CHAPTER - VII

TERRAIN FACTOR CONTROL OVER LION HABITAT

PREAMBLE

The distribution of various faunal species (both carnivores and herbivores) has been usually attributed to the vegetation, which in turn is controlled by various climatic factors.

The present study, which includes a detailed survey of geology, geomorphology, soil type and quality, and quantity and quality of surface and subsurface water, has invoked a hypothesis which highlights the control of various terrain attributes over the lion habitat.

HYPOTHESIS

The author's premise is that a definite relationship exists between terrain factor (topography and soil type) and the distribution of lions. In Africa, areas having extensive lion distribution are mostly vast tracts of flat or gently rolling land. To highlight this geological control, a superimposition of past Asian, present Indian and African, and East African lion distribution over relevant soil maps have been made (Fig. 43,44,45,46& 47). Interestingly, a majority of the lion distribution falls on soils derived by the process of lateritization.

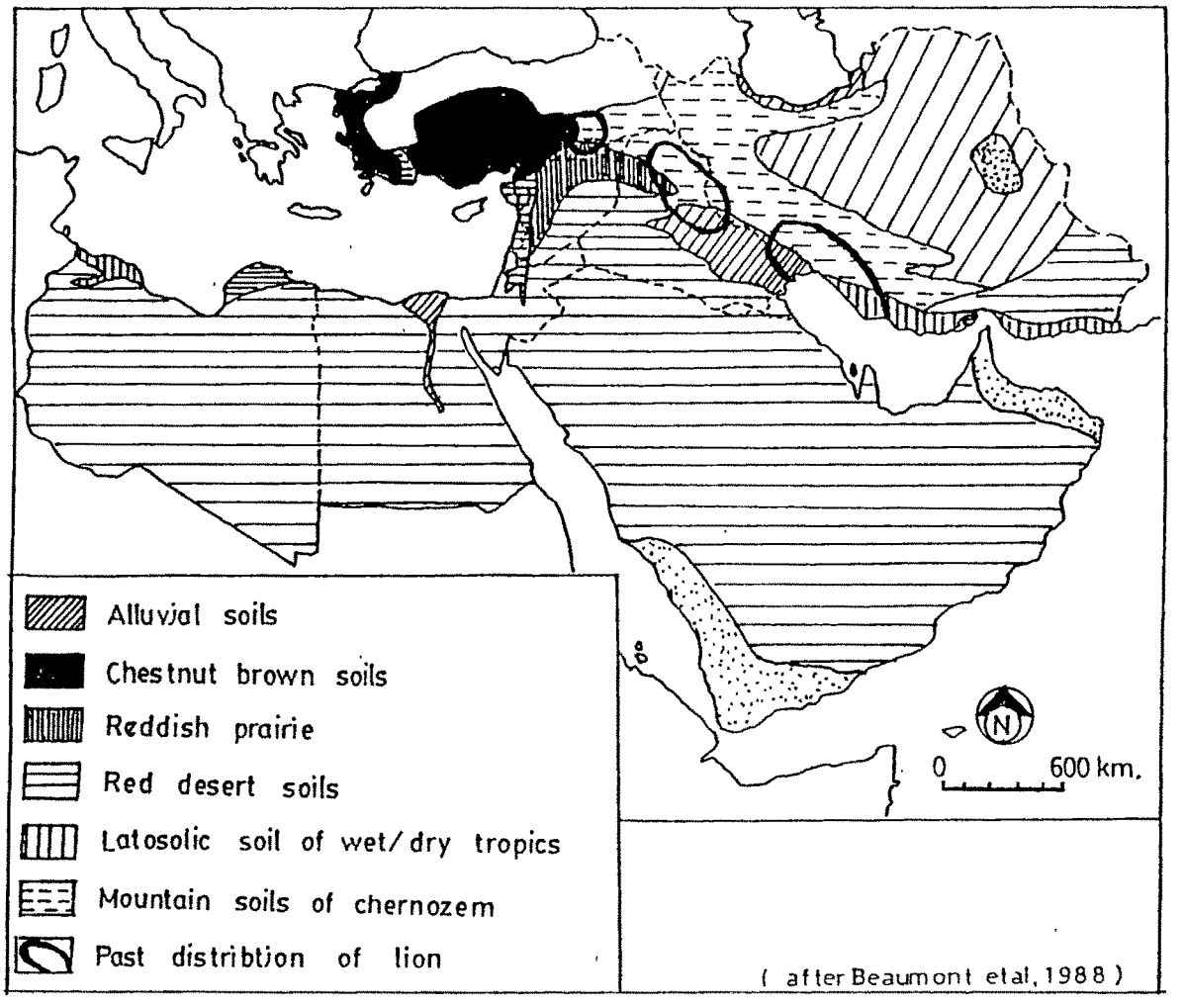
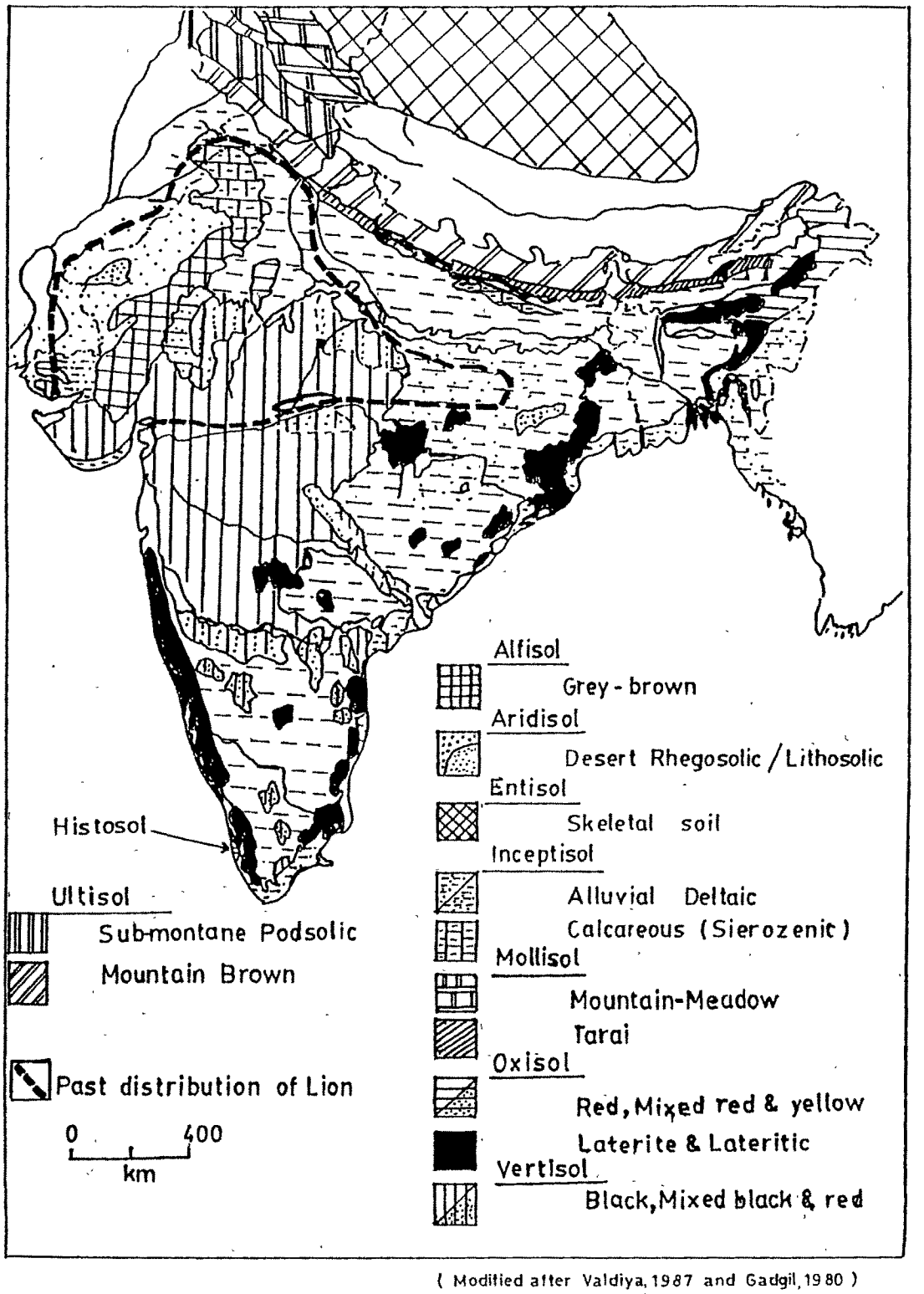


FIG. 43. PAST DISTRIBUTION OF LIONS / SOILS OF MIDDLE EAST



(Modified after Valdiya, 1987 and Gadgil, 1980)

