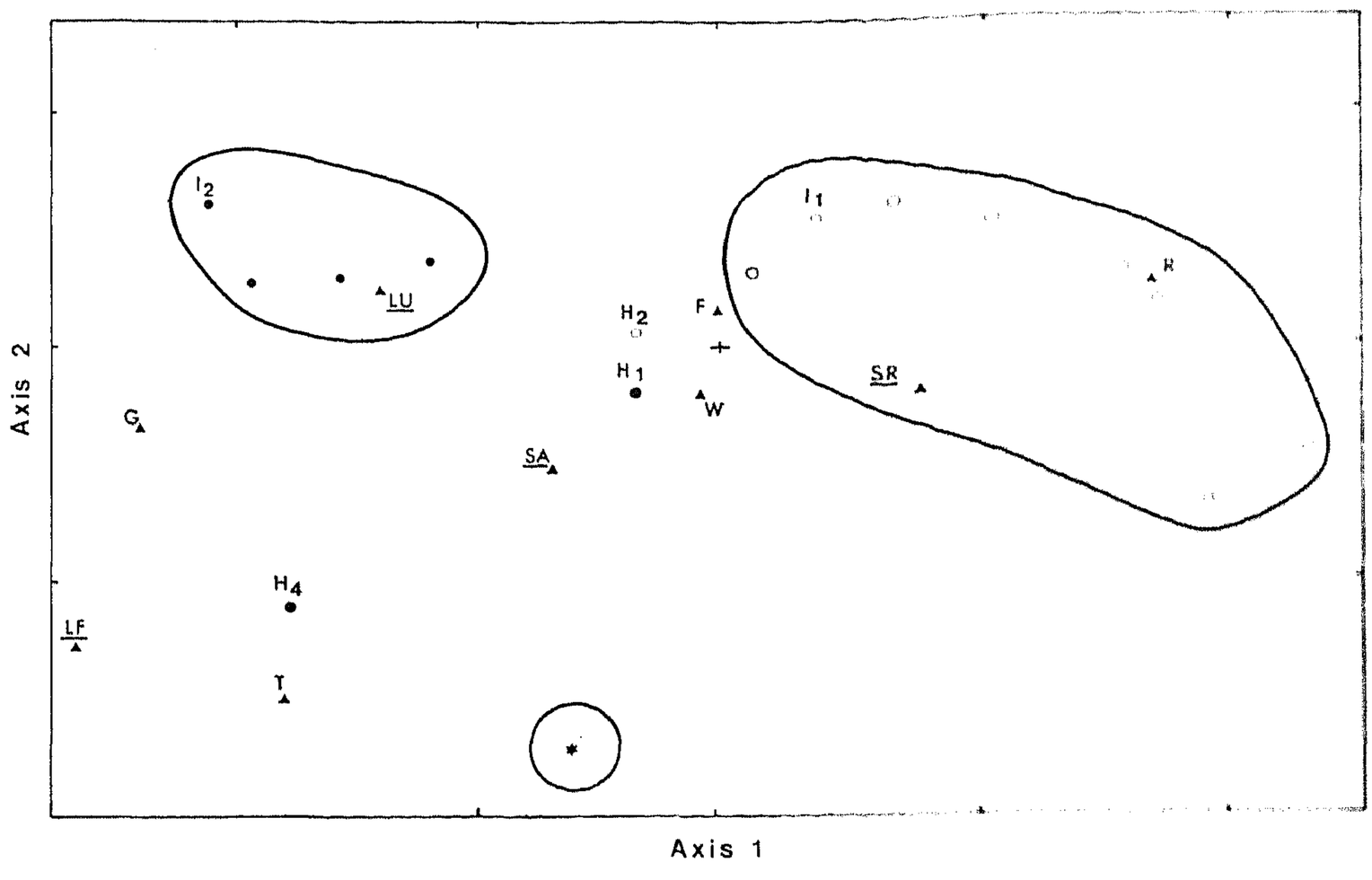

Fig. 2. Ordination of the time-budgets of the weaned horses in the breeding unit, Autumn and Winter 1975. Legend as for Fig. 1.

Note added in proof: bars should be put through symbols of horses H_1, H_4, I, and H_2.

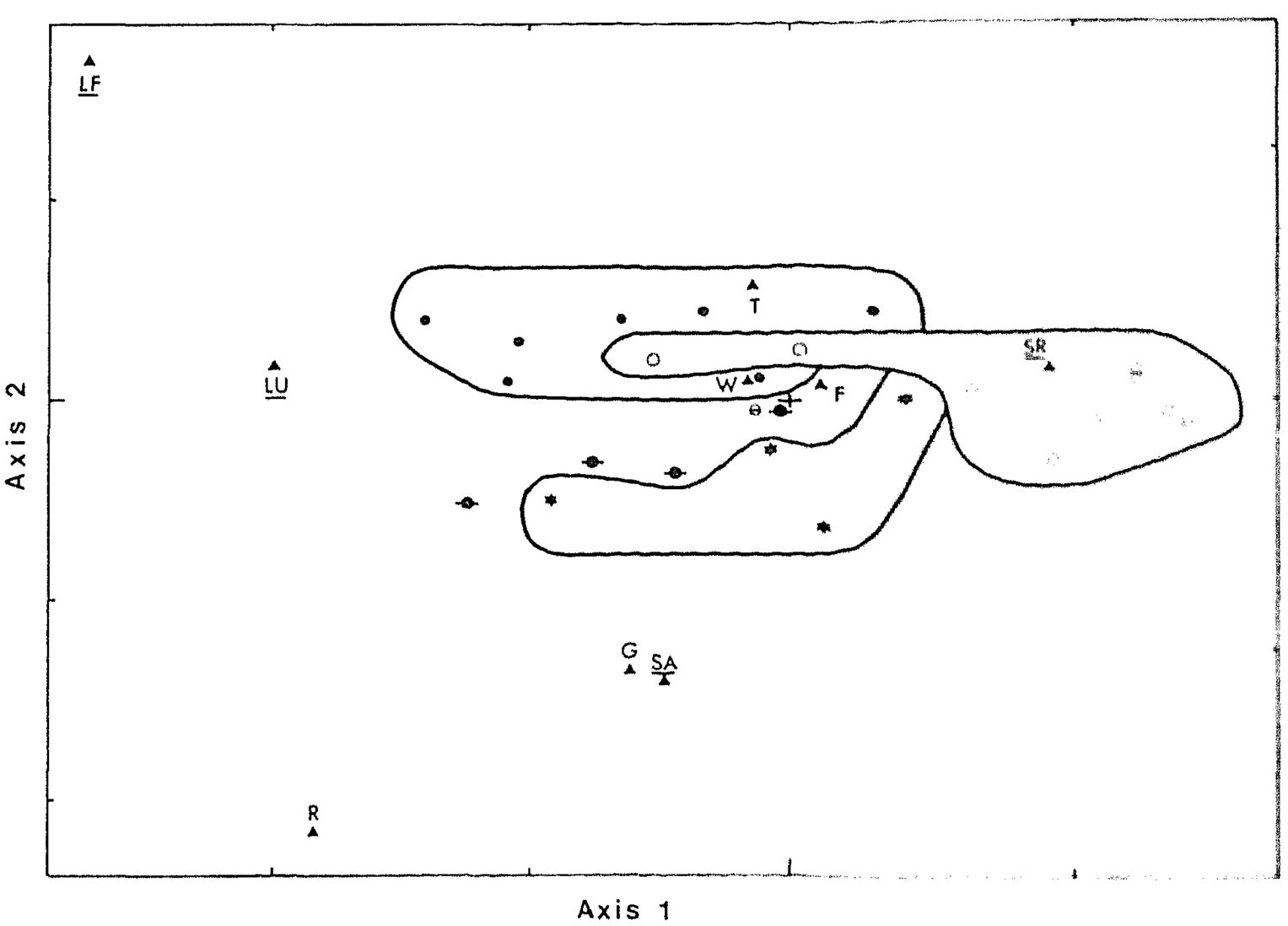

Fig. 3. Ordination of the time-budgets of the weaned horses in all groups, Spring, Summer and Autumn 1976. Legend as for Fig. 1.

TABLE 6

Contributions (see text) made by the individual horses to Axis 1 of the correspondence an
analyses of the different periods

Period		1975 Sp + Su	1975 A + W	1976 Sp + Su + A	1976 W	1978 Su	
Horse	9	0.017	0.001	0.033	0.0		0.043
	5	0.129	0.342	0.246	0.413		0.026
Adult	7	0.082	0.240	0.0	0.200	E 1	0.044
♀ ♀	C 1	0.183	0.155	0.186	0.003	G 3	0.020
	D 2	0.220	0.183	0.216	0.174	H 2	0.073
	E 1	0.090	0.066	0.043	0.109	I 2	0.063
	G 3	0.086	0.031	0.140	0.056	I 7	0.062
				H 2 0.100	0.013	I 8	0.049
				I 1 0.180	0.111	J 4	0.025
Young	H 2	0.053	0.007	I 2 0.002	0.005	J 6	0.042
♀ ♀	I 1	0.0	0.010			K 2	0.002
						K 5	0.006
Adult	D 1	0.227	0.022	0.001	0.011		0.039
♂ ♂	G 4	0.042		0.097	0.016		0.072
				H 1 0.020	0.0		0.005
				H 4 0.002	0.007		0.023
						I 3	0.0
						I 4	0.062
Two-year	H 1	0.008	0.007	I 3 0.0	0.08	K 1	0.001
old ♂ ♂	H 4	0.034	0.198	I 4 0.183	0.054	K 3	0.013
				I 5 0.066	0.016		
				I 6 0.024	0.224	K 6	0.024
	I 2	0.026	0.278	I 7 0.137	0.0	L 1	0.074
	I 3	0.021	0.155	I 8 0.009	0.0	L 3	0.036
Yearling	I 4	0.187	0.238	J 1 0.003	0.398	L 4	0.080
	I 5	0.002	0.089	J 2 0.048	0.011	L 7	0.016
	I 6	0.092		J 3 0.230	0.025		
				J 4 0.127	0.031		
				J 5 0.012	0.371		

The horses were weighted equally, and the most important horses for each axis are underlined.
Sp = Spring; Su = Summer; A = Autumn; W = Winter.

TABLE 7

Contributions made by the individual horses to Axis 2 of the ordinations

Period		1975		1976		1978
Horse		Sp + Su	A + W	Sp + Su + A	W	Su
	9	0.031	0.007	0.011	0.004	0.018
	5	0.001	0.013	0.003	0.013	0.001
	7	0.012	0.028	0.018	0.007	E 1 0.007
Adult	C 1	0.007	0.006	0.003	0.007	G 3 0.0
	D 2	0.000	0.002	0.001	0.0	H 2 0.005
	E 1	0.005	0.018	0.001	0.0	I 2 0.001
	G 3	0.007	0.024	0.002	0.030	I 7 0.004
				H 2 0.003	0.051	I 8 0.0
				I 1 0.007	0.020	J 4 0.007
Young	H 2	0.065	0.0	I 2 0.0	0.030	J 6 0.005
♀ ♀	I 1	0.007	0.019			K 2 0.006
						K 5 0.064
	D 1	0.132	0.182	0.018	0.242	0.041
	G 4	0.049		0.072	0.070	0.030
Adult				H 1 0.0	0.080	0.031
♂ ♂				H 4 0.108	0.016	0.121
						I 3 0.016
						I 4 0.290
Two year	H 1	0.028	0.003	I 3 0.002	0.0	K 1 0.001
old ♂ ♂	H 4	0.055	0.077	I 4 0.065	0.045	K 3 0.009
				I 5 0.021	0.031	K 6 0.007
				I 6 0.034	0.006	
	I 2	0.027	0.023	I 7 0.004	0.013	
Year-	I 3	0.064	0.006	I 8 0.050	0.061	L 1 0.159
lings	I 4	0.028	0.005	J 1 0.002	0.006	L 3 0.022
	I 5	0.004	0.009	J 2 0.045	0.001	L 4 0.035
	I 6	0.029		J 3 0.039	0.030	L 7 0.121
				J 4 0.028	0.0	
				J 5 0.054	0.041	

The horses were weighted equally, and the most important horses for each axis are underlined.
Sp = Spring; Su = Summer; A = Autumn; W = Winter.

TABLE 8

Contributions made by the activities to the Axes 1 and 2

Period	Mare Axis (Axis 1)					Stallion Axis (Axis 2)				
	1975		1976		1978	1975		1976		1978
Activity	Sp+Su	A+W	Sp+Su+A	W	Su	Sp+Su	A+W	Sp+Su+A	W	Su
Standing resting	0.199	0.666	0.566	0.574	0.055	0.047	0.045	0.012	0.009	0.008
Lying up	0.419	0.754	0.933	1.141	0.334	0.267	0.022	0.003	0.003	0.236
Lying flat	0.621	0.503	0.470	0.496	0.173	0.146	0.115	0.115	0.009	0.184
Standing alert	0.059	0.002	0.073	0.004	0.280	0.049	0.116	0.415	0.668	0.398
Trotting	0.066	0.042	0.0	0.001	0.008	0.027	0.030	0.004	0.785	0.008
Galloping	0.026	0.050	0.004	0.030	0.005	0.005	0.001	0.012	0.199	0.002
Rolling	0.009	0.002	0.018	0.002	0.038	0.003	0.0	0.015	0.060	0.108
Walking	0.0	0.003	0.010	0.019	0.015	0.0	0.018	0.003	0.048	0.016
Foraging	0.098	0.001	0.028	0.002	0.092	0.008	0.073	0.009	0.123	0.041

The activities were weighted according to the time spent by all the horses. The most important activities for each Axis are underlined.

TABLE 9

Time budgets, expressed as % time spent in each activity, of horses of different age/sex classes during two periods of 1975

Age/sex Class	No. of horses	Activity: Standing resting	Lying up	Lying flat	Standing alert	Trotting	Galloping	Rolling	Walking	Foraging
Adult ♀♀	7	16.20 a	6.09 a	1.16 a	7.50 a	0.26 a	0.14 a	0.05	9.08	59.54
Young ♀♀	2	13.48 b	10.60 b	2.47 b	7.73 a	0.45 b	0.27 b	0.13	7.98	56.84
Yearlings	5	12.09 b	10.60 b	3.16 b	7.87 a	0.45 b	0.32 b	0.14	9.03	56.37
Young ♂♂	2	13.61 b	7.10 c	3.96 b	9.16 b	0.58 c	0.47 b	0.09	7.76	57.24
Adult ♂♂	2	14.45 b	8.27 c	4.75 b	10.73 b	0.94 c	0.37 b	0.12	9.50	50.82

a. Spring and Summer 1975

Age/sex Class	No. of horses	Activity: Standing resting	Lying up	Lying flat	Standing alert	Trotting	Galloping	Rolling	Walking	Foraging
Adult ♀♀	7	21.01	3.94 a	0.31 a	6.01	0.09 a	0.05 a	0.02	5.51	63.05
Young ♀♀	2	19.52 a	6.93 a	1.10 a	4.90 a	0.11 a	0.08 a	0.01	5.25	62.18
Yearlings	4	13.49 b	8.90 b	1.67 b	5.92 a	0.30 b	0.28 b	0.01	5.55	63.89
Young ♂♂	2	15.26 a	5.99 a	2.38 b	7.04 b	0.32 c	0.17 b	0.01	5.59	63.15
Adult ♂♂	1	19.40 a	6.67 a	1.89 b	8.67 b	0.58 c	0.27 b	0.01	7.05	55.49

b. Autumn and winter 1975

Different letters indicate that the age/sex classes differ significantly ($p < 0.05$, runs test.).

Adult ♀♀ - females with foals. Young ♀♀ - young pregnant females. Yearlings - aged 1-2 years.
Young ♂♂ - males aged 2-3 years. Adult ♂♂ - > 3 years.

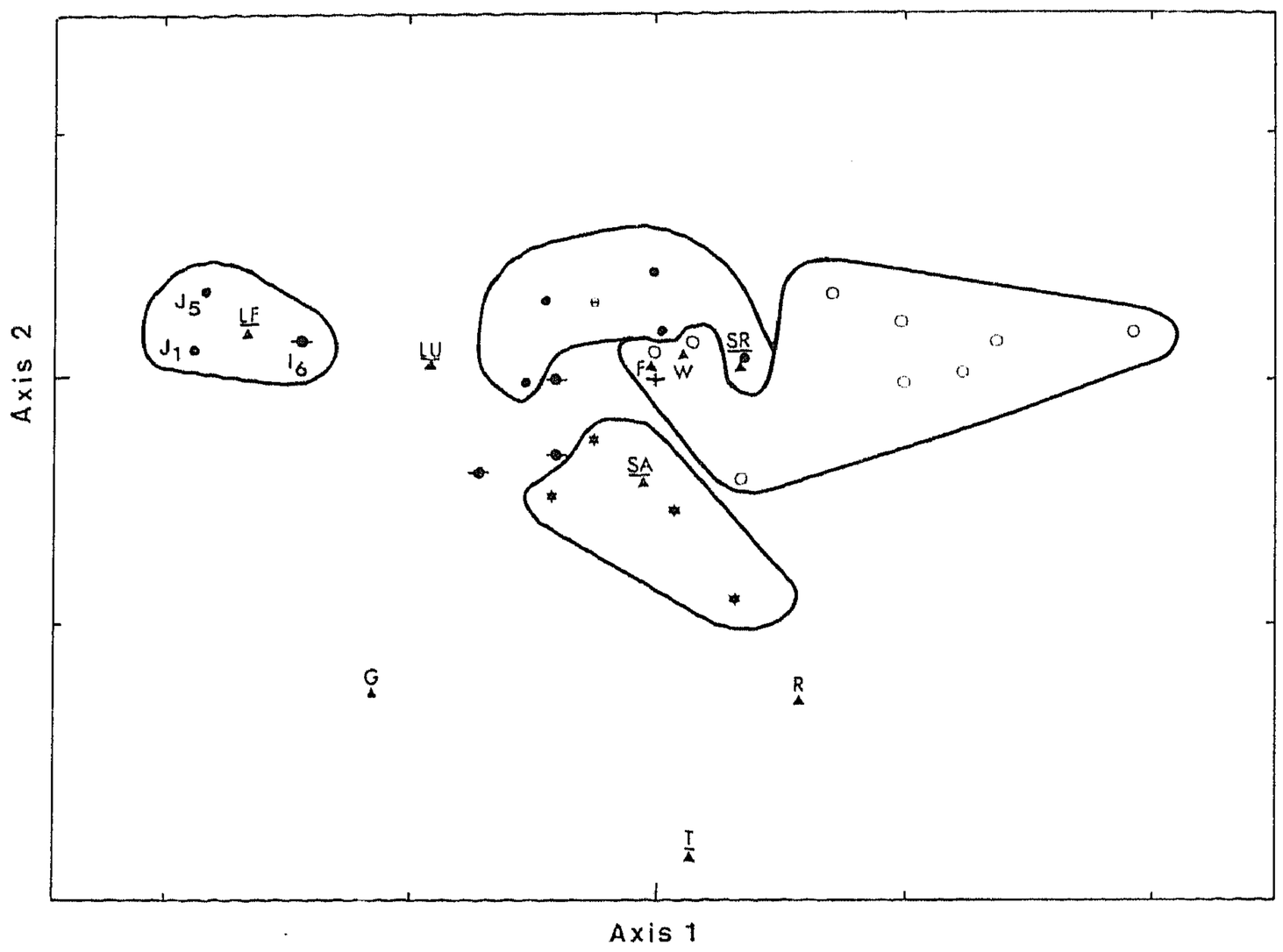

Fig. 4. Ordination of the time-budgets of the weaned horses in all groups, Winter 1976. Legend as for Fig. 1.

while I2, who was of similar agoe to I1 but only foaled a year later, showed no comparable change in her time budget, Figs. 1 & 2.

The time-budgets of the five age and sex classes are given in Table 9b: significant differences were found between the classes for the same activities as in the previous period, the only important difference from the spring and summer period being that males no longer showed significant difference from adult females for Standing resting and Lying up.

The results for the first period of 1976 were similar to those of the previous year. The "Mare axis" was again bipolar with large contributions from individuals of the adult female, and the yearling age classes, Table 6. For the "Stallion axis", large contributions came from males only, usually adults, Table 7. Activities making large contributions to the axes were identical with those of the previous period, Table 8. The ordination is shown in Fig. 3: three groupings can again be distinguished, though they are less distinct than in the previous year (cf. Figs 1 & 2). The time-budgets are presented in Table 10a, where the sole young female, I2, has been included with the yearlings.

TABLE 10

Time budgets of horses of different age/sex classes during two periods of 1976

Age/sex Class	No. of horses	Activity: Standing resting	Lying up	Lying flat	Standing alert	Trotting	Galloping	Rolling	Walking	Foraging
Adult ♀♀	9	20.30 a	4.17 a	0.56 a	6.84 a	0.42	0.20 a	0.05	8.96	58.50
Young ♀ Yearlings	1 / 7 \	15.03 b	7.23 b	2.66 b	7.15 a	0.61	0.21 a	0.10	9.42	57.54
Young ♂♂	4	13.77 b	7.99 ab	1.48 c	10.14 b	0.38	0.35 b	0.17	8.51	57.40
Adult ♂♂	4	15.99 b	4.65 ab	1.94 c	11.08 b	0.49	0.40 b	0.26	9.98	55.15

a. Spring, Summer and Autumn 1976.

Age/sex Class	No. of horses	Activity: Standing resting	Lying up	Lying flat	Standing alert	Trotting	Galloping	Rolling	Walking	Foraging
Adult ♀♀	9	22.61 a	3.03 a	0.15 a	6.49 a	0.08 a	0.04	0.02	5.86	61.71
Young ♀ Yearlings	1 / 6 \	19.20 a	6.25 b	0.72 b	5.82 a	0.00 a	0.06	0.03	5.99	61.90
Young herd	3	13.59 b	9.61 c	2.31 c	6.02 a	0.00 a	0.23	0.0	5.85	62.41
Young ♂♂	3	17.94 a	7.58 b	0.64 b	8.33 b	0.35 b	0.06	0.0	4.46	60.65
Adult ♂♂	4	18.66 a	5.25 b	0.65 b	8.94 b	0.69 b	0.17	0.04	5.82	59.69

b. Winter 1976.

Different letters indicate that the age/sex classes differ significantly ($p < 0.05$, runs test.).

Adult ♀♀ - females with foals. Young ♀♀ - young pregnant females. Yearlings - aged 1-2 years.
Young ♂♂ - males aged 2-3 years. Adult ♂♂ - > 3 years.

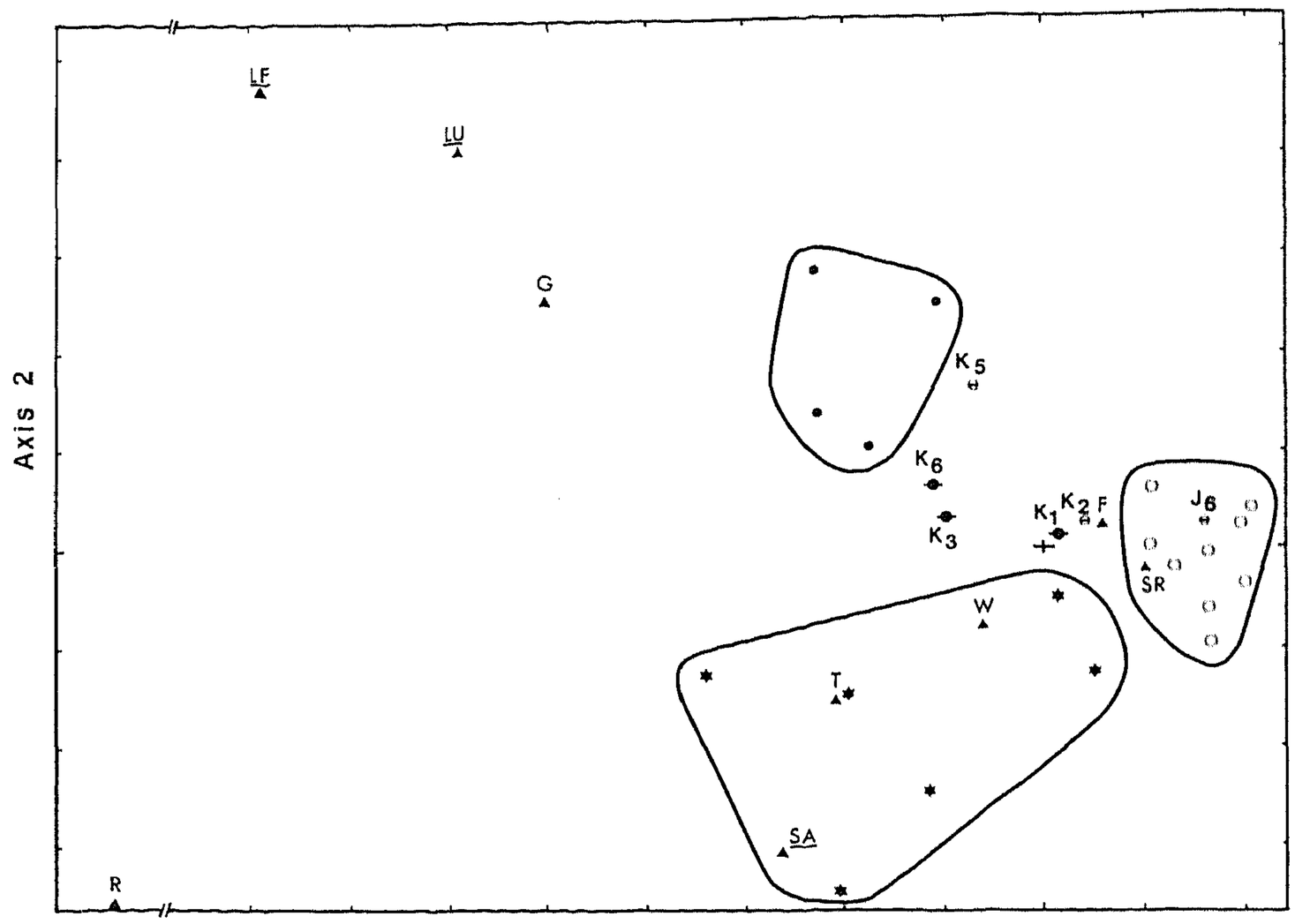

Fig. 5. Ordination of the time-budgets of a sample of weaned horses from all breeding units, Summer 1978. Legend as for Fig. 1.

For the second, winter, period the classes of horses making major contributions to the axes remained the same, Tables 6, 7 but for the "Stallion axis" Lying flat was replaced by Trotting as an important contributor, Table 8. In previous periods, males had high values for this activity, Tables 9, 10, but the difference here was very marked. The ordination is shown in Fig. 4 and is notable for the appearance of a grouping of three young horses of the Bachelor group (Table 1b) which are isolated from the rest on the "Mare axis". This group was therefore retained separately in the presentation of the time-budgets, Table 10b. In this period the adult females were characterised by time-budgets with relatively small amounts of time spent lying down; the yearlings and young horses by larger amounts of time spent lying; and the males by relatively large amounts of time spent Standing alert and Trotting. These results are in part reflections of the considerable changes in social structure of the herd which occured during this period (see Introduction). These changes involved intense conflicts between the adult and some of the young males and resulted in the formation of a second breeding herd, and in the isolation of the Bachelor group (I6, J1, J5) from the breeding herds.