

THE RESPONSE OF COMMENSAL HAMADRYAS BABOONS TO SEASONAL REDUCTION IN FOOD PROVISIONING

A. BOUG*, S. BIQUAND**, V. BIQUAND-GUYOT**, K. KAMAL*

ABSTRACT

On top of the scenic escarpment road of Al Hada, people regularly feed baboons and members of a large troop of *Papio hamadryas* developed commensal habits, waiting for handouts beside the road. Alarmed by the increasing baboon number, local authorities wish to control the troop's enlargement. A direct solution to prevent the troop's growth would be to forbid people to feed baboons. However, both the sufficiency of natural vegetation and the ability of the troop to return to feeding on natural resources is uncertain. The response of baboons to a reduced provisioning was studied when the road was closed for maintenance during winter. We compared the relative share of natural vegetation and handouts in the troop's diet along the year and monitored range use in relation to food availability. The main effects of handout reduction were the enlargement of daily range combined with relocation and diversification of sleeping sites, the troop splitting into small sleeping groups. Baboons switched easily to a natural diet. Numerous plant species were consumed, but the Juniper species typical of these elevations were the most commonly selected. The results show the feasibility and efficiency of the reduction of food provision in managing such commensal groups living partially from human handouts.

Key words : *Papio hamadryas*, commensalism, food choice, home range, Saudi Arabia.

INTRODUCTION

The National Commission for Wildlife Conservation and Development recently began a decisive research program to curb the problem of raider and commensal baboons in Saudi Arabia (Biquand *et al.* in this issue). One of the solutions proposed to prevent the extension of commensal groups, is to stop people from feeding baboons. However, both the sufficiency of natural vegetation and the ability of the baboons to return to feeding in nature remains uncertain.

* National Wildlife Research Center, PO Box 1086, TAIF, Saudi Arabia.

** 42, rue des Boulangers, 75005 Paris, France.

One such commensal group was regularly fed by people on top of Al Hada escarpment road (30 km West of Taif), it was composed of 220 individuals at the beginning of our observations in August 1990, and the number rose steadily. Baboons were mainly fed by motorists at lay-bys. We studied the response of the troop to the sharp reduction of provisioning occurring when the road was closed for maintenance during the winter months of January and February 1991.

METHODS

For this study, we marked a one male unit comprising of 1 adult male and three females individually identified by ear tags, the adult male was also equipped with a radio collar. Another one male unit was identified by ear tags only. This second unit frequented the same resting and sleeping sites, and belonged to the same clan (according to the definitions of Kummer, 1968).

The clan was followed for 5 full days each month for one year. Data were collected by instantaneous scan sampling every 15 minutes centered on the radio collared male and including all individuals visible in his vicinity. We recorded the location of the groups and instantaneous activity of its members.

Activity states recorded were as follows :

- *Resting* : Animal sitting, laying, sleeping or looking about.
- *Moving* : All locomotor activities.
- *Feeding* : Allocated to two categories : Human : All handouts (mostly bread, biscuits and fruits). Natural : feeding from natural vegetation.
- *Foraging* : Food gathering and manipulation of potential food items.
- *Grooming* : Autogrooming and Allogrooming and positive social interactions.
- *Other activities* : Play, agonistic interactions, suckling.

Monthly data were collated for activity, daily routine, food choice and ranging of this hamadryas group. The percentage of time spent in each activity or location is estimated by the percent of samples in which the activity or location appeared. The Chi Square test at the 0.05 % threshold was used for testing all differences between percentages referred to in the article.

The observation year has been subdivided into three periods for this analysis :

- January-February. The road is closed and the level of provisioning is at its lowest.
- Spring (March to June). Provisioning occurs but the general status of natural vegetation is good and baboons can rely partly on natural foods.
- Summer-Autumn (July to December). Provisioning occurs at its highest level ; vegetation is dry.

RESULTS

ACTIVITY BUDGET

The activity budget of the group varied according to two factors : the amount of food provided by people, and the marked seasonality in the availability of natural foods.

Considering the whole year, the main diurnal activity was resting, followed by moving (Table I). Baboons were feeding during 18.5 % of the total time including 15.0 % of total time on food provided by people.

TABLE I
Activity distribution.

	All year	Low provisioning	High provisioning	
	(%)	Jan.-Feb.	Spring	Summer
Resting	41	45	37	42
Moving	27	24	33	24
Feeding	18	14	17	21
<i>Handouts</i>	15	7	12	19
<i>Natural</i>	3	7	5	2
Foraging	2	3	1	2
Grooming	6	8	6	6
Other	6	6	6	5
	100 %	100 %	100 %	100 %
N	40 536	7 291	11 665	21 580

EFFECT OF THE LEVEL OF PROVISIONING

We first compare the period of lower provisioning with the summer and autumn period of high provisioning. The intermediate season is dealt with afterwards.

When provisioning is low feeding fell to 14 % of the activity budget. As foraging time increased, the total time processing and eating food (17 %) was significantly less than when provisioning occurs (21 %). Resting and social activities significantly increased.

The reduction in handouts significantly affected the time spent around lay-bys, where food is mainly distributed (40 % and 58 % of observations around provisioning sites in low and high provisioning periods respectively). The activity profile changed (Fig. 1). Time spent feeding from handouts declined while time devoted to resting and social activities increased. Grooming is the predominant social activity. Resting remained the main state, but changed in nature. When provisioned, 58 % of resting time on park areas includes vigilance, while during the non-provisioned period only 26 % of rest time is vigilant.

Outside parking areas, feeding on natural vegetation increases in correlation with the restriction of resting and social activities (Fig. 2). Moving is significantly reduced.

Thus resting time is partly reallocated according to foraging needs in and outside the provisioning areas. Time spent moving and vigilant on the provisioning areas is increased when people feed baboons, which is essential when the pattern of food delivering is unpredictable.

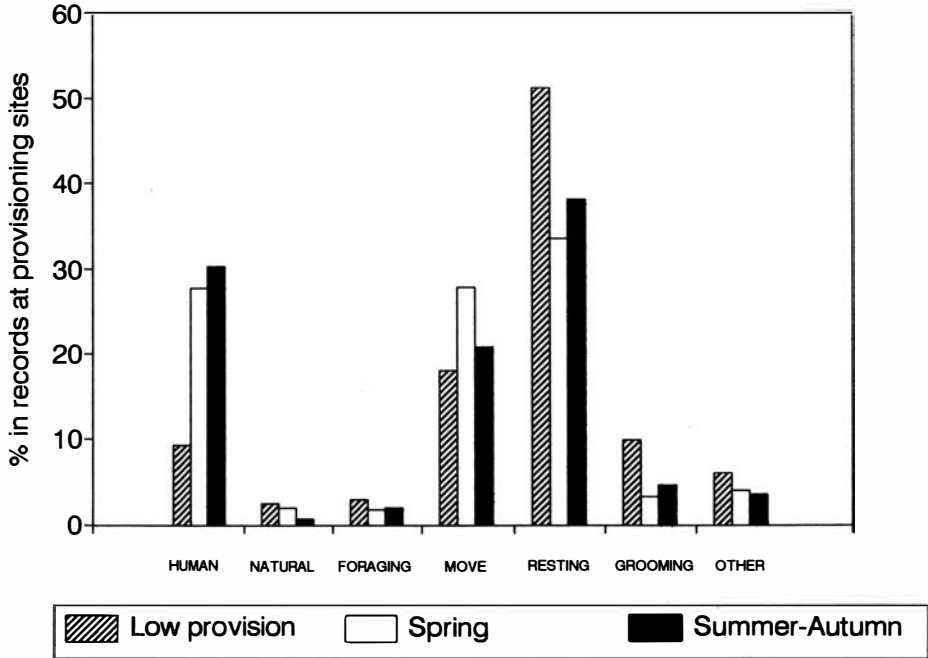


Figure 1. — Activity profile of Al Hada baboons in provisioning areas. Percent of each activity in total records in provisioning areas per period.

The spring period, when human food is distributed and vegetation relatively abundant shows intermediate figures for feeding activities between the high and low provisioning periods (Figs. 1, 2). Time spent around the lay-bys is similar to low provisioning period. However, the time spent moving is significantly higher than in other situations both in provisioning areas and outside. Resting and social activities are lower in the provisioning areas. Analysis of the daily routine (see below) shows that the baboon group adopts an intermediate routine during this period, frequenting both provisioning areas and the wild. The high movement rate reflects frequent short moves to the food close to the lay-by, and the long range moves to the sleeping sites and natural foraging areas. Resting and socializing time is here reinvested in moving to the food. Corresponding with a lower rest level at the provisioning sites, rest activity outside consists mostly in sleeping, the percentage of vigilant rest is 7 %, compared with 14 % during summer and autumn provisioning and 23 % when not provisioned. This suggests a limit to the reallocation of rest time for movement.

DAILY ROUTINE

The daily routine of this commensal group begins by leaving the sleeping sites at dawn. When the road is open, baboons immediately move to the provisioning areas where they spend 2 hours feeding (Fig. 3). Following this early

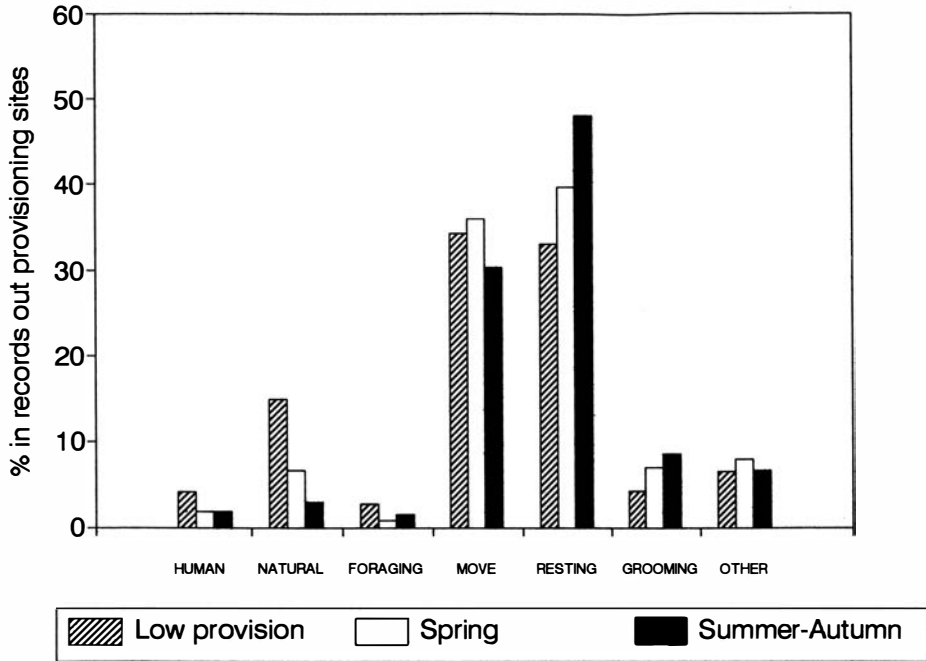


Figure 2. — Activity profile of Al Hada baboons outside provisioning areas. Percent of each activity in total records outside provisioning areas per period.

phase, feeding activities continue declining to reach a minimum at 12:00 (6 hours after the start of activity). Food consumption is highly correlated with the proximity to the lay-bys ($R = 0.8$, $p < 0.001$). The decrease in feeding is associated with baboons moving out of the provisioning areas to rest in quieter places (located in summer close to the permanent water points). The group moves back to the provisioning sites from 12:00 to 15:00 while feeding activity increases. Feeding starts to decline after 17:00 as baboons shift to resting sites near the provisioning sites.

When the road is closed (Fig. 4), provisioning in parking areas is reduced and irregular, the daily routine is inverted. Baboons are around lay-bys during mid-day. Food consumption is not clustered in time and does not correlate with proximity to provisioning sites. Compared with times of provisioning, the intensity of feeding never reaches the high levels encountered during the morning feed on handouts, however, the feeding session is much longer than when animals are provisioned.

Baboons depart the lay-bys at 12:00, (the time they return when provisioned), they go and feed on the natural vegetation in wilder areas. The afternoon feeding session in the wild is more intense than the morning one.

When the road is open and natural vegetation abundant (in spring from March to June), the morning feeding session takes place around provisioning areas but

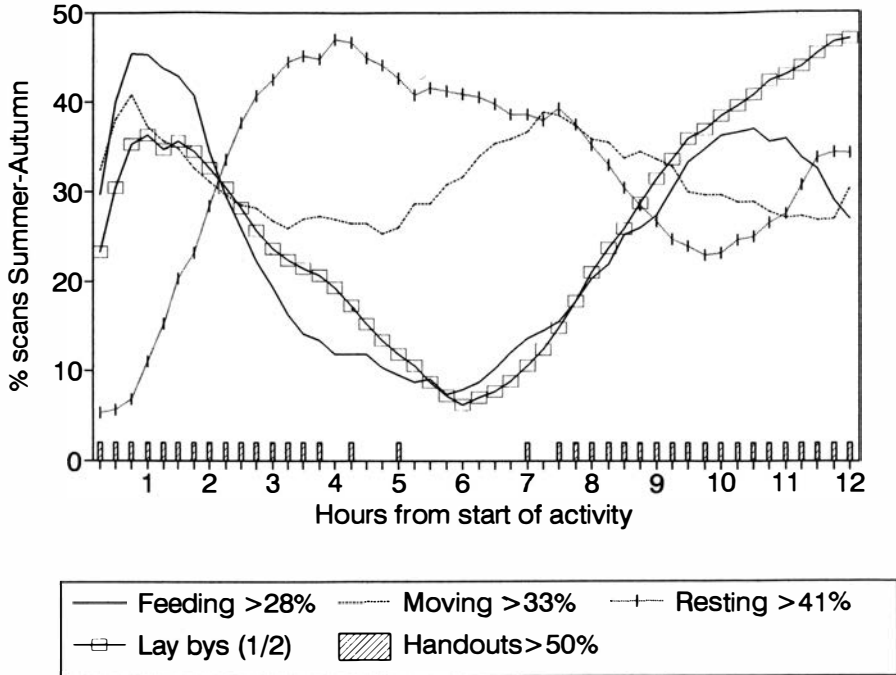


Figure 3. — Daily activities of Al Hada baboons during the low provisioning period. For each activity we show the percentage of scans (quarter hours) in which this activity involves more than 28 % (feeding), 33 % (moving), 41 % (resting) of individuals scanned. This represents 50 % of records in which the activity is expressed. The percentage of scans around lay-bys has been halved to allow easier comparison. All quarter hours in which handout feeding has been > 50 % at least once have been marked by bars on the axis. All curves have been smoothed by a 4-terms moving average transformation.

baboons leave the place early after only a 3 hours stay at 9:00 am (Fig. 5). There is no afternoon move to the provisioning areas, and the late afternoon feeding occurs in the wild.

The daily routine thus comprises 2 feeding sessions when baboons are provisioned. When not provisioned the feeding is continuous throughout most of the day. In spring, after visiting the provisioning areas, baboons do not stay around, they move to the wild where they feed. The instantaneous level of feeding activity for the group is much higher when baboons are provisioned, i.e. more baboons feed at the same time on this clumped, rich food. Midday resting occurs in the wild when baboons are provisioned (spring and summer). When not provisioned, resting takes place around the provisioning sites in the morning and after leaving them in the afternoon.

LOCATION OF SLEEPING SITES

Over the course of the year, 11 sleeping sites were used by our marked clan. During summer, when hot and dry weather combines with increased provisioning,

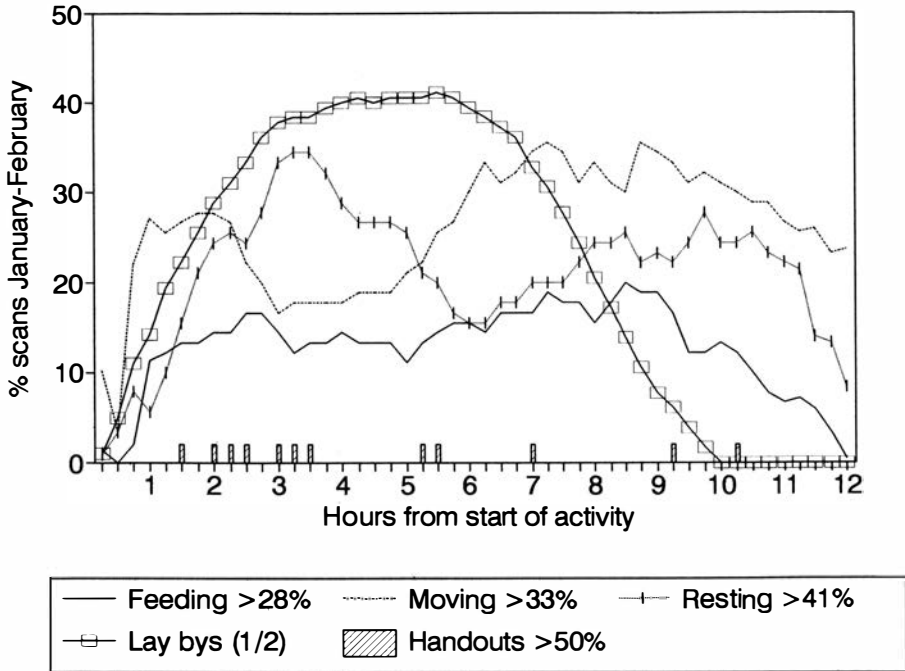


Figure 4. — Daily activities of Al Hada baboons during spring. For each activity we show the percentage of scans (quarter hours) in which this activity involves more than 28 % (feeding), 33 % (moving), 41 % (resting) of individuals scanned. This represents 50 % of records in which the activity is expressed. The percentage of scans around lay-bys has been halved to allow easier comparison. All quarter hours in which handout feeding has been > 50 % at least once have been marked by bars on the axis. All curves have been smoothed by a 4-terms moving average transformation.

baboon use the highest sleeping sites which are close to the feeding spots and to permanent water sources. From July to December, three sleeping sites are used exclusively. They are open rock ledges near the feeding sites, at around 1 900 meters above sea level.

From January to June, 8 additional sleeping sites were used. Their common features are low elevation (down to 1 400 meters), they are distant from parking areas and have a closed aspect, these include caves. The sleeping sites are also close to the natural feeding sources and not related to permanent water points since during winter and spring, water can be found in wadi beds or cracks in rocks.

In comparison to the use of only 3 sleeping sites by the clan from July to December, 10 sleeping sites were used from January to June. Competition for sleeping sites was higher in summer, when our clan always shared sleeping ledges with other clans in the vicinity of the car parking areas. In winter, the greater distances covered give different groups access to a number of alternate sleeping sites and the sleeping parties are mainly restricted to clans on their own.

NATURAL AND HUMAN FOOD

During our observations, the road was closed in winter, from January to February when baboons fed mainly on natural vegetation. The spring followed

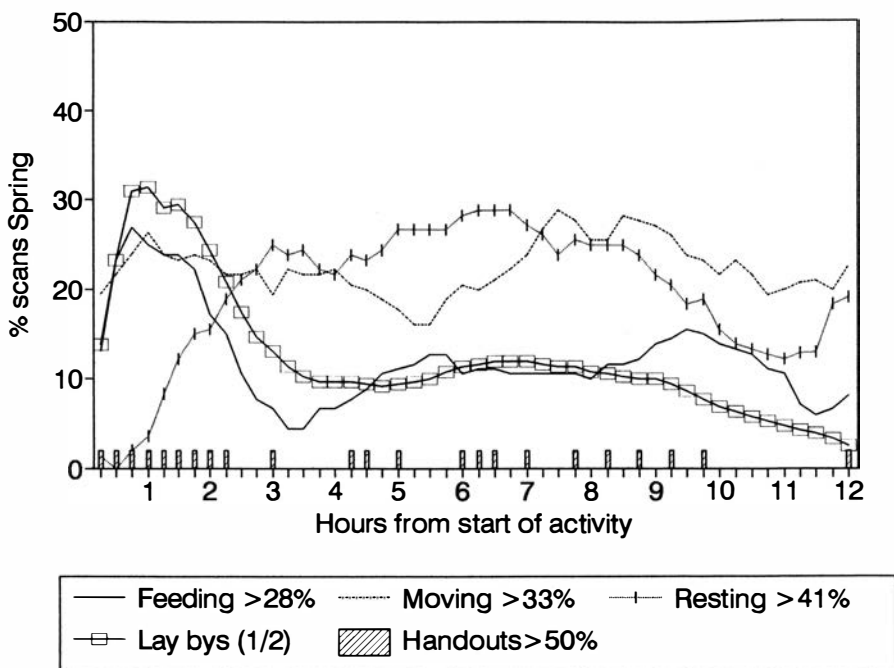


Figure 5. — Daily activities of Al Hada baboons during summer and autumn. For each activity we show the percentage of scans (quarter hours) in which this activity involves more than 28 % (feeding), 33 % (moving), 41 % (resting) of individuals scanned. This represents 50 % of records in which each activity is expressed. The percentage of scans around lay-bys has been halved to allow easier comparison. All quarter hours in which handout feeding has been > 50 % at least once have been marked by bars on the axis. All curves have been smoothed by a 4-terms moving average transformation.

from March to June, and baboons continued to feed on wild vegetation. The total percentage of natural food in the diet was the highest when the road was closed (47 %), significantly reduced during spring (31 %) and the rest of the year, reaching a low of 9 % in summer and autumn. This was the first indication that reducing food provision indeed drove baboons to natural food. Over the year, food from natural sources accounted for 19 % of the total feeding records (Table I).

Food of human origin remained a major source in the morning, even in the months of low provisioning, when the little food provided was given early morning. The percentage of human food in morning feeding records was 58 % in the two first hours when the road was closed. When the road was open it reached 93 % in spring and significantly increased to 97 % from July to December. During this first feeding bout, 41 % and 39 % of the total food records were observed respectively when the road is open in Spring and Summer-Autumn, but only 17 % during the low provisioning period.

The bulk of food intake takes place before 16 :00, 10 hours from start of activity, when provisioning is low and during Spring (98 % and 93 % respectively), while still 24 % of feeding is recorded after 16 :00 around lay-bys when provisioning is high.

Thirty nine plant species were used by baboons, 13 species accounting for 85 % of the natural feeding. Six food groups were identified (Table II).

TABLE II

List of the plants consumed by baboons.

Genus or Group	Percent in natural diet	Month of maximum consumption and main species
Juniperus species	23.1	<i>J. excelsa</i> November-December, <i>J. phoenicea</i> , May-June
Acacia species	20.4	<i>A. iraquensis</i> , January-February.
Gramins	16.5	<i>Themeda triandra</i> , <i>Hyparrhenia hirta</i> February-March
Ficus species	13.1	<i>F. salicifolia</i> , June-July.
Osteospermum	7.2	<i>O. vaillanti</i> , February-April.
Withania	4.5	<i>W. somnifera</i> , March-April.
Others	15.2	<i>Rumex nervosus</i> (2.9%). All year.
Total records	1 390	

The main food plants were Junipers, accounting for 23 % of natural food consumed. Two species occur in Al Hada, *Juniperus excelsa* and *Juniperus phoenicea*. The latter, of mediterranean origin, was preferred. Its seed production was greater and extended over a longer period than that of *excelsa*. Hamadryas ate the seeds, leaves, flower and bark.

Four Acacia species made up the second food group and accounted for 20 % of natural food records. *Acacia iraquensis* was preferred, leaves and pods were consumed.

Grasses accounted for 16 % of the natural diet. While the extensive feeding on Junipers and Acacias has not been reported from Ethiopia (where food plants of hamadryas were described by Kummer, 1968), the reliance of the Arabian hamadryas on grasses is indeed a shared characteristic with the Ethiopian hamadryas.

Ficus species were also important food sources. Fruits accounted for 13 % of natural feeding records.

Other important species were *Osteospermum vaillanti* and *Whitania somnifera*, small bushes of which flowers and seeds were consumed.

56 per cent of the food was collected from trees (Junipers, Acacias and Ficus), and the contribution of annual species was very low. All species were consumed seasonally, and together the 6 main plant groups provide a continuous natural food supply over the year (Fig. 6).

DISCUSSION

A clear difference in activity patterns, ranging and feeding was shown to be correlated to the level of provisioning. The hamadryas group we followed

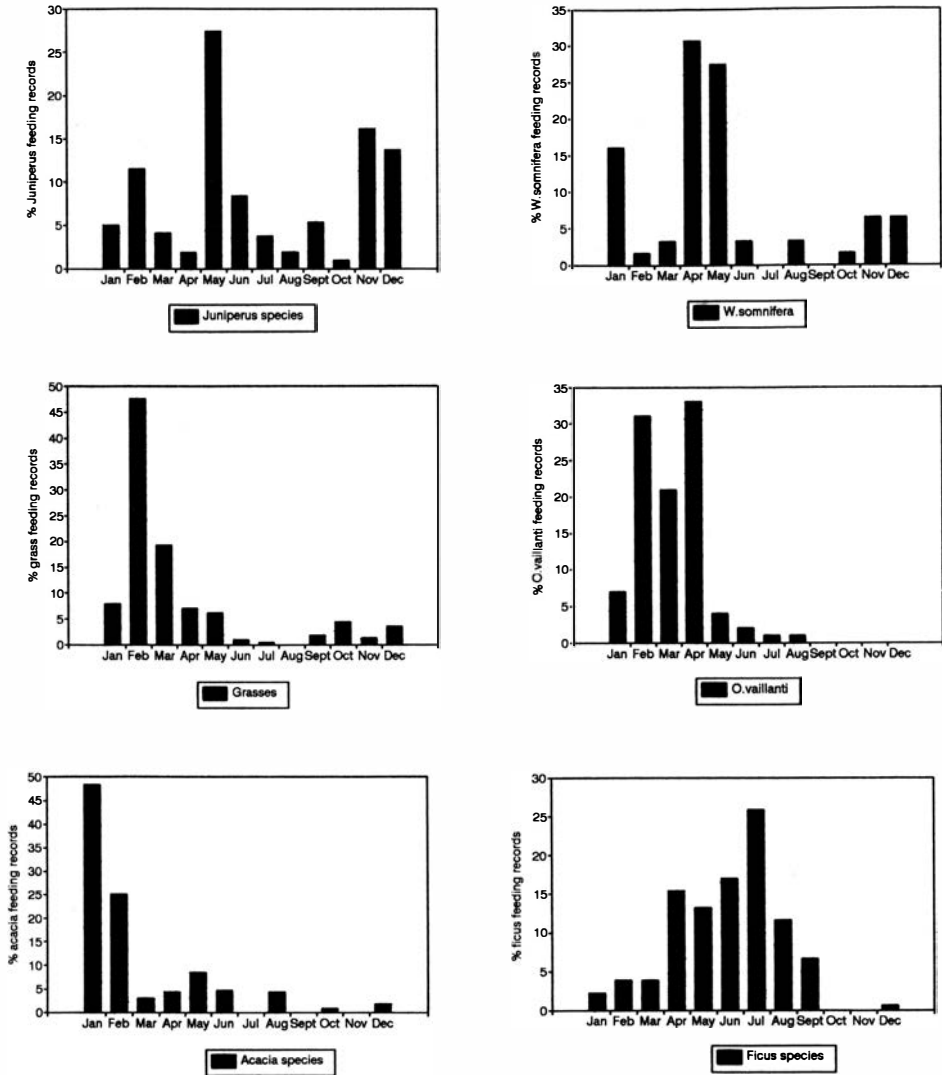


Figure 6. — Distribution of feeding records on 6 plant groups. Data presented is the monthly percentage related to the yearly consumption in each group.

depended more on natural vegetation when human food was reduced. It increased its daily travel outside provisioning sites and expanded its ranging, adapting efficiently to the new situation. We should, however, mention that the road is closed every year for 2 to 3 months, and the baboons cope readily with this cyclic phenomenon.

Previous studies on provisioned primates all show a decrease in feeding time associated with provisioning or raiding (in the rhesus, Marriot, 1988 ; Malik & Southwick, 1988 ; and in baboons, Forthman-Quick & Demment, 1988). While no

datum is available for the Arabian hamadryas, African baboon species in the wild typically spend from 40 to 50 % of their time feeding (Post, 1981 ; Bercovitch, 1983). This time is reduced to 10-20 % by raiding crops or garbage pits (Forthman-Quick & Demment, 1988 ; Muruthi *et al.*, 1991), a value similar to the rate we observed for all periods. These comparative data point out that the impact of human food during the low provisioning period of January-February is not negligible and strongly reduces the need for foraging natural food.

However, our results suggest that the hamadryas in Al Hada spent more time feeding as provisioning increased. Compared to the period of low provisioning, feeding time increased during spring when natural food remained a significant part of the diet and more even in Summer-Autumn when the part of natural food was minimal. While the baboons appeared somewhat leaner in the low provisioning period, we assume that their basic nutritional requirements are met during this 2 month period. The 30 % increase in feeding time from low provisioning to high provisioning time and the switching from natural to human food implies a much greater difference in energy intake, since the caloric gain per gram is considerably higher for human food than for natural food (Forthman-Quick & Demment, 1988 ; Fa, 1986). The hamadryas in Al Hada are likely to be overfed during periods of higher provisioning.

This observed increase in feeding time could partly resort to a bias in data collection. Indeed, the scan sampling we used is intrinsically favoring the representation of long and regular activities, at the expense of an under-representation of discrete and irregular activities. Indeed, the patterns of intake vary according to the nature of food. Food items handed out by people are mostly sizable items, such as flat bread or fruits, which unit consumption takes time ; eating from natural vegetation, baboons collect mainly « one-bite » items such as flowers, seeds or small fruits. The time feeding on natural food is then underestimated in our sampling method. Further collection of continuous activity data would be needed for a better estimation of time spent feeding.

Fa (1988), studying the provisioned groups of macaques in Gibraltar, observed that the members of a group in contact with tourists were feeding more than their metabolic needs. He suggested that these macaques were conditioned to seek a specific gustatory reward, such as sweetness, found only in human food. The macaque troop, however, stayed all the day waiting for tourists while we observed the hamadryas leaving the provisioning areas during mid-day in summer, even as food was still available.

In terms of management, our results point to people distributing food as the causal agent in commensal behavior. This suggests that a change in human behavior, a permanent reduction in provisioning, would settle the problem of growing baboon numbers around tourist sites. However, the significant contribution of grasses to the diet points to another major problem : competition with domestic livestock. Overgrazing is a major concern in Saudi Arabia, and competition between herbivores is amplified by the low productivity of a semi arid environment. Baboons can only sustain themselves over the year if plant diversity and abundance are sufficient. We have shown in a previous study that a reduction in plant diversity leads to increased crop raiding (Biquand *et al.*, 1992).

We expect our studies to contribute to the establishment of effective management strategies, restoring to the baboons their role in the ecological system.

Obviously, public awareness is a major concern, and our message to people is that watching baboons is much more enjoyable when they are feeding in the wild than when they are begging or stealing food.

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RÉSUMÉ

En haut de la falaise de Al Hada, les automobilistes de passage nourrissent quotidiennement les babouins et une grande troupe de *Papio hamadryas* vit principalement de cette manne. La croissance de cette troupe de singes commensaux préoccupe les autorités locales qui aimeraient en limiter l'effectif. La solution la plus directe serait l'interdiction de nourrir les animaux, poussant ainsi les babouins à exploiter la végétation naturelle, mais la qualité des ressources naturelles et la capacité des babouins à les utiliser restent incertaines. La réponse à une réduction de l'apport alimentaire a été étudiée pendant que la route était fermée pour réparation en hiver. Nous avons comparé au cours de l'année la répartition de l'alimentation de la troupe entre nourriture naturelle et nourriture d'origine humaine ainsi que les variations du trajet en fonction des disponibilités alimentaires. Les effets principaux de la réduction de l'apport de nourriture sont l'accroissement du trajet quotidien, accompagné de la relocalisation et de la diversification des sites de sommeil. La troupe se divise aussi en groupes plus petits. Les babouins s'adaptent facilement à un régime naturel et consomment de nombreuses plantes. Les genévriers (*Juniperus excelsa* et *Juniperus phoenicea*), dominants sur le site, sont l'élément majeur du régime d'hiver. Les résultats montrent la faisabilité et l'efficacité de la réduction des apports alimentaires pour réduire la pression exercée par de telles groupes commensales sur les alentours de villes et des sites touristiques.

Mots-clés : *Papio hamadryas*, commensalisme, choix alimentaires, domaine vital, Arabie Saoudite.

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