FIG. 44. SUPER-IMPOSITION OF LION DISTRIBUTION / SOILS OF INDIA

Past distribution of lions in India is shown by dark broken line

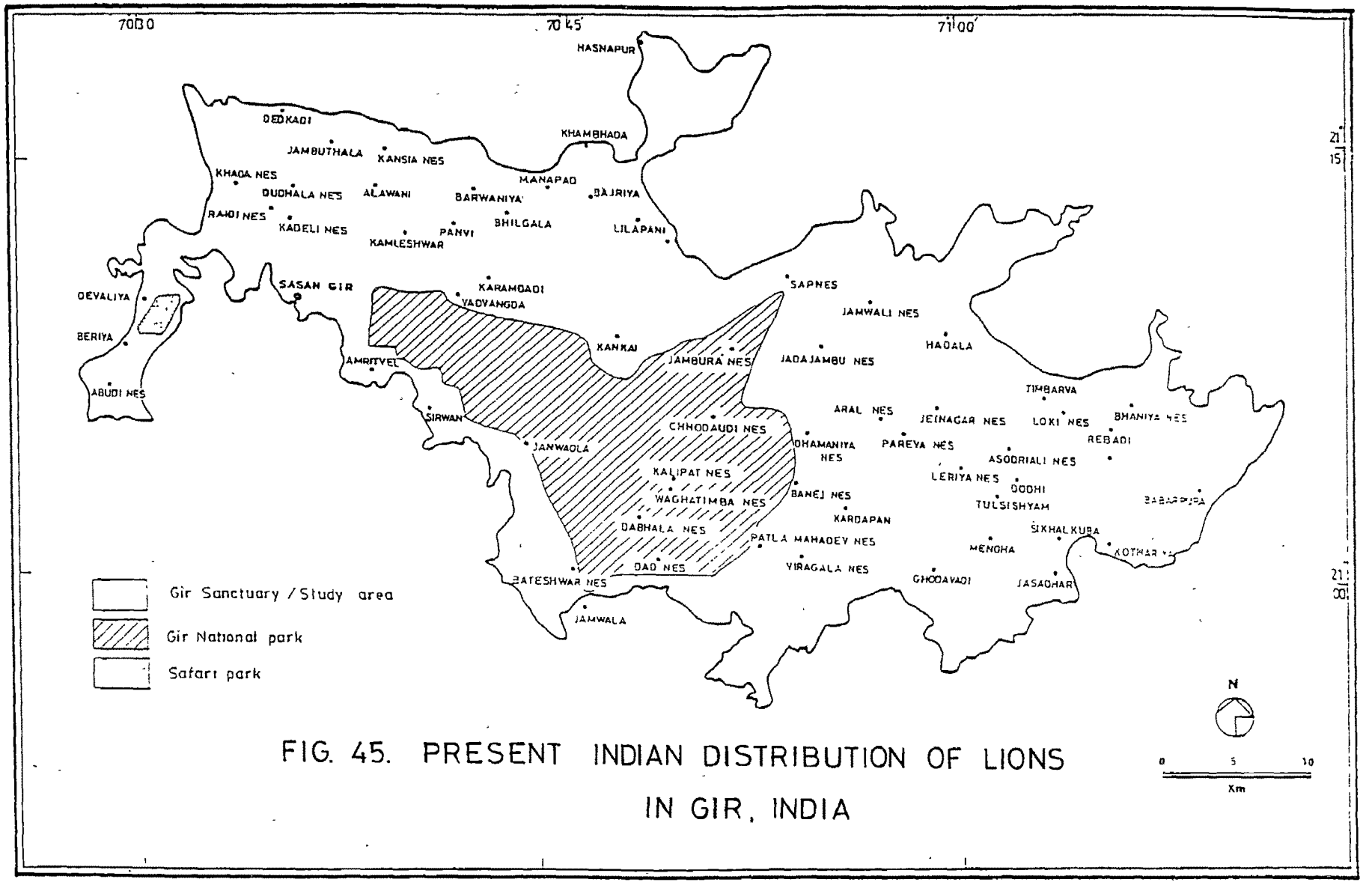
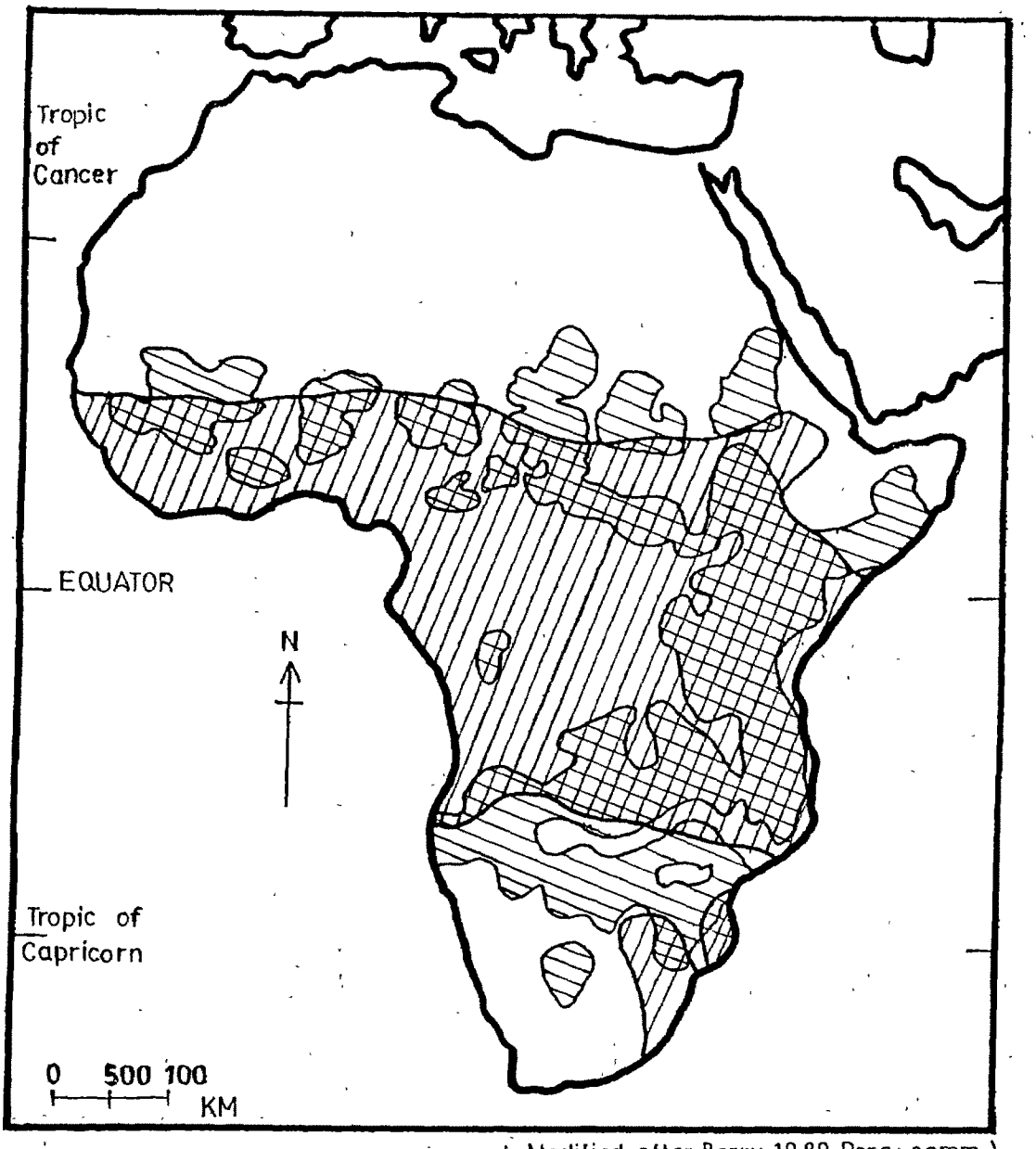


FIG. 45. PRESENT INDIAN DISTRIBUTION OF LIONS IN GIR, INDIA



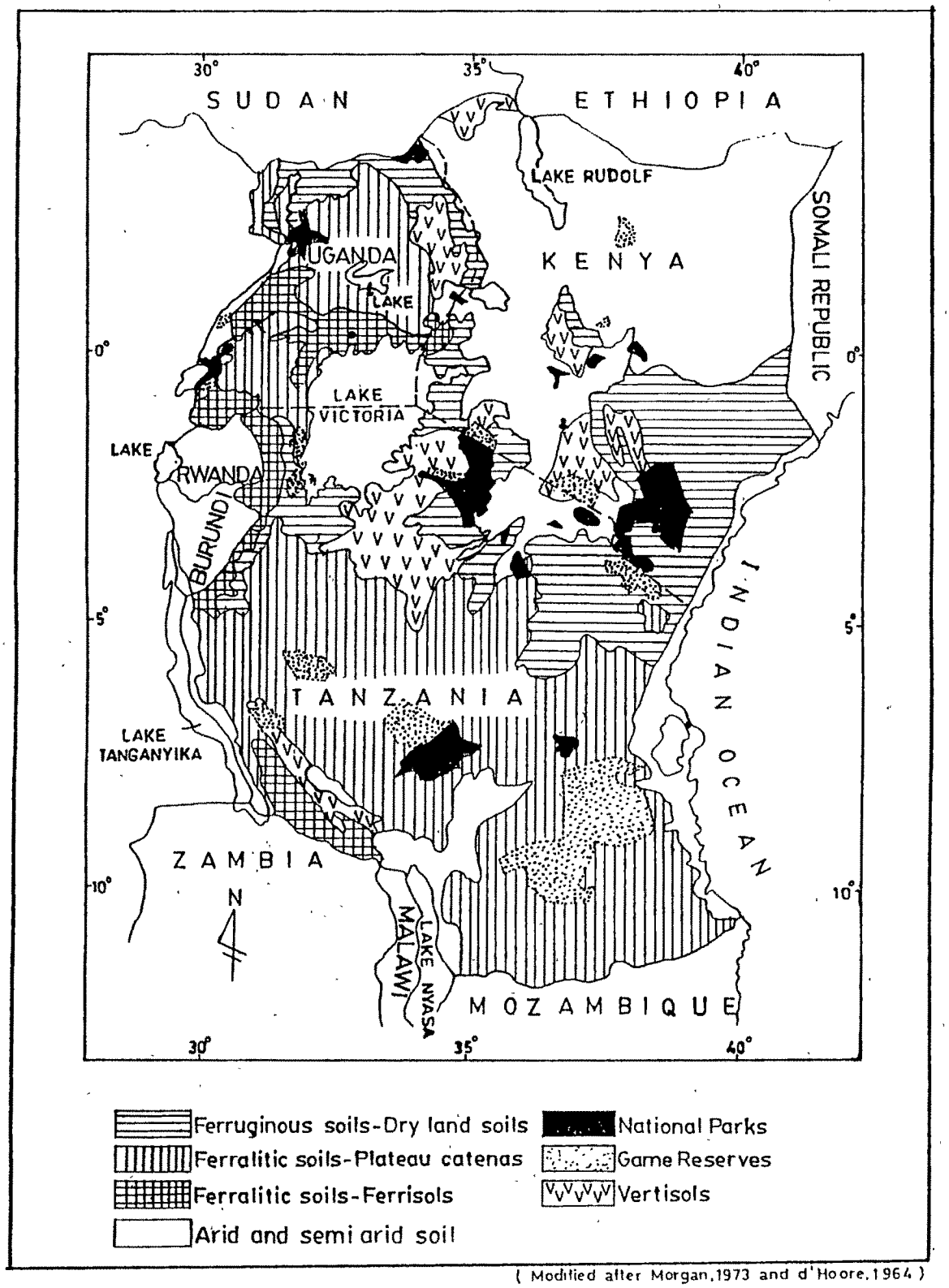
(Modified after Berry, 1989, Pers; comm.)

Areas of Latosols

Distribution of Lions

Distribution of Lions on Latosols

FIG. 46. PRESENT AFRICAN LION DISTRIBUTION SUPERIMPOSED ON AREAS COVERED BY LATOSOLS



(Modified after Morgan, 1973 and d'Hoore, 1964)

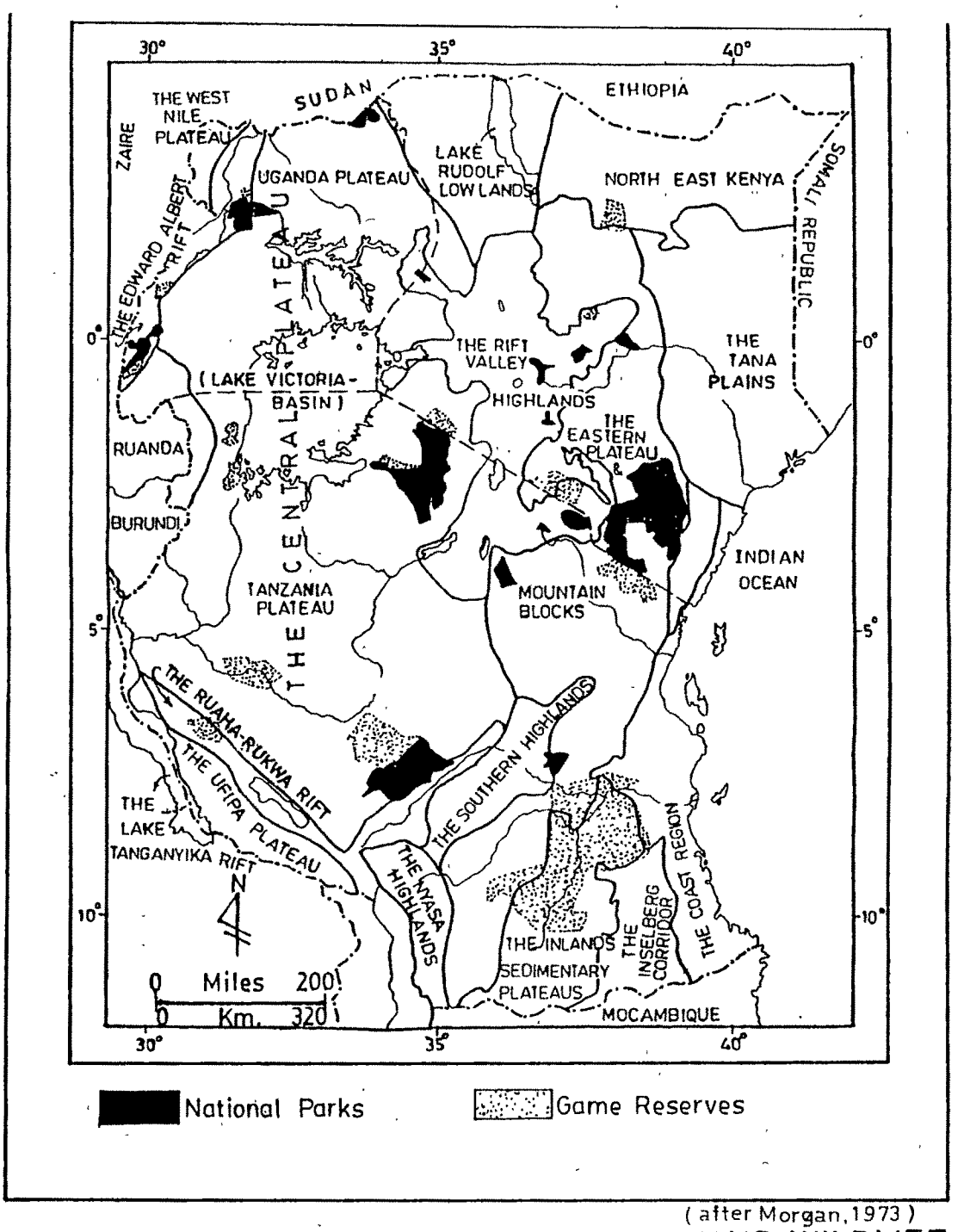
FIG. 47. SUPER-IMPOSITION OF THE VARIOUS WILDLIFE SANCTUARIES ON SOIL MAP OF EAST AFRICA

Lateritic rocks provide areas that are gently undulating or nearly flat, and such flat laterite areas with their characteristic soil cover constitute an ideal habitat of the lion, affording it greater visibility, airiness, large tracts of land without any natural hurdles, providing ample space to chase and hunt. To establish this geomorphological and geological control on lion's habitat preference, a superimposition of the physiographic map/game reserves having lion population in East Africa has been made (Fig. 48), and it is observed that nearly all of the National Parks and Game Reserves are located on dominantly lateritic plateaux. Though, there are some exceptions with, some national parks being located in mountainous or hilly areas, but then a major part of such national parks do include surrounding low flat lands, providing ample hunting grounds for the predators.

In India, the Gir area in Saurashtra (Gujarat) is the only abode of the Asiatic Lion (Panthera leo persica). The topography of the Gir Lion Sanctuary no doubt is rugged (Fig. 15), but it is surrounded by gently rolling land which used to be a thick forest in the past and served as hunting grounds for the lions. But, now the flat part of the lion habitat has been gradually converted into agricultural fields and human settlements.

LION DISTRIBUTION : A HISTORICAL AND GEOGRAPHICAL PERSPECTIVE

At present, lion distribution is restricted to some areas in



(after Morgan, 1973)

FIG. 48. SUPER-IMPOSITION OF THE VARIOUS WILDLIFE SANCTUARIES ON THE PHYSIOGRAPHIC MAP OF EAST AFRICA

the African continent and in the Gir area of Gujarat state, India. In both these cases, the animal is not an indigenous one and perhaps came from Central Europe. A millineum ago, Europe had an ample lion population, as borne out by their mention in many legends. The lion made its first appearance during the Cromer interglacial (1 m.y. ago), the warm interval between the first and second (Gunz-Mindel) glaciations. The lion being essentially an inhabitant of mainly open country, withdrew from post-glacial Europe when it became densely forested, probably disappearing from most regions during the Azillian period of the Neolithic (8000 B.C.) (Guggisberg, 1975).

From its original home in Central Europe, the lion spread south-eastwards into north-western Asia from where it diverged southwards (Fig. 49) through Palestine and Egypt into Africa, where due to ambient habitat conditions it fluorished, subsequently establishing its dominion practically throughout the entire continent excluding some equatorial forests and the Sahara.

During subsequent migrations, it came eastwards towards Arabia and then southwards through the northwest passes, into India (Fig. 49). Among the countries of the Middle East, lions were abundant in Iraq, and even more so in Iran, where they were met along the lower reaches of the Tigris and Euphrates (Fig. 43) (Kinnear, 1920). In Iran, lions existed

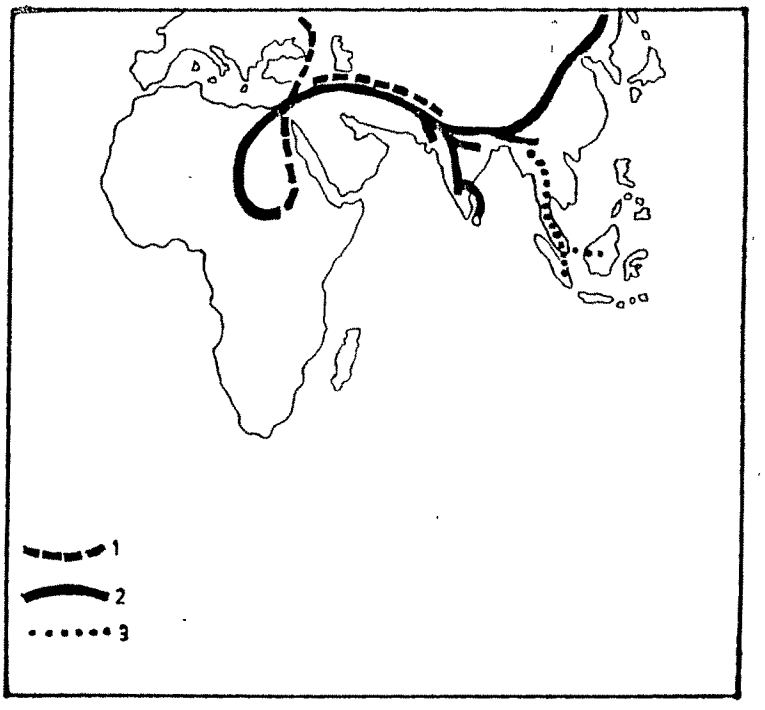


FIG. 49 MIGRATION ROUTE OF LIONS FROM EUROPE TO AFRICA AND ASIA

(after Tiwari, 1985)

Broken line shows migration towards Africa (e.g. Crocuta). Bold line shows migration towards Oriental region (e.g. New forms like Lion, etc.). Dotted line shows migration towards S.E. Asia (old forms like civets, mouse deer, etc.).

in considerable numbers on the coastal side of the oak-bearing Kubha-Ye-Zagros mountain chain and in the riverain forest of Khuzestan. The dense reeds of Dasht-Ye-Arjan valley were ideally suited for lionesses to drop their litters. Lions did not cross the mountain chain into the valleys of the Persian interior (Layard, 1887).

Evidence of lions in the largely barren interior of Iran, Afghanistan and the western-most portion of Pakistan is lacking for the past 200 years. However, since lions colonised India from the west, they must have certainly crossed this area. In Pakistan, it was common along the Indus and its tributaries (Joslin, 1973).

In India, lion distribution has been reported throughout the northern plains, upto Bengal in the east, but not beyond the Narmada river in the south (Fig. 44). This sudden stop in the proliferation of the lion, is indicative of its relatively recent arrival in India, dating not more than 6000 B.C. (Rashid, 1965).

The Gir Forest

The Gir forest of India, is rugged and hilly, particularly the northeastern and western portions, with the Gir hills, a low range of volcanic origin, varying in elevation from 131 to 587 m above mean sea level, surrounded by flat lands all around; the eastern portion of the sanctuary being a rolling

Acacia savanna, with Anogeisus latifolia replacing Teak (Tectona grandis). The geological scenario consists of basalt, dolerite and limestone. The soil type varies from ferruginous in the north and east, to vertisols in the southwest and along the river valleys.

In the past, lions were mainly centered in the Gir, which was then a compact block of forest over 5000 sq.km in extent. In the early part of the century, the Gir forest was connected with the Girnar and Mitiyala hills by corridors of rough semi-wooded and sparsely populated country, as also with the Barda and Alech hills, and the wild wooded strip between Dhank and Chorwad along the sea-coast (Fig. 50). This enabled the Gir lions to commute freely to and from these pockets at will. By 1908, expanding cultivation divided the Gir into three parts (Fenton, 1908).

In the Gir forest, the lion found its movement restricted and started struggling for existence, due to a steady loss of habitat by the huge influx of domestic livestock and annual fires which destroyed the natural vegetation and accelerated the process of xerification, resulting in an alarming decline in the population of wild ungulates which constituted the natural prey of the lion.

The area of the Gir forest was reduced to about 2590 sq.km at the beginning of the present century. Two decades ago it had shrunk to about 1295 sq.km (Oza, 1974). At the moment,

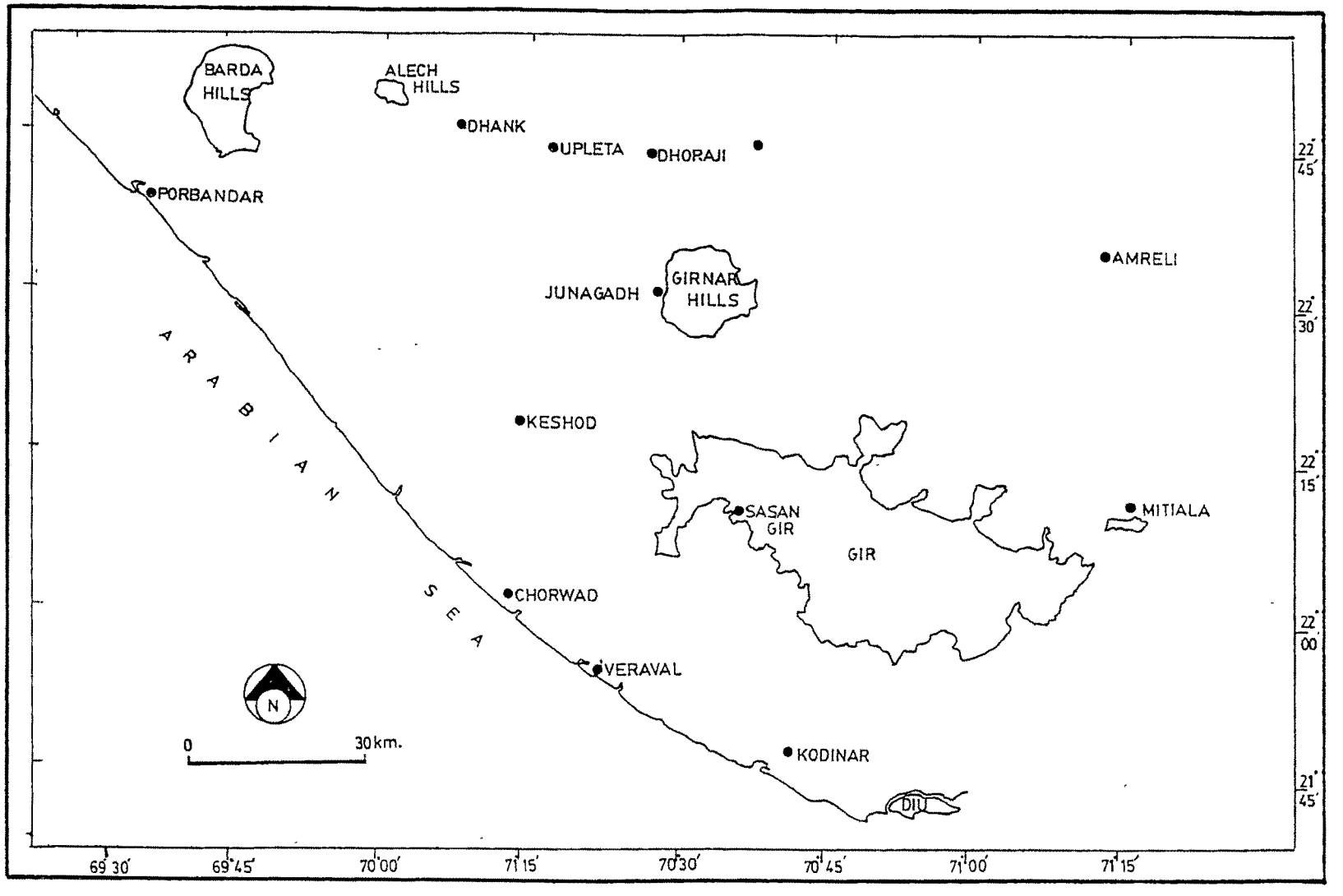


FIG. 50. PAST AND PRESENT LOCATIONS OF LIONS IN AND AROUND GIR FOREST

In past forest corridors radiating from Gir to Barda, Alech & Girnar hills, Dhank and Mitiyala covered an area of about 5000 sq. km. Bold lines show present forest pockets with Gir as the only abode of Asiatic lion.

the Gir Wildlife Sanctuary has an area of only about 1412.13 sq.km with a national park/core area of 258.71 sq.km (Fig. 45). Further the forested area outside the sanctuary has decreased from 1850 sq.km in 1871 to 240 sq.km in 1969 (Sinha, 1987).

Lions were found within the Gir hills and to some extent in the surrounding lowlands. Most of the hills were designated as Gir Wildlife Sanctuary, and used primarily for domestic grazing, forestry and tourism. But in the course of time, the surrounding low lands were increasingly cultivated, so much so, that at present almost 70% of the land adjacent to the sanctuary is now under cultivation.

Thus, what was a "lion's true habitat" has now been converted into land used for human habitation, cultivation and pastoral purposes.

TERRAIN CONTROL

The terrain factor (topography and soil type) had a distinct control over the distribution of lions. In Africa, areas having extensive lion distribution are mostly vast tracts of flat or gently rolling land. To highlