THE CAMEL AND ITS ROLE IN SHAPING MIDEASTERN NOMAD SOCIETIES

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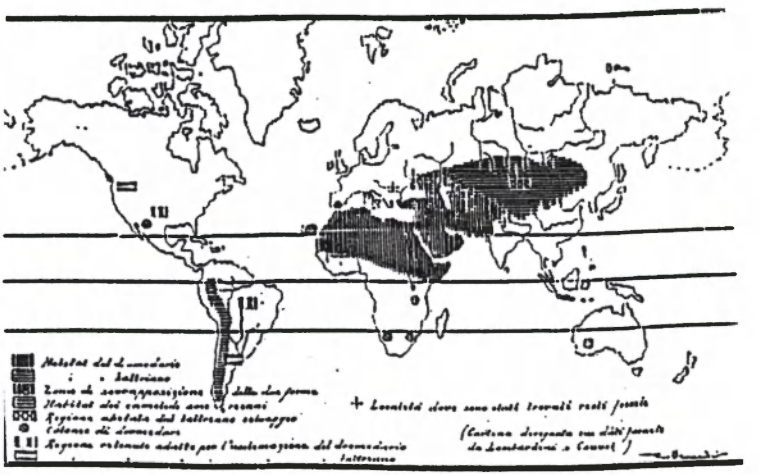
Introduction

Twice since the turn of the present era groups of nomads have coalesced to form military machines that allowed them to break out of the steppelands and the deserts which were their home to overrun vast stretches of the old world and to establish huge empires encompassing numerous peoples: the Arab Bedouin under the successors of the Prophet Mohammed in the 7th century, and the Mongols under Genghis Khan and his successors in the 13th century. In both cases a key factor in the structuring of the conquering societies and the shaping of their armies was their principal herd animal, serving as the source of their wealth and sustenance as well as providing the mount upon which they rode to war. In the case of the Mongols of Central Asia this was the horse; in the case of the Arabs it was the camel. The role of the horse in shaping the societies of the cold deserts and steppes of Central Asia has been described eloquently a number of times. The present paper will seek to do as much for the camel. Beginning with a brief review of the salient biological characteristics which fit the camel for its extraordinary role, it will demonstrate the manner in which the camel both caused and made possible the desert warfare upon which the victories of the Bedouin were based; victories which in turn made possible the emergence of the Islamic Empire of the 7th and succeeding centuries. It will finally consider the way in which the possession of the camel helped to shape both, the Bedouin society of the desert and the urbanized society of the Islamic Empire.

Biological characteristics. The family Camelidae originated in North America in Pliocene or early Pleistocene times, and developed from a rabbit sized ancestor to an animal much like the modern species.[1] During some of the Pleistocene periods of low sea level the camel passed over the Bering Strait and expanded through the Central Asiatic desert belt to the deserts of the Near

East and Arabia, and on, all the way to North Africa. In Eurasia and Africa there are now two subspecies: the one-humped and the two-humped camels, the former hot desert adapted, the latter thriving in cold deserts. Many geographically defined strains are recognized[2], some of them being referred to as thoroughbred. These presumably are products of prolonged and systematic trait-selected inbreeding to produce animals suitable for different uses or use in different places. For example, some camels have hard feet and consequently do well on stony mountain trails. Caravans which have to negotiate rocky trails in mountainous regions include some of these specialized animals in their strings and shift loads to them when reaching the foot of the mountains.[3] Crosses of one humped and two humped camels yield progeny showing hybrid vigor in size and carrying capacity but are of somewhat limited fertility.[4]

Figure 1



It has been suggested that the defenselessness and relatively low mobility of the old world camelids may have been a factor forcing the animal to retreat to inhospitable areas free of predators, and this in turn directed evolution toward those special adaptations which characterize the present day representatives.[5]

The common idea is that camelids were present in prehistoric North Africa, but probably died out during the latter half of the third millennium without having been domesticated. The presence of domesticated dromedary camels in that continent in recent times, according to that view, is due to a comparatively late reintroduction.[6] Bulliet suggests that this may imply that the original wild camel in Africa may have been less well adapted to hot desert than the one-humped form that was introduced later and now thrives there. In what follows attention will be focused on the one-humped non-hybrid dromedary camel, partly because this is the only old world representative of the species for which there are detailed physiological data, and partly because it is the interaction of this type of camel with its nomad hosts that has been of primary importance to the people of the Near East and North Africa.

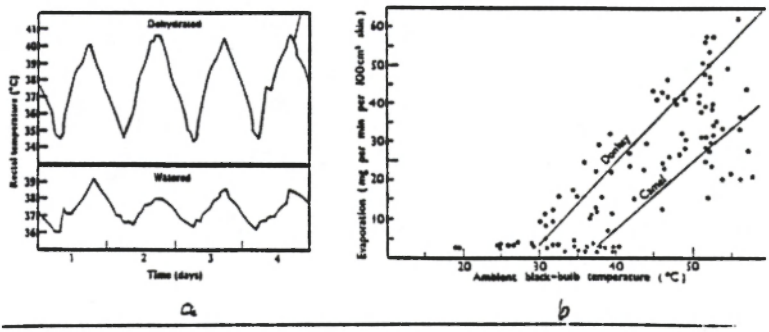
Three elements of the camel's make-up are crucial to its usefulness: their ability to survive in hyper-arid environments, their locomotor endurance, and their strength. Physiological adaptation to desert conditions is striking--it extends to details such as occludable nostrils. Most important, however, and at the core of the remarkable ability of the dromedary camel to survive in arid and hyperarid regions, is its ability to hold off or to withstand the effects of dehydration while tolerating high ambient temperatures during the day.

Physiological water loss involves principally two components: unavoidable loss in urine, and water loss by evaporation as part of thermal defense in a hot climate. In the camel, urinary water losses are minimized by its remarkable ability to produce highly concentrated urine. The camel's ability to excrete high concentrations of salts in its urine also allows the animal to drink saline water from desert sources which neither humans nor donkeys are capable of doing.

Water loss in hot environments primarily occurs as a result of sweating to dissipate heat by evaporation. In the camel, water loss via this method is minimized by a number of specializations, most important among them being its unique ability to relax its thermoregulation. Compared to most mammals, the camel experiences wide fluctuations of deep body temperature which means thermoreg-

ulatory sweating is delayed until the deep body temperatures reach sufficient highs during the daytime (Figure 2).[7,8]

Figure 2



A further defense against the dehabilitating effects of dehydration is the camel's ability to draw upon the large pool of all body fluid compartments rather than, as in most other mammals, the much smaller extracellular fluid compartment only.[9] As a consequence, the blood plasma volume - and indirectly the circulatory efficiency - is reduced to a far smaller extent than would be the case for comparable degrees of dehydration in other mammals. This enables the camel to survive the loss of more than 25% of its total body water that would be lethal to most other species.

The low rate of water loss when working in the desert heat, combined with the increased tolerance of such water loss permits the camel to perform useful work for longer periods of time and to cover far greater distances between waterings than any other domestic animal including the donkey.[10] Under summer desert conditions, the camel needs to be watered at intervals of about a week while in cool, relatively moist seasons, it can go for months without water. These needs are easily met as the camel can consume brackish water from desert surfaces that would be impotable to other species.[11] (Table 1)

Table 1

Resistance of Animals to Hunger, Thirst, and Fatigue

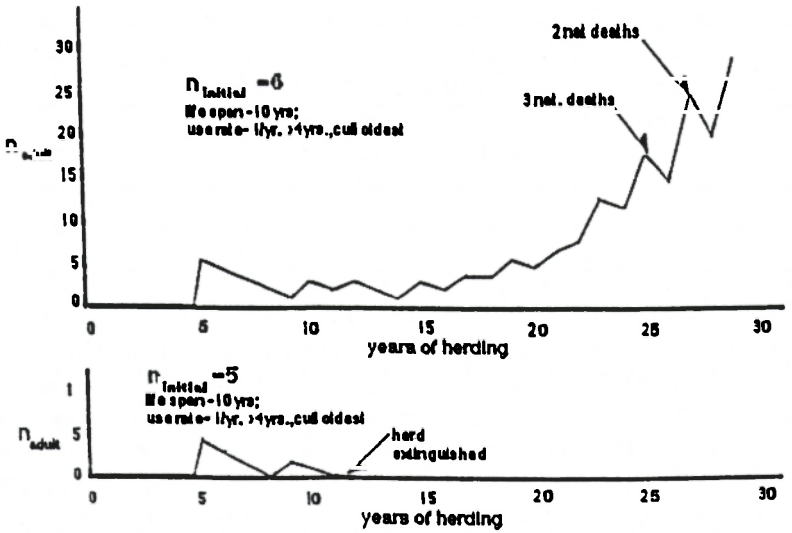
Species	Max. no. days without water-cool season	Max. no. days without water-hot season	Max. no days without food-hot season	Max. kilometers per day
camel	90	5-7	5-7	80
cow	3	2	2	20
calf	1	1		10
goat	15	2	2	20?
sheep	30	1-2	2	30?
donkey		4		

Conversely, at least some of these regulatory adaptations to a desert environment may turn into disadvantages when the animal is exposed to a less arid climate with fresh vegetation having a lower sale content than the desert plants to which it is attuned, as well as perhaps to insect-born parasites, such, in particular as some trypanosomes.[12]

Like other hot weather animals, the dromedary camel is long-limbed and well adapted to relatively rapid movement. It has a pace-gaited gallop that is most uncomfortable for the rider but is capable of reaching speeds up to 20-25 miles/hour over modest distances. A camel can sustain a trotting speed of about 8.5 miler/hour for 6 or 7 hours a day for 6 to 10 days before requiring a prolonged rest. Pack camels in a caravan walking under a load can cover an average of 15 to 20 miles a day for distances of 1,000 miles or more.[13] As a result of the combination of its sustainable endurance on the trail with its sparse needs for water, nomads in possession of this animal find desert regions with distances of 100 miles between water holes accessible even in summer. Desert raiders depending upon camels can readily achieve penetrations of up to 1500 miles provided such few water holes as are known to them are not dried out and are not interdicted by the enemy.

As a beast of burden, the cross between one and two-humped camels can readily bear up to 1200 lbs., and the one-humped camels in common use can readily carry loads of more than 400 pounds. Their carrying capability far exceeds that of the horse or donkey.[14] In military operations camels loaded with water bags were used from an early date on to permit operations deep into the desert.[15]

Figure 3



The period of gestation of the camel is about 13 months. Since males come into rut for only 1 to 2 months each year, timed to coordinate with the principal local rainy period, a female is likely on the average to produce no more than one young every two years.[16] Because of this slow rate of reproduction, herd survival is precarious. When numbers drop below a certain level they tend to become extinguished (Figure 3).[17] Rebuilding a viable herd of camels requires a definable number of animals, that is dependent upon the breeding circumstances. All this has important consequences for camel breeding pastoralists.

The *nāqa*, the mature female camel, can be counted on to product each day for 11 months out of the year more than one gallon of high fat high protein milk, said to remain consumable for longer periods than milk from other domestic species.[18] Lactation is sustained even while the animal is being worked, and persists to a remarkable extend even as the animal is being progressively dehydrated.

Probable date of domestication of the Camel. Circumstantial evidence[19] has been marshalled to indicate that the period of domestication of the wild dromedary camel (which apparently had died out on the African continent by the beginning of the third millennium but survived in the wild state on the Arabian Peninsula and may have been observed on the Red Sea coast and in the hinterland of the Hejaz as late as 280 BC[20]) may correspond roughly with the date of domestication of the Bactrian camel (in the second half of the third millennium BC) and may have preceded the domestication of the horse (around 2000 BC). The range of suggested dates for the dromedary is between 2000 and 1900 BC - and the most likely place is somewhere in South Arabia, east of what became the Yemen. This would have been near the sea where a population drawing their livelihood from fishing and hunting at sea might have had occasion to attempt domestication of an animal which was "half tame from living in a predator-free environment" (Bulliet). Terms associating the camel with the sea at an early date, such as the Sumerian "beast of the sea" and the biblical "ship of the desert," illustrate and support this point of view.

Biblical texts indicate that well before the year 1000 BC some of the populations of the area were in possession of important herds of camels. Even if one discounts Abraham's camels as a late interpolation, there is the vivid description of the camel-riding Midianites who fought with Gideon, i.e., at a date which falls before 1000 BC. Since riding a tamed animal is likely to represent an advanced stage of domestication, this description implies that the beginnings of the camel-herding tradition on which the Midianites drew cannot have fallen much after 1500 BC and thus may correspond roughly with the time of the spread of horseback riding, generally placed in the second half of the 2nd millennium.[21] This in turn meshes not badly with clay tablet evidence from Mesopotamia which suggests that

here, too, the camel was a rarity until the time of the Aramaean invasions from Northern Arabia somewhere between the 16th and the 13th centuries BC. It has been suggested that the 'Aribi introduced fully developed camel nomadism into the desert regions formerly occupied by the Aramaeans at a time which pretty well coincides with the Midianite invasions of Syria and Palestine. Overall, there seems to be general agreement with Albright's view that the camel as an effective element is clearly recognizable in the relations between sedentary and nomadic groups in the Middle East only from the 11th century BC onward.[22]

The importance of the camel to peoples which make use of it often finds an expression in the form in which they appear in literary references: the Midianites, "owners of innumerable camel herds;" "the people of the camel who were made to pay tribute;" and even more clearly and unambiguously in the self description of the much later Banu Hillal in the 'Geste' of the Bani Hillal (*'qissa bani hillal wa-ma jara lahum fi taghribatihim* - dating arguably to the 14th century though written down only during the 19th[23]) as "people of the warhorse and the mehari" (*ahl al - 'auda wa -'l-maz 'l*). All this suggests that, whatever may have been the case in the diversified societies responsible for the first domestication of the camel, by the time it appears in the light of history this animal has come to play a central role in the life of the camel herding people. It is clear, too, that its role could vary a great deal in different societies: camels might be a source of meat, dairy animals, beasts of burden and of traction, riding animals for transporting some of the people from one camp to the next, for herding, or warrior's mounts.

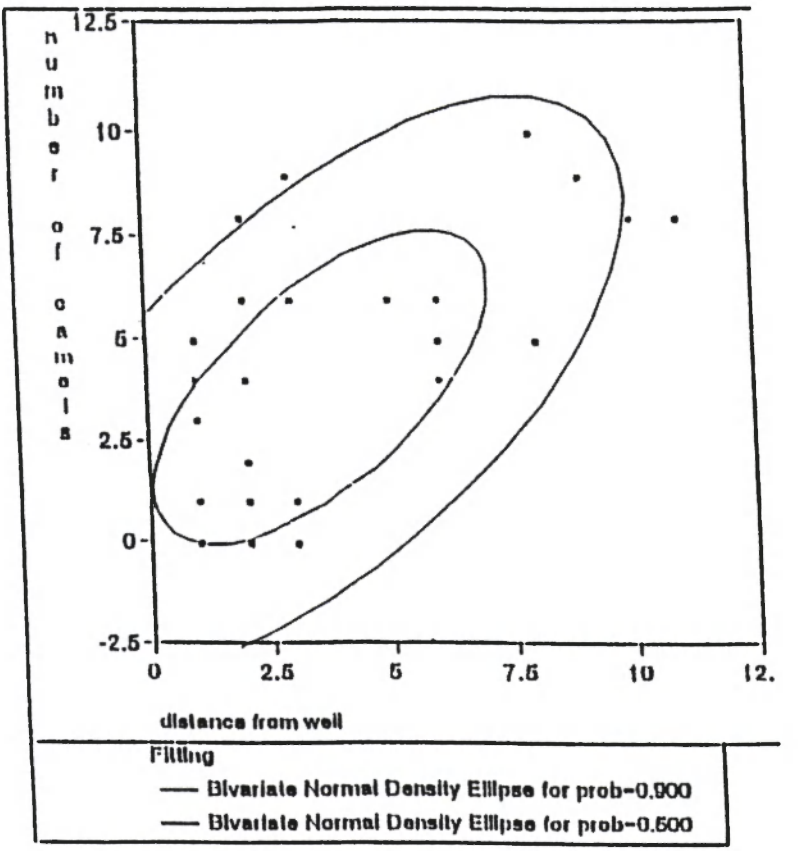
Utilization of the domesticated camel - Types and Scope of Related Activities. Present-day camel nomad populations represent a wide spectrum of camel usage- from the milk- and meat-using Somali,[24] to the goat and sheep-keeping Rendille[25] to the camel-dependent deep desert Baja[26] whose camel-tending young men - *mishrab* - absent themselves from base camps for a good part of the moist season, to such groups as the Ruwala[27] in the central regions of the Arabian peninsula and the Tuareg[28] in the central and eastern Sahara, both of whom retained a raiding and trade-oriented pattern of life well into the 20th century.

All camel nomad tribes share the attitude that, while redundant males are surplus and may be sold or castrated and put to work as pack animals, breeding female camels are never to be sold. They can be acquired only through gift (as to a newborn boy child), or by breeding one's own herd, or by raiding. The slow rate of reproduction of the camel, commented on earlier in this paper, renders dependence on breeding precarious. If there is any attrition of animals, for flesh or sale or as a result of being raided, it is sustainable only if one or one's tribal group possesses a herd numbering in excess of a minimum number of fertile females probably ranging from 5 to 10 animals per tent. Thus, for instance, in the case of the Baja tribes of the Eastern Desert of Egypt, as well as among the Reguibat of Mauritania, drought-induced losses of stock have resulted in reductions of herd sizes in many cases below the critical level, and thus irreversibly transformed a substantial part of the population from herdsmen to laborers or tenant farmers. Probably, too, because the possession of the camel enlarges the radius accessible for pastoral exploitation, among the Rendille of Kenya one can discern a well defined relation between herd size and the distance to which the family groups can remove from the nearest permanent water source (Figure 4).

It now becomes clear why camel-raiding has been such a frequent feature of the activities of camel nomads and such a powerful factor in shaping their value system: it is at once an effective means of replenishing one's own herds and of weakening one's opponents. Under such circumstances it is little wonder that tribal ethics accept camel-raiding as a most honorable pastime, and the pursuits necessary to sustain such activity as those most worthy of men laying claim to noble descent.

Before going further, one should emphasize the really remarkable scope of activities associated with the camel in the Near East and the Arabian Peninsula. Records indicate that in the 9th pre-christian century in the course of a campaign an Assyrian ruler's troops took no fewer than 30,000 camels as booty.[29] While there are no data for populations of such an early time, 19th century records concerning the Ruala bedouin, an important north Arabian tribe shows that it counted at that time about 5000 tents.[30]

Figure 4



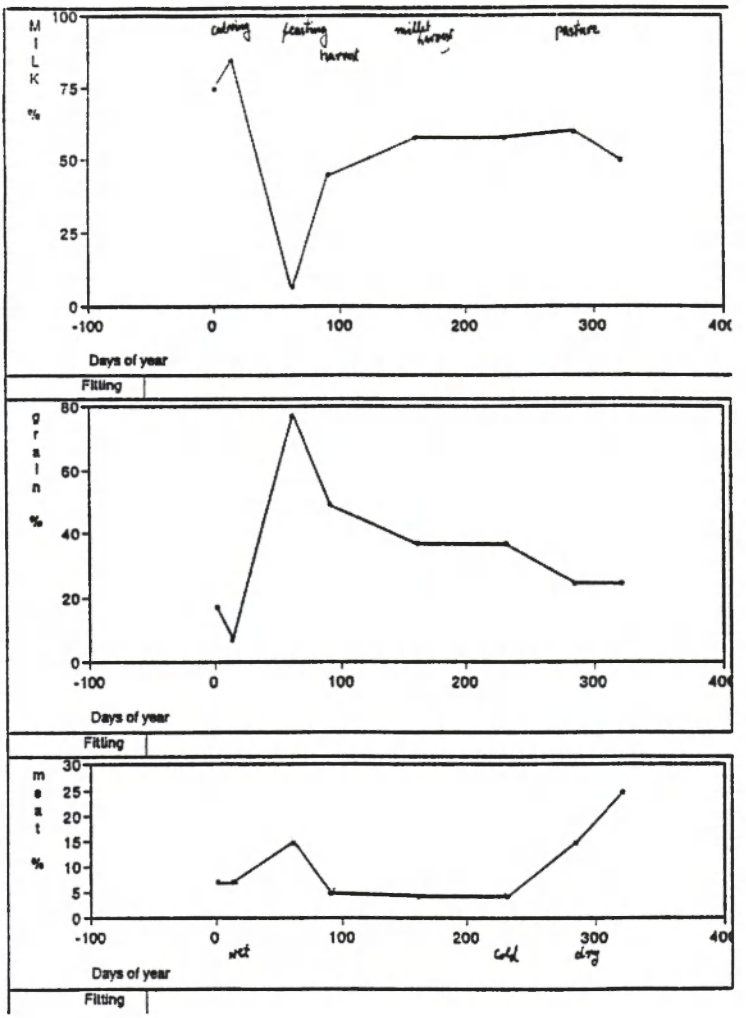
Figures for camel holdings vary a bit, but indications are that herds amounted to 6 to 20 animals per tent. Based on this figure the holdings of this tribe at the time can be estimated at 40,000 or 50,000 camels. At then current prices (about £ 50 per camel in Alexandria) this means that the herd represented a potential value of about £ 2,000,000 to 2,500,00. If one deduces from the herd size model of Figure 3 that a yearly attrition rate of 10% is quite sustainable, and assumes that this might be split more or less evenly between use for flesh at home and sale abroad, this implies a yearly

income of £ 150,000 to £ 200,000, or about £ 30 to 40 per tent in the form of cloth and cash.

Even disregarding the participation of these groups in the money economy of the adjacent sedentary populations, there is the important matter that, while camel milk may be a primary constituent of some nomad diets and camel flesh is by no means unknown, even the most extreme desert camel nomads consume considerable quantities of vegetable foods (Figure 5). These must be obtained from more sedentary populations, either elements of the nomad tribes electing or constrained to a cultivator's and small pastoralist's mode of lie, or agriculturists or agro-pastoralists alien to the nomad tribes but living adjacent to the nomads' desert pastures. The ability to obtain such foods is essential to enable the great nomads to lead their hearing lives, and one element in which is really a regional symbiotic form of coexistence of sedentary and nomadic populations (cf. Kroeber's referring to such nomads as incomplete societies[31]).

Another factor of the greatest importance was that, beginning centuries before the establishment of Islam, nomad-bred camels were essential to the caravan traffic of the Peninsula and the lands just to the north of it, ferrying incense, gold, spices and other products from South Arabian Indian Ocean ports to Mesopotamia and Syria, and weapons, cloth, iron, and grains southward to Arabia. In the Sahara a similar development occurring some centuries later led to the so-called triangular trans-Saharan traffic[32] involving gold, salt, and slaves exchange between Sahel empires, the Mediterranean coast and the Near East, with intermediary northern desert ports like Sijilmasa or Ghadames. The threat of raids and need for protection against them led to the formation of convoys - caravans - let by nomad guides who often doubled as mediators in the negotiations between local tribal leaders and caravans wishing to pass their lands unmolested. Such convoys were guarded by nomad warrior escorts and for safety tended to be quite large - 1200 to 2000 camels and 1000 or even several thousand men were not unusual. A fine example of this, and an illustration of the economic as well as political importance of a single caravan of this kind, is that which was at the center of the famous Battle of Badr, between

Figure 5



the Meccan caravan and auxiliaries hurriedly called from Mecca, and the raiding party under the Prophet Muhammed. This battle is considered to have been of primary importance in establishing the

Medinan Muslim state and severely undermining the strength of the Meccan Quraish merchants.[33]

Since it is not reasonable to assume a mean load per dromedary camel of around 500 lbs., a caravan of 2000 camels must be considered as capable of transporting a total burden as large as 1,000,000 lbs. Experience in more recent caravans across the Sahara suggests that 60 to 75% of this may have represented merchandize, so that a single caravan could move 300 to 400 tones of goods. Taking 1500 miles as the average distance such caravans traveled across the Arabian Peninsula, and a mean daily march of 15 to 20 miles, the total transport in one direction could be accomplished in about 100 days. There are clear indications that profitable cargo could be picked up at either end of the road, so that a round trip for such a convoy might require 7 months (longer if time required for recuperation of the animals is considered) and could result in the exchange of as much as 800 tons of merchandise between the northern and the southern desert ports. This is an impressive figures which helps to explain why, once the camel was available in numbers, land transport of the precious goods from the east and from the incense lands to the Fertile Crescent and the Mediterranean was in principle quite competitive with maritime transport. Its relative importance varied with the political conditions governing passage through the Bab al-Mandeb or up the Persian Gulf to Basra. The scope of these operations was such that caravan traffic could readily constitute a major source of cash income for the camel nomads and, incidentally, a potentially bountiful resource for raiders, justifying the raiders in taking of substantial risks, and the merchants in paying of considerable 'protection moneys.'

Taken together these data makes it clear that in no sense can one consider the camel nomads' mode of life as that of pure pastoralists. It is very clear that the nomad existence, even after the fullest development of camel herding and camel breeding skills, must have remained a symbiotic or quasi-symbiotic one, involving the nomads with a variety of sedentary groups, within their tribal structure or with non-tribal adjacent groups which had remained responsive to developments in the more highly organized states bordering upon their deserts.

The role of the camel in shaping camel nomad societies. What was the role of the camel in shaping the structure of the societies of which the Great Nomad tribes formed a part? What are the characteristics of nomad society that can be traced to the possession of the camel? And can the cause-and-effect relations that govern the history of the formation of such societies be elucidated? Did the nomad societies arise *de novo* among populations ethnically distinct from their sedentary neighbors or was there a flux and reflux in which groups springing from settled populations adopted a nomad pastoral mode of life, and conversely nomad groups abandoned their migratory ways to become sedentarized to establish equilibria which might fluctuate with time and external conditions?

Five distinct approaches can be recognized which provide data on the basis of which these questions can be considered:[34] (1) primary literary or artistic documents; (2) a copious secondary descriptive literature seeking to deduce the history of nomadism and of nomadic groups in the Middle East,[35] (3) the technological historians - such as Richard Bulliet of "The Camel and the Wheel"[36] - whose work sheds light especially upon military implications of the material culture of camel nomads; (4) the ethnographers and sociologists, concerned with social structure and the relations between sedentary and nomadic populations, a numerous group such as those who looked at the Al Murrah of the Rub' al-Khali,[37] the Rwala Bedouin,[38] the Tuareg,[39] the Rendille of Kenya,[40] and several of the Somali clans,[41] and the fine summary of much of this work both in the West and in the Soviet Union by Khazanov;[42] and (5) the archaeologists, to-date only a scattered few, including those who made relevant observations on this subject incidental to tradition-guided excavations, as well as those who performed quantitatively oriented archeological studies, like LaBianca and associates in the Heslan region in Trans-Jordan[43] or Sadr in Northern Ethiopia.

The earliest *literary evidence* for the coming into prominence of the camel in the Mideast would seen to be the previously mentioned passages referring to the Aramaeic and Midianite irruptions of people owning and using 'countless camels.' While legitimate in the context in which they were mentioned above, these references in the present context entail an element of circular reasoning: Are they evidence for increased aggressiveness among established camel

nomads, or are they indications that, when the camel became available in numbers, this rendered previously docile tribes aggressive? The scantiness of the information available for this region and this remote time does not permit a choice to be made between these alternatives on the basis of the literary evidence alone.

The Qur'an contains only a single passage referring to the creation of the camel as a visible sign of the mercy of Allah.[44] On the other hand the camel figures prominently in the poetry of the Arabic tribes.[45] Reference has already been made to the extraordinary wealth of terms designating the camel, its properties, its gait, and the parts of its body; a total of no fewer than 6000 distinct terms, according to Hammer Purgstall.[46] In the pre-Islamic Ayam literature, the camel figures as the reliable mount which carries the rider toward battle or makes it possible for him to escape danger, or brings him home triumphantly to the tents of his people, or as the camel stallion who embodies his master's fury and aggressiveness in battle.[47] Even though this literature tends to emphasize the drama of cavalry battle, i.e., horse mounted warriors, it contains an abundance of references to the came in battle, probably reflecting the fact that at all times the horse was a rare luxury creature in the desert, costly and requiring elaborate care and hence probably in large measure a chief's prerogative rather than the mainstay of the raiding forces. In the poetry of the largely subsistence pastoral Somali the camel is mentioned over and over as the very incarnation of generosity, a source of wealth, beautiful to the point where it is not uncommon to find beloved women compared to camels or the camel's gait or the like.[48]

Hammer Purgstall in a remarkable compilation has shown that Arabic poetry distinguishes five major uses to which the camel is put, illustrating the central role of camel husbandry in the culture of the Arabs: *milch camel*; *pack camel*; distinction being drawn between the water bearing camel, the food carrying camel, and the general pack camel of the caravans; *the camel bearing the women's litter*; including the one bearing the girl carrying the tribal fetish as a standard in battle; or the marriage camel carrying the bride litter; *the riding camel*, including the *thelul* - the racing, the battle camel, and the *rahila*, the camel ridden during travel; and finally *the meat*

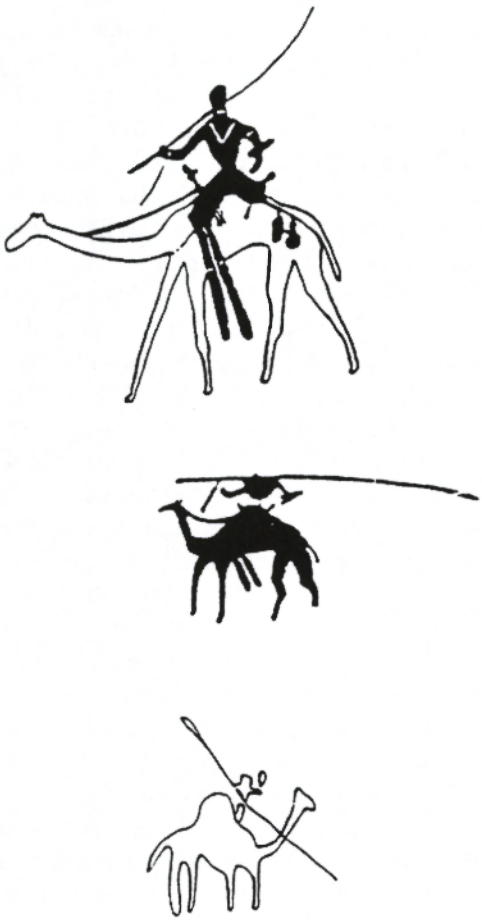
camel, including the guest camel, butchered as part of the hospitality offered to a guest, the sacrificial camel, used in both pre-Islamic and Islamic ritual, and the funeral camel.[49]

Lhote[50] described the *rock art of the Sahara* and explored the formation to be drawn in from it regarding the relative timing of utilization of horse and of camel in the area. His general conclusion, that use of horse-drawn chariots and use of the horse in warfare in the region preceded the arrival of the camel, seems valid and confirms the literary evidence. The inference that the transition probably took place around the turn of the Christian era, though in accord with Gautier's inferences from the literary evidence, is less well secured, resting exclusively upon stylistic evidence. He did not have at his disposal methods for reliably dating rock engravings such as have been developed in the meantime in the course of studies of desert varnish,[51] a technique yet to be applied to Saharan material. While Lhote recognized the significance of indications from the representation of the saddle arrangement used, in the absence of sharper definition of the dates of the individual pictures he could reach only vague conclusions relating to the interaction between Berber and Arab presence in the vast area of the Sahara and its adjoining lands. Significant in the present context is the conclusion, apparently well supported, that the advent of the camel, however important it may have been to the economy of the deep Saharan nomads, can hardly have been of such revolutionary importance as was postulated by Gautier. The rock carvings provide ample evidence of the existence of trans-Saharan traffic using chariots and carts drawn by animals other than the camel well before the arrival on the scene of the camel in numbers.

The rock carvings representing camels are focused largely upon their military use, mounted by riders bearing spears (both the 'lance' - the long stabbing weapon, and the 'javelot,' the shorter throwing spear which has remained in use among the Tuareg to this day [Figure 6]) and shields. Lhote emphasizes the point made above that as a warrior's mount the camel is useful to the raider in the desert, but that the conquering warrior depended by preference upon the horse in actual combat.[52] No attempt was or can be made to draw inferences from any of this material alone regarding the

influence of the acquisition of the camel upon the societies of the region.

Figure 6



From his review of the literary sources describing historical developments in western North Africa E. F. Gautier[53] made a strong case for the view that camels in significant numbers were not available there before the first century AD. Caesar captured, and mentioned the capture, of a mere 22 camels, but by 370 AD

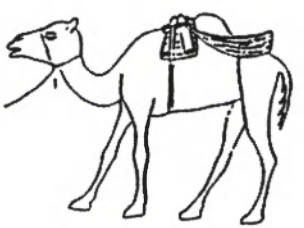
General Romanus could requisition no fewer than 4000 camels from the inhabitants of Leptis.[54] Gautier came to the conclusion that the Romans were responsible for the introduction of the animal, only to find that they had inadvertently imported into North Africa an element that would cause previously peaceable tribes of small agro-pastoralists to be converted into warlike nomads. At a distance of more than 50 years, Gautier's interpretation seems to go further than warranted by his data. While the data seem to support strongly a degree of association of the two events in time, to the point of suggesting a relatively tight time window for both, they are hardly specific enough nor sharp enough to allow deductions as to causality.

Among the Arab historians and geographers Ibn Khaldun recognized the importance of the camel as it conferred great mobility upon Arabs and Berbers who lived in the deserts. His principal contribution in the present essay, however, is his insistence upon the fundamental contrast between the virtuous and warlike desert nomads and the vice-ridden and effeminate sedentary folk and city dwellers. It is this contrast which he perceived as underlying the pattern of recurrent conflict, driving an essentially cyclical course of North African history. This view of events recognizes a kind of fluidity between nomads and sedentary peoples in that the former, inevitably victorious in battle, came to occupy the towns where, in the course of a generation or two, they lost their desert-born virtues and strength, becoming city dwellers and subject to renewed conquest by those who had remained behind in the deserts and hence retained their ancient prowess. Ibn Khaldun failed to recognize the possibility that the transition from sedentary agriculturist to nomad may have occurred gradually and may even have been reversible. He also ignores the possibility that the relations between nomadic and settled populations might be symbiotic rather than inevitably hostile.[55] Although he speaks of the attack-and-withdrawal strategy followed by the camel nomads, he also fails to mention explicitly the role of the camel in the military activities of these people except as providing, together with their women and children, a back-up rank in battle - *mujbāda* - which inspired the men to fight more courageously.[56]

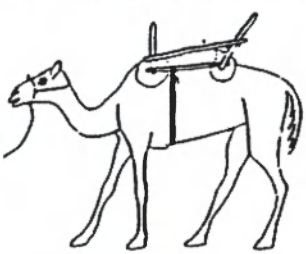
The third line of information that provides insight into the impact of the camel on nomadic societies is *the history of technology*. The principal scholar to be considered in this context is Richard Bulliet. The two most important ideas proffered by Bulliet related to the near total disappearance of wheeled transport from the area in which the camel was encountered[57] and the successive transformations of the camel saddle and its military implications. It is the latter development that is of principal interest in the present context.

Figure 7a-d

a. Schematic drawing of Socotran camel sad-



b. Schematic drawing of South Arabian riding saddle.



c. Schematic drawing of Teda *terke* saddle.

d. Schematic drawing of Mauretanian *rahla* saddle.

Bulliet recognizes a progression in the design of the camel saddle.[58] The most primitive form consisted of little more than pads strapped on the back of the dromedary so as to surround and flatten out the contour of the hump, and is encountered in Socotra and among the Somali (Figure 7a). Neither of these populations ever ride their camels, using them instead for milk, meat, and for transport only insofar as it related to moving camp. A case can be made for the idea that the camel was introduced into both of these areas early and that their usage has remained at a relatively primitive stage. In the case of the Somali there are indications from the ethnographic material that migrations associated with these nomadic populations are of modest extend.[59]

A second stage, Bulliet suggests, is the development of the so-called south-Arabian saddle whereby the rider is accommodated behind the hump (Figure 7b). This, too, is of considerable antiquity as camel riders utilizing this kind of mount are unmistakable represented on Assyrian tablets. Its use continues to the present in parts of the Arabian Peninsula and regions to the east of there, and observation confirms the impression that this is a very adequate arrangement for transport purposes but unsuitable as a seat for fighting from camel-back with sword or spear. For this purpose a far more stable seat and better control of the animal are required than can be achieved by the rider mounted behind the hump on the South Arabian saddle.

Bulliet suggests that the significant step in this regard was the development of the north-Arabian camel saddle (Figure 7c and d). In both the south and the north-Arabian saddles the important new idea was the use of rigid arched supports, either before or behind the hump to mount the rider directly above it as in the north-Arabian camel saddle, or before it in the flexure between hump and neck to mount the rider in front of the hump above the shoulder of the animal, as in the Tuareg and related Saharan camel saddles. The importance of the firm support is reflected in the arabic term used for this kind of arrangement: *shaddad*, which is derived from *shadid* - meaning strong, firm. The attainment of this stage of saddle development made possible the emergence of the camel-mounted warrior as an effective fighting man.

The probable date for the development of this type of saddle, marking the transition from what Hōgemann terms the proto-Bedouin stage to the fully developed Bedouin, certainly falls prior to the Battle of Magnesia in 189 BC when camel-mounted warriors wielding swords and spears formed part of Antiochos III's army. It seems likely that this type of warrior was known much earlier: Around 481 BC Xerxes' troops included Bedouin contingents armed with bow and arrow and mounted on camels. By 405 BC Ktesias was familiar with the existence of camel-riding troupes armed with long swords 'with which they could reach the enemy from the height of their seat.'[60] Hōgemann concludes that a reasonable date for the first introduction of the *shaddad* in camel contingents of the Persian army must fall between these two limits, i.e., in the middle of the fifth century BC.

The weaponry available to the early raiders consisted of bow and arrow,[61] but with the arrival of the *shaddad* warriors added the lance and sword, and some, especially in North Africa, availed themselves of small shields mounted on the left arm or of large gazelle-hide shields, the Lamtuna shield mentioned by al-Idrisi.[62] The Tuareg swords as well, probably, as those of Arabian bedouin resemble the old Frankish (and Iranian) swords, being almost straight with a slightly curved tip. As they were only about 80 cm. long their usefulness was limited as the rider sat anywhere from 9 to 13 feet above the ground. The early sources mention sabers four pekhas in length, i.e., 5.5 feet that allowed the rider to reach the enemy more easily from such heights. Camel-mounted warriors used the long saber at and before the battle of Magnesia in 189 BC.[63] I have not encountered later mention of such weapons.

References exist to lances 10 to 15 feet long, and evidence of their use is supported by some of the Saharan rock paintings (Figure 6), a 16th century Persian miniature,[64] and by a photo of a horse-mounted sheikh around the turn of the present century.[65] However, the spears in current use among the Tuareg are no more than 6 to 6.5 feet long rendering them of limited value to a camel rider.

Evidence of the long saber and lance serves to confirm Lhote's judgment that the camel-mounted nomad warrior on the *shaddad* could indeed be very effective in combatting unmounted foes such

as might be encountered in raiding an oasis, tribal herds, or caravans protected by warriors relying on similar equipment. However, even with the use of the shaddad the camel was hardly a match for the horse in shock combat nor could the camel be expected to withstand a cavalry assault.[66,67]

The relative weakness of the camel as a mount in shock warfare must have been realized quite early by the bedouin chiefs and gave rise to a further development around the turn of the millennium. The practice of horseback riding exposed the relative weakness of the camel, and led to the extensive use of equines in combat situations. Horses and camels were jointly present in the bedouin contingents supplied by King Malchus of the Nabataeans for Titus' attack on Jerusalem in 67 AD, and by the second and third century AD raids against holdings of Damascus were undertaken by bedouin using horses and camels conjointly; the latter for the long sweep of the approach, and the horses for the actual assault. Ammianus Marcellinus reported in the 4th century AD the use of similar tactics by the Blemmyes (the Baja) of the eastern deserts of Egypt.[68] As far as weaponry is concerned, too, it would seem that both the lance and the saber in use among the camel nomads would have been far more powerful if wielded from horseback rather than camel-back.

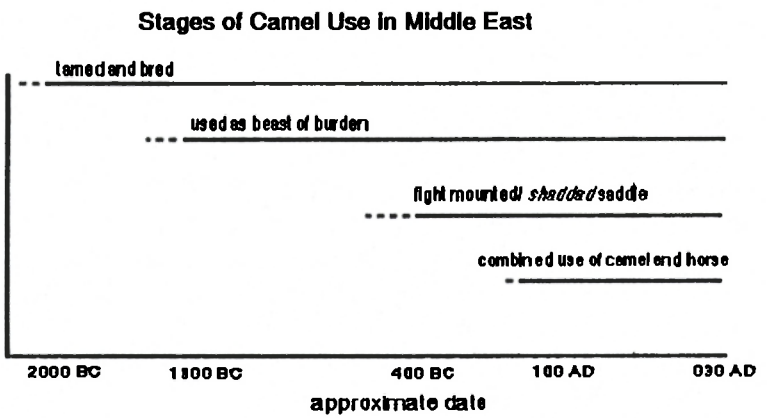
There are thus indications that by the early centuries to our era the Arabian bedouin as well as some of the eastern Tuareg rode *to* their battles on camel but, whenever possible, switched to their horses for the actual action. The importance given by the tribesmen to this combined use of the two mounts in desert warfare is richly documented in the Arabic poetry of the ayām times in the form of elaborate praise heaped upon either mount by the singers.[69]

As a battle tactic such joint use of horse and camel combined the best features of the two animals. Deployment of the horse in long distance raids (up to 850 miles!) was possible for the camel warriors because the fast striding camel could not only carry the raiders near their target, but could bring along water reserves to see the company over waterless stretches and also, by means of its milk, could supply essential nutrition to maintain the horses on such long excursions into arid lands.

An important limitation in the application of the combined use of horse and camel in warfare must have been the difficulty of maintaining the horse under desert conditions. At least in the 19th century this unmistakably made the horse into a luxury possession among the desert-dwelling tribes: Among the Ruala, Musil reported that there was not more than one horse to every five warriors. Among the Al Murrah the ratio was said to be even lower, not much larger than 1 to 20. A number of reports emphasize that only the chiefs could afford to go to war mounted on a horse. I have not come across analogous figures for medieval campaigns nor to any clear reference to whether or how the problem was resolved at the time. In connection with the Almoravid campaigns in the Sahara, there is mention of 30,000 camel riders involved in an attack upon the Oasis Sijilmasa - but no details with regard to the actual action by which this fortified place was taken.[70]

With the perfection of these techniques all of the components were on hand upon which the military strength of the camel nomads vis-á-vis their sedentary opponents could be based. Such forces would prove invincible whenever tribes or tribal alliances were unified enough to assemble sufficient numbers of warriors to confront the armies of their more highly organized foes. The time relations between these different developments are summarized and related to the time of the great Muslim conquests in Figure 8. In principle it would appear that at least by the 3rd century of the present era the technical as well as the tactical basis had been laid for effective deployment of nomad forces in any kind of conflict. The lag between this point and the emergence of increasing aggressiveness among the tribes of the Arab Peninsula suggests that here other factors - climatic, population pressure, or economic - must have come into play. The North African situation, on the other hand, suggests that here technologic and tactical factors may well have been factor shaping the relations between the nomads and the sedentary population from late Roman times on.

Figure 8



There is a large ethnographic literature dealing with the material culture, social structuring, and interaction with sedentary neighbors of camel nomad tribes. In considering this one must realize from the outset that any nomad society must be conceived of as a part of a regional system. As Kroeber pointed out more than forty years ago, nomad societies are inherently incomplete and dependent even at the level of mere subsistence upon supplementing the products of their pastoralism with products of agricultural or arboricultural groups.[71] While the resulting interaction frequently takes some form in which nomad and sedentary populations carry on separate existences and meet only at intervals to exchange- or to extract- the required commodities, in many of these societies the separation is not nearly so rigid. The relation often tends to be characterized by a degree of fluidity in which nomads may choose to reside part time and eventually full time in settled communities and transfer their economic activities there; or, under economic or political pressure, sedentary agro-pastoralists may elect to dedicate themselves full time to a pastoral mode of production and, especially if this involves camel herding, the entire group or a specific fraction thereof, will migrate with the herds and adopt a nomadic life.

The mobility of such pastoral societies likewise tend to involve them with their neighbors, the more so the greater the mobility. In the case of the camel nomads, mobility is inherently high, and its

effects are augmented by the inhospitable character of the terrain for which the camel is especially adapted. In discussing the biology of the animal it was already suggested above that it may owe its survival to its ability to survive in hyperarid environments which, because of the scarcity of their resources, tended to be shunned by predators. Camel herders, too, may well at the start have perceived their mobility in the desert as an effective defense against domination or exactions by richer and more highly organized societies upon whose domain they bordered. Bedouin strategy has been compared to naval strategy, using the pathless wilderness as a staging area from whence they could emerge at a time and place of their choosing, and as a refuge into which they could retire at pleasure when their purposes had been achieved. Quite apart from its military implications, the mobility of the camel nomads is the basis for their commercial intercourse with more developed and more affluent societies outside their desert fastness. They are the only ones in a position to breed the camels in their desert environment; and without their cooperation as guides through the deserts which are their home, caravan traffic across the Arabian Peninsula and the Syrian desert, or between the northern and the southern 'shores' of the Sahara could scarcely have assumed the proportions and the commercial importance which it did achieve in the Middle Ages.

An important additional characteristic is impressed by the biology of the camel upon societies which have elected to depend upon this animal. As pointed out earlier in this essay the slow rate of reproduction of the dromedary renders herd size a major determinant of the stability of the resources of a given group. This is the more critical inasmuch as the camel, unlike the horse, has only a weakly developed herd instinct. Control of a camel herd requires a high man-to-camel ratio. As a consequence, in contrast to the situation encountered by horse-breeding nomads, herds tend to remain rather small (20 is not uncommon while the very wealthy may have herds of as many as 50 head, as against herds of many hundred horses in the Central Asian steppes). All this makes camel herds potentially labile and renders raiding an attractive, if not indeed an essential, component of the tribal ecology. As a result, any camel breeding society is likely to take on quasi-military traits.

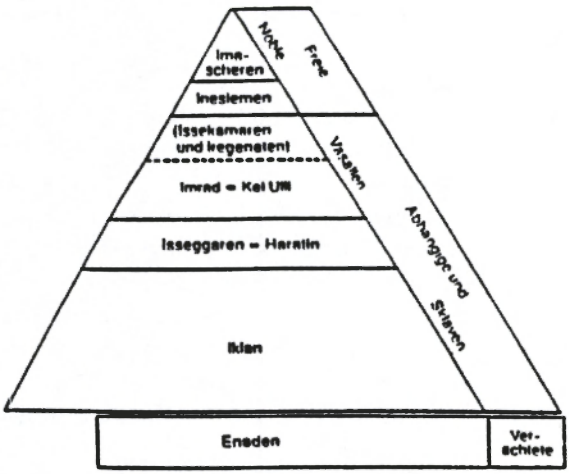
As a further consequence of this pattern and of the mobility of small groups within it, the size of a cooperating herding group may change rapidly in response to changing requirements, giving these societies a segmentary character.

There are numerous patterns of social structure which can be compatible with a camel breeding economy. Khazanov, in considering camel nomadism in the Middle East, recognized a number of such variants differing profoundly in their manner of utilizing the camel and in the role of it plays in their economies.[49] He divided the groups on a regional basis, distinguishing an East African type (e.g., the Rendille,[72] Somali[73]), characterized by largely subsistence use of their herds; a Northeast African type (e.g., the Baja deep desert herders); a Near Eastern deep desert type (e.g., the Ruala,[74] the ,28 Al Murra[75] with strongly developed raiding traditions), and North African deep desert or mixed desert-cum-oasis types (i.e., Saharan - e.g., Tebu or Tuareg[76] as well as Reguibat of Western Mauritania[77]) of nomads who, besides subsisting in large measure upon their camels, ride them for military as well as caravan purposes; and a Sudanese type (e.g., the eastern Tuareg). Numerous subtypes are also recognizable.

Variations in the patterns of camel pastoralism are only partly determined by ecological considerations. Within each of the transitional regions one can recognize several alternative ways of adapting,[78] associated with different migration patterns,[79] and each of these tend to call forth a distinct pattern of coexistence between large-animal herders, small-animal pastors, and agriculturalists. Especially at the margins of the true deserts these relations may be characterized by the kind of fluidity already alluded to above and thus provide a model for eventual sedentarization of some of the nomad groups. In the central regions of the hot deserts only the camel can serve as a basis of subsistence, but even here differences in the pattern of interaction with sedentary populations are noticeable, as when comparing the Tuareg of the Haggar (Figure 9) with, for instance, the Al Murra of the Rub' al-Khali or the Ruala of the Nufud.[80] On the whole, however, among the deep desert nomads of a single given region one finds a considerable degree of homogeneity in social structures as well as in attitudes. In particular, the similarity of such patterns among the inhabitants of the Arabian and

Syrian deserts may well have been one of the keys to the explosive effect of the message of the Prophet Muhammad in triggering the great bedouin-led conquests which established the early Muslim empire.

Figure 9

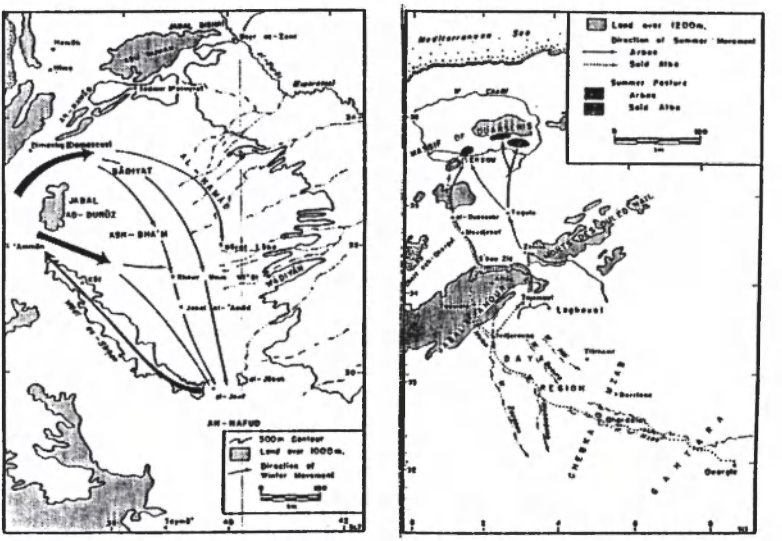


1 Hierarchisches System der Tuareg

More than 30 years ago Paula G. Rubel[81] proposed that the generative kinship model of pastoral societies in a given region is in large measure determined by the mix of animals they keep and by the pattern of their pastoralism. While promptly criticized by Pastner,[82] the general conclusion seems to be born out of much subsequent work addressing present-day camel pastoralists. Thus for instance, Lewis[83] has noted the correlation of species emphasis among pastoral groups in northern Kenya with variations in their several culture patterns. In a general way, mobility of a group is increased by the possession of camels and decreased as the relative importance of sheep and goats and of agriculture increases relative to that of camels (cf Figures 4 and 10). Differences in culture patterns include both, differences in the uses to which the animals are put - e.g., the fact that neither Somali nor Rendille ever ride their camels, while Baja and other Sudan tribes habitually do so- and structural differences such as those reflected in the family

structures and genealogies which were the focus of Rubel's as of Lewis' studies.

Figure 10



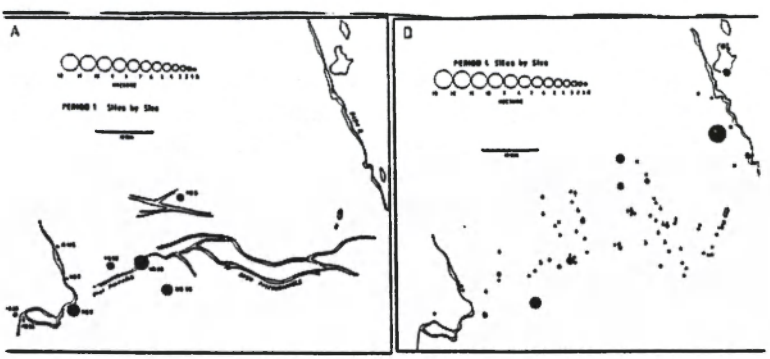
Herd composition among nomads tends to be determined by a desire to maximize reproduction. Such a strategy calls forth herds the composition of which is inherently unstable and readily leads to overpopulation such as is characteristic of the cattle owning societies of much of savannah Africa.[84] In the case of the camel, overcrowding effects become noticeable especially during times of drought when pastures near sources of water can become severely depleted. At the other extreme the pattern of reproduction of the dromedary camel is unstable in the face of herd attrition (see Figure 3), and will either be amended by camel trading to remedy losses, or result in forced abandonment of a pastoral mode of life based on the camel by the afflicted population as in the cases of the Baja of the eastern desert of Egypt, or of the Reguibat of Mauritania following the droughts of the 1920s and 30s. Indeed, this kind of shift is part of the broader problem of sedentarization which has

engaged the attention of anthropologists, agronomists, and political leaders of these regions.

The *archeological evidence* bearing on the camel nomads is the result of attempts to derive quantitative information from the results of ethnoarcheological excavations and excludes the epigraphic material touched upon in an earlier section of the present communication.

In the nature of things, highly mobile nomad populations tend to leave behind traces that neither in density of accumulated material nor in stratigraphic distribution lend themselves readily to quantitative analysis. In reference to camel nomads in particular, two approaches have been attempted to overcome this problem: Sadr and colleagues[85] working in the southern Atbai region between the Atbara River and the Northern Ethiopian highlands derived estimates concerning settlement size and distribution on a regional basis for three successive periods of roughly 1000 years each, extending from about 3500 BC to about 200 AD. They constructed size-frequency and wealth-level site distribution diagrams and compared these with settlement distributions for modern day populations and the predictions of theoretical models regarding the interaction of sedentary populations and highly mobile pastoralist groups. Their data reveal a continuous progression of the settlement pattern of the region, from one bespeaking a largely sedentary and partially urbanized population coexisting with a relatively scarce component of small establishments which suggest the emergence of a small agropastoral element, toward a population structure made up in its majority of sites representing the transient encampments of mobile pastoral people (Figure 11).

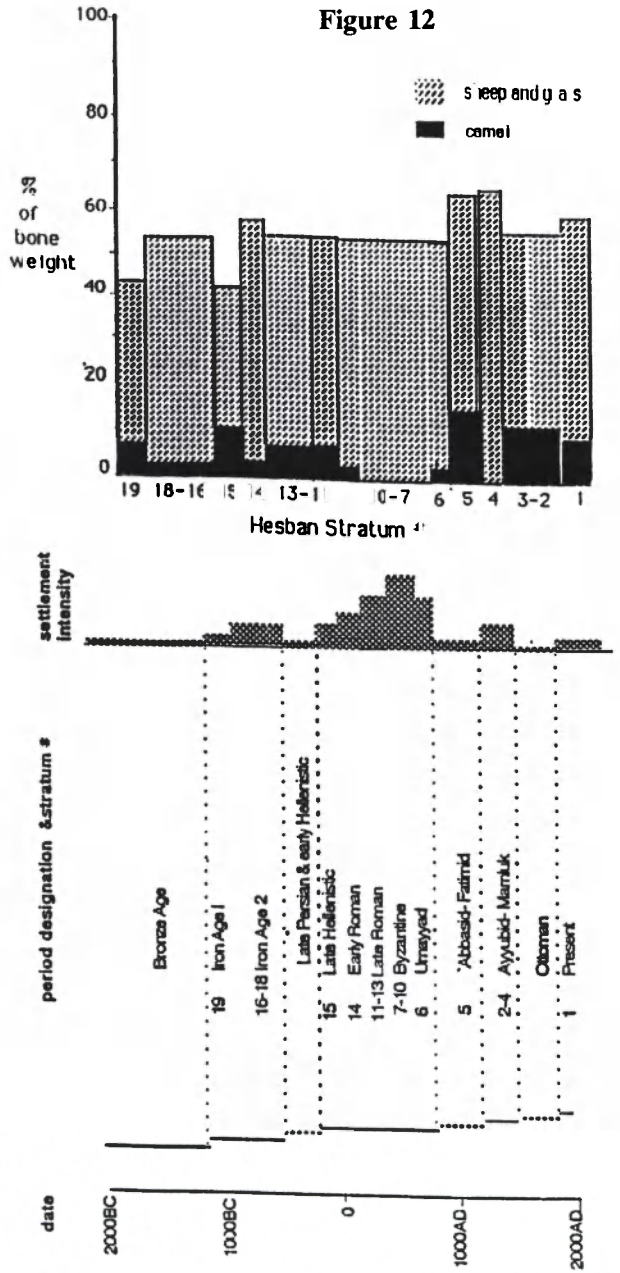
Figure 11



These data are compatible with a model reflecting the kind of fluid condition alluded to above in which agro-pastoral populations provide a reversible intermediate condition between fully sedentary agriculturists (and - in an advanced stage of stabilization - horticulturists and orchard keepers) and nomads who dedicate themselves wholly to the keeping of herds. The nature of the terrain makes it seem plausible that in this site camels should have constituted an important component of any nomad herds though actual remnants to support this assumption are still lacking. The authors themselves note that the nature of their material dictates an extremely wide-meshed time frame (of the order of a thousand years!) for these findings and prevents any convincing deductions regarding the rate at which successive steps of the observed changes might have occurred, or any effective correlation with other historical data for the region.

An alternative approach makes use of detailed stratigraphic data from individual more densely settled sites, occupied continuously for an extended period and located in a fluid zone dividing the settlements of a sedentary population from desert or near-desert regions inhabited by nomads. In the absence of the sort of settlement patterns derivable only from regional studies, such investigations must rely on indirect methods for inferring changes in the relative importance of nomads with time. Zoo-archeological data which might lead themselves to such interpretation are exceedingly rare. The one such report pertinent to the present discussion is the result of extensive tell excavations at the site of Tell Hesban in Tans Jordan, conducted over nearly two decades as the Heshbon Expedition.[86] From the point of view of the present discussion the most significant results of the great amount of work devoted to this site are summarized in Figure 12. The data cover a period of nearly 4000 years, and the stratification is such that temporal resolution is at the level of one or two centuries. The data reflect the contribution of the camel to what the authors call the 'food system' of the region. As reflected in relative bone mass the meat component of this system is dominated throughout by sheep and goats; however, camel bone remnants in variable amounts are also present almost throughout the entire period of occupancy. The excellent temporal resolution achieved invites relating the varying

Figure 12


100
80
60
40
20
0
% of bone weight
sheep and goats
camel
19
18-16
13-1
0-7
6
5
4
3-2
1
Hesban Stratum #
settlement intensity
period designation &stratum #
Bronze Age
19 Iron Age I
16-18 Iron Age 2
15 Late Persian & early Hellenistic
Late Hellenistic
14 Early Roman
11-13 Late Roman
7-10 Byzantine
6 Umayyad
5 'Abbasid-Fatimid
2-4 Ayyubid-Mamluk
Ottoman
1 Present
date
2000BC
1000BC
0
1000AD
2000AD

proportions of camel bones in different strata of refuse to the changing political conditions in the region. In particular they reveal the almost complete disappearance of camel remnants during the period from the time of Roman occupation of the region through the end of the Umayyad khalifate, and the high level of utilization of camels for food during the Abbasid and Ayyubid dynasties. Mathematical analysis of the data fails to show any significant degree of correlation between estimated settlement intensity and the proportion of camel bones in the accumulated material (correlation coefficient = 0.4; probability of chance occurrence = 0.23!), so that the relative importance of the factor of settlement density in determining the relative importance of camel meat in the diet of these communities cannot be assessed.

Cautious interpretation suggests that these data may reflect fluctuations in the extent to which camel meat was utilized relative to other herd animals, and that these in turn are likely to reflect fluctuations in the degree of access of nomads to the markets of the community. Such access would be expected to be minimal during the periods of Roman and Byzantine government when it is known that strenuous efforts were made to fortify the borders against nomad incursions while the urbanized communities flourished. The authors interpret their data as suggesting that the nomad/sedentary boundary over this long period was indeed a fluid one, presumably determined by variations in the relative strengths of the organized states at the boundary of which Tell Hesban was located, and of the camel rearing nomads who roamed in the adjacent desert. To this extent the result of this ambitious project support the indications from the Atbai data[87] in pointing to camel nomadism as a somewhat fluid and reversible response to conditions prevailing at a given time in the region, including not only ecological but also social, economic, and political factors. More specific conclusions with regard to the actual forces at work can hardly be drawn from these data. Not only are they not fine-grained enough to allow correlating specific events with particular manifestations, but they also are handicapped by the fact that throughout the period studied camel meat was only a minor component of the population's diet and in a sense competed at all times with beef, while meat from

ovine and caprid sources remained consistently the major component of the people's meat diet.

Conclusions:

It seems clear the camel is the key without which there could have been no nomads in the hot deserts of the Old World. This one domestic animal provided food, transportation, and a basis for military power, and continued to do so under conditions no other animal of comparable capabilities could endure.

The combination of biological characteristics of the camel with the restraints imposed by the ecology of the deep desert environment in turn conditioned special social manifestations which differentiated the segmentary societal forms of bedouin tribes from those developed among the horse-rearing nomads of the cold deserts of Central Asia: there was no Genghis Khan among the bedouin, and no Muhammad among the Turko-Mongols. At this point there is no convincing way of determining whether the primary factor here was the animal or the environment; it seems most likely that both factors come into play.

Examination of the social and the ecological structures as they exist among modern camel-breeding populations all over the Middle East reveals a number of possible patterns of social and of economic structuring. However, among deep-desert dwelling camel nomads of pre-Saudi days the scarcity of natural resources seems to have limited the possibilities to two: on the one hand was the pattern common to the societies of the tribal bedouin on the Arabian Peninsula, with symbiosis of noble and pariah tribes caring for distinct species of herd animals and performing different functions in the daily round; and on the other hand the Tuareg pattern of the Sahara was characterized by a multi-tiered society in which different functions were allocated to different classes, although, as in the bedouin societies, the 'nobles' reserved to themselves both camel husbandry and warfare.

In either case the biology of camel reproduction limits the size and stability of herds and encourages the development of camel raiding with its associated valorization of military structures and military virtues. Among the bedouin tribes in particular, survival of the society as a whole then became contingent on the imposition

of a rigid code upon such predatory activity. A case can be made for the conclusion that the system of values and the rules of proper behavior imposed by the *ghazu* complex, the peculiar type of long range raiding characteristic of the deep desert tribes, contributed in an important fashion to the molding of Islamic law and the definition of values considered important in the formation of the Islamic empire. There is some suggestion that a willingness to improvise and to try innovative ideas, though within strict limits, might have formed an important part of this complex.

The technological devices and the tactical concepts which together rendered the camel a formidable factor in desert warfare emerged stepwise over a long period of time. The time frame of these developments is sufficiently vague to make it impossible to determine now whether, as assumed by Bulliet, the technology drove the tactical concepts, or conversely, perceived tactical need drove the emergence of technology.

State formation seems to have been largely in abeyance among the camel nomads except in zones characterized by a more generous ecology than the deep desert, and in zones adjacent to regions in which sedentary irrigation agriculture had been established early where consequently state formation, too, had occurred at an early date. On the other hand, it can be argued that conditions in the Arabian Peninsula made for remarkable culture homogeneity among the multiple tribal societies occupying these deserts and that this homogeneity may have been the real key of the explosive activation of the Arabian bedouin tribes by the injection of the ideology that found its expression in Muhammad's revelation.[88]

In addition to thus molding bedouin society, the camel can lay claim to having modified commercial and urban society in two important ways with implications that could be touched upon only briefly in the present communication: the existence of the dromedary camel as a domestic animal available readily and in considerable numbers in the Middle East together with its extraordinary fitness as a beast of burden made this animal a major factor in the elimination of wheeled transport from the entire area (cf. Bulliet). Elimination of the need for making provisions for wheeled transport within the cities, in turn, was a potent factor giving their character-

istic shape to the convoluted narrow passages of the living quarters inhabited by most of the population of Medieval Islamic cities.

Finally, it might be mentioned that a case can be made for the idea that the possession of the camel may have been a significant element in the complex accounting for state formation among these nomad populations in seeming defiance of the predictions of Marxist theory related to the concept of the Asiatic Mode of Production. Discussion of this problem, however, transcends the bounds of the present essay.

Acknowledgement:
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Appendix

The role of the camel in the disappearance of wheeled transport. R. W. Bulliet proposes that the availability of the camel as a transport medium was a major cause of the disappearance of wheeled vehicles (but not other forms of rotary motion devices) over the entire Middle East wherever the domesticated camel is encountered. This occurred among people who had used the cart previously in one form or another in peace and in war for millennia. Bulliet seems to have been the first to have called attention to this phenomenon. Although his evidence is somewhat indirect - largely linguistic and art historic in nature - in the aggregate it is convincing. It conforms with much more recent observations which confirm that even in the 19th century wheeled transport continued to be in abeyance among populations over the entire region. A marked reluctance to reintegrate the wheel into their transport schemes persisted among these populations almost until the advent of modern motorized transport. Determining the time when the original abandonment occurred in different regions proved difficult; a reasonable range for the Near East is derived from contrast between the use of carts in Roman times around the turn of the present era, and evidence a few centuries later that camel transport was substantially cheaper, and perhaps officially favored in such localities as Palmyra as well as under Emperor Diocletian in Syria. Bulliet concludes from the sum of the evidence he could marshall

that in the Near East camel-back transport displaced the oxcart or mule-drawn vehicles sometime between the beginning of the Christian era and about 500 AD, i.e., well before the beginning of the expansion of Islam. It seems likely that the development was fostered by - though not wholly dependent upon - the progressive deterioration of the Roman road system during the period.

The development in the Sahara and adjoining regions appears to have followed a time course not readily distinguishable from that applying to the Near East. There is a suggestion that developments in the more northerly parts of Africa proceeded along somewhat different lines, and that here the cart as a means of transport and as an aid in agriculture never was wholly displaced.

A change in the concept of transportation of such dimensions as the abandonment of wheeled transport inevitably must have brought about profound changes in the societies in which it occurred. It probably lent additional momentum to the incorporation of camel nomad societies into the fabric of adjacent sedentary societies by emphasizing reliance upon camel caravans for long distance transport. It also is at least associated with - Bulliet makes a case for 'it brought about' - a radical change in the urban landscape, i.e., the disappearance of the rectilinear town plans inherited from classical antiquity, and their progressive replacement by the labyrinthine Islamic city. While the change in the means of transportation can hardly be considered as the sole cause of the altered spatial concept, this assuredly could not have developed in a society relying on wheeled transport. What may be called the basic planning concept underlying of the mature Islamic city embodies *sharî 'a* law concepts (cf., e.g., Alsayad, N., *Cities and Khaliphs - on the genesis of Arab Muslim Urbanism* - Greenwood Press, New York, NY 1991). The operative clause relevant here is the one insisting that the width of the streets is to be determined with reference to the passage of loaded pack animals, reflecting the striking disregard of wheeled transport. There is evidence that this attitude had become established well before the time when the Prophet ruled over his faithful.

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NOTES

1. Systematics: order Artiodactyla, suborder Ruminantia, infraorder Tylopoda, superfamily Cameloidea with two species: Auchenids and Camelids, latter in old world only.
2. Gautier- Pilters, H. and Dagg, Al. *The Camel - Its Evolution. Ecology, Behavior and Relationship to Man*, (Chicago: The University of Chicago Press, 1981), p. 7.
3. *Encyclopedia of Islam*, New Edition, vol. 1, "Badw".
4. Bulliet, R.W., *The Camel and the Wheel*, (Cambridge: Harvard University Press, 1975), chapter 6, "One Hump or Two."
5. Bulliet, R.W., *The Camel and the Wheel*, (Cambridge: Harvard University Press, 1975), chapter 2, "The Origin of Camel Domestication."
6. This 'diffusionist hypothesis' is bitterly opposed by some who hold that the dromedary camel never died out on that continent and that present day dromedaries are the descendants of the original wild strain. cf. e.g. Cauvet, C., *Le chameau* (Paris: Jourdan, 1947).
7. Thus, instead of the 2° diurnal range of deep body temperatures maintained in other mammals, in water-deprived camels the daily deep body temperature cycle may spread over a range of nearly 7°C (Figure 2a). Following the wide swings of change in desert ground temperatures between day and night, the animals allow their body temperature to fall drastically during the night without shivering in temperature defense, and allow their body temperature to rise to substantially higher levels than other mammals before initiating sweat production to cool themselves during the hot day: Sweat production in the camel is 'turned on' at a threshold skin temperature of about 35° C, 6 or 7° higher than, for instance, in the donkey, another desert dwelling mammal (Figure 2b). As a result of this adaptation of the thermoregulatory system total sweat production of the camel over a working day is far less than it would be under similar conditions in an animal of similar size thermoregulating in the way of mammals not specially adapted to desert conditions.

In addition to this, however, the cooling of the body during the night, which the camel tolerates without shivering, provides a low starting temperature in the morning so that a greater heat influx will be required during the day to reach the already high deep body temperatures at which temperature defense mechanisms are called into play. This mechanism is rendered highly effective by the fact that the camel is a large animal and thus provides an ample heat sink, as well, perhaps, as by the geometry of the single fat hump; both of these factors reduce surface-to-volume ratios to result in relatively slow rates of change in deep body temperature for a given skin-to-ambient temperature gradient.

8. Schmidt-Nielsen, K., *Desert Animals - Physiological Problems of Heat and Water* - Oxford (Oxford: University Press, 1964), chapter 2, "Basic Problems - the advantage of a large body."

9. Ibid. pp., 63-67.

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11. Monod, T., *Pastoralism in Tropical Africa*, (Oxford: Oxford University Press, 1975) Introduction, p. 11.

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13. Cf. e.g. time/distance relations shown for caravans in the Sahel, in: *al-Idrisi - Kitab nuzha almushtag fi - 'khtiraq*, recent Arabic ed. Beirut, 1989, e.g., climate 1, sections 2 and 3.

14. Leese, A. S., *A Treatise on the One-humped Camel in Health and Disease*, (Stamford, Ls: Haynes & Son, 27).

15. Eph'al, I., *The Ancient Arabs - Nomads on the Edge of the Fertile Crescent 9th - 5th Centuries*, (Jerusalem, The Magnes Press, The Hebrew University, 1982), p. 46, quoting Borger in M. Dunand's *Til Barsib*, Paris, 1936 for documentation of fragments of a historical inscription from Nineveh; Herodotus, D. Geen Trsl., *History*, (Chicago: University of Chicago Press, 1987, p. 214; cf. also Aurel Stein, *On Central Asian Tracks*, Putnam Publs., p. 19 regarding the use of ice-loaded camels to assure a water supply for his work in the Gobi desert.

16. Hjort, A. and Dahl, G., "A Note on the Camels of the Amra'ar Beja," in: Cochrill, W. R., Scandinavian Institute of African

Studies, 1984, - pp. 50-76 - reports that camel production of calves formerly was 11, but recently has been reduced to 6 to 7 calves per lifespan of the mother animal.

17. Cf. fig. 3 legend.

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31. Kroeber, A. L. - *Anthropology: Cultural Patterns and Processes*, (New York: Harcourt Brace & Co., 1963), p. 212.
32. Bovill, E. W., *The Golden Trade of the Moors*, (London: Oxford University Press, 1968).
33. Asad, M., trsl., 'Abu Abd Allah Muhammad al-Bukhâri - *Kitâb al-Jami as-Sahih*, (Gibraltar: Dar al-Andalus, 1938), pp. 261-306.
34. Discounting at once the lone sociologist - Laroui - who from the height of his doctrinaire position covered with invective all those who chose to seek insight into these matters by examining facts rather than by arguing from theoretical constructs.
35. Most persuasive among them perhaps Gautier, E. F., *Le Passé de l'Afrique du Nord-les siècles obscures*, (Paris: Payot, 1937); also Lhote, H., "Le cheval et le chameau dans les peintures rupestres du Sahara," *Bull. IFAN*, 15 [3]: 1139-1237, 1953; and of course the incomparable Ibn Khaldun, *The Prolegomena*, F. Rosenthal trsl., (New York: Pantheon Books, 1958), all concerned primarily with developments in North Africa; and Musil, A., *Manners and Customs of the Rwala Bedouins*, (New York: American Geographical Society, 1928); O'Leary, S., del., *Arabia before Muhammad*, (New York, 1928) and others interested in the bedouin of the Arabian Peninsula and the Near East.
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55. His grim assessment of the baleful effects of the invasions of the Banu Hillal into the culture lands of the Mediterranean coast of North Africa may stand as an example of overkill in this respect.
56. Both, the Rwala and the Âl Murrah took a chosen virgin mounted in a camel litter together with the tribal fetish into battle until comparatively recent times.

57. Cf. Appendix.
58. Bulliet, R. W., *The Camel and the Wheel*, chapter 4, "The North Arabian saddle and the Rise of the Arabs,"
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61. Clay tablets suggest a short recurved, possibly compound bow wielded by a soldier sitting behind the rider guiding the camel.
62. al-Idrisi - *Opus Geographicum*, Fasciculus II-Climate II, Section 1.
63. Hōgemann in: *Alexander der Grosse*, pp. 37-39, citing Appian as well as Diodorus Siclius.
64. S. C. Welch, *Persische Buchmalerei*, (Munchen, 1976), p. 39; not terribly promising for the power of camelry since it is excerpted from a painting entitled 'the murder of Uayna and Raiya' by Sheikh Muahammad -- and incidentally in the form in which it appears in Hōgeman is a classical example of complete falsification of the meaning of the original picture by selective copying.
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72. Hjort, A. and Dahl, G., "A Note on the Camels of the Amra'ar Beja," in: Cochrill, W. R. (1984).
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80. It has also been contended that the contrast between developments in the Central Asian steppes and those in the Arabian peninsular and at the margins of the Syrian deserts cannot be attributed to difference in the principal mounts of the nomads inhabiting the two regions but rather support the hypothesis that formation of stable states presumes a higher level of fertility than can be encountered in the hot deserts, and that the marginal statelets (like Hira or Petra) which may form in such regions are inevitably too closely dependent upon developments in the adjoining more fertile districts of successfully established major states to serve as successful nuclei for state formation in the adjoining desert. (cf. Crone, P., *Meccan Trade and the Rise of Islam*, (Princeton: Princeton University Press, 1987).
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Legends for Figures

Figure 1. Geographical distribution of the one-humped and the two-humped camels and of the South American camelids (from: Droando, Ivo- *Il camello* - Instituto Agricolo Coloniale Italiano, Firenze, 1936; figure 3, p. 14).

Figure 2. Physiological peculiarities which contribute to the adaption of the camel to hot and dry desert conditions: a. Diurnal fluctuations of deep body temperature in well watered and dehydrated camels illustrating the wide fluctuations of deep body temperature in dehydrated camels, and the effect of hydration in rendering camel temperature regulation not unlike that of other mammals; b. Differences in the critical ambient black-bulb temperature above which sweat production sets in in the donkey and the camel; (Reprinted by permission from: Schmidt-Nielsen, K., Jarnum, S. A., and Houpt, T. R. - "Body temperature of the camel and its relation to water economy" - American Journal of Physiology 188: 103-112, 1957, ©American Physiological Society, Bethesda, MD).

Figure 3. Computer modeling of changes in herd size with time as a function of initial herd size. The model illustrated in the figure represents total number of surviving adult animals, n_{adult}. It was developed, counting female animals only since breeding herd composition typically requires only one mature male to more than 30+ females (to represent the real situation one should double the

numbers of mature animals to take into account the effect of a sex ratio near 1.0 among the newborn and special disposition of the males by sale or castration for use as burden carriers). The following assumptions were made: The herd is started with $n_{initial}$ newborn animals; the youngest over 4 years old, is consumed each year; the minimum reproductive age is 5 years, and the reproductive rate is one calf per 2 years per mature female. The figure illustrates the fact that modelling then shows that, with those not unrealistic assumptions, the herd will become extinguished in 12 years or less if it is started with fewer than 6 animals; if it is started with six or more animals it will thrive and continue to expand. The average age of the surviving herd stabilizes at about 6.5 years.

Figure 4. Relation between camel herd size and distance of dwellings from the nearest well among the Rendille of Marsabit in Kenya. Data from: Schwartz, H. J. - "The transport Camel of the Rendille of Marsabit" - in: Cochrill, W. R. - *The Camelid vol 1* - Scandinavian Institute of African Studies, 1984.

Figure 5. Seasonal variation of the proportions of milk, meat and grain in the diet of the Kel Tameshek Tuareg. Data from: - Smith, S. E. - "Environmental Adaption of Nomads in the Sahel" - in: Weissleder, W. - *The Nomadic Alternative* - Mouton Publishers, Paris, 1978.

Figure 6. Rock paintings showing camel riders with lances or javelins. a. and b. fig. 60, p. 131, and c. fig. 35, p. 135 reprinted by permission from: Bulliet, R. W. - *The Camel and the Wheel* - Harvard University Press, Cambridge, MA, 1975. ©1975 by the President and Fellows of Harvard College.

Figure 7. Different types of camel saddles - schematic drawings. Reprinted by permission from figures 15, 27, 54, 59 in: Bulliet, R. W. - *The Camel and the Wheel* - Harvard University Press, Cambridge, MA, 1975. ©1975 by the President and Fellows of Harvard College.

Figure 8. Stages of the development of the techniques of military use of the camel in the Middle East.

Figure 9. Hierarchic System of the Tuareg, illustrating the relation of the nomadic warrior nobles and their vassals to the sedentary farmer, slave, and craftsmen classes. Reprinted by permission from: figure 1, p. 14, Göttler, G. - *Die Tuareg - Kulturelle Einheit und Regionale Vielfalt eines Hirtenvolkes* - ©DuMont Buchverlag, Köln, 1989.

Figure 10. Comparison of the migration pattern of the camel owning Ruala bedouins of the Nefud desert (a) with that of predominantly goat- and sheep-herding Beni Mguild of the Middle Atlas (b). Reprinted by permission from figure 3, p. 41 and figure 12, p. 101 of: Johnson, D. L. - *The Nature of Nomadism* - The University of Chicago, Department of Geography Research Paper No. 118, Chicago, IL, 1969.

Figure 11. Changes over about 1300 years in distribution of population in the Southern Atbai in the Eastern Sahel by size and number of individual sites to illustrate one kind of archaeologic evidence of nomadization. (a) - earliest and (b) latest of the period represented in Sadr's materials. Reprinted by permission from figures 4.1a and d, p. 54-55 of: Sadr, K. - *The Development of Nomadism in Ancient Northeast Africa* - ©University of Pennsylvania Press, Philadelphia, PA, 1991.

Figure 12. Changes in relative settlement intensity and in the proportion of camel bone refuse in middens in successive strata of Tell Hesban, illustrating the disappearance of camel bone in the refuse accumulating during the period of strong government under the Roman Empire. Data from LaBianca, Ø. S. - *Heslan 1 - Sedentarization and Nomadization* - Food System Cycles at Hesbanand Vicinity in Transjordan - Hesban Expedition Reports - Inst. of Archaeology and St. Andrews University Press, Berrien Springs, MI, 1990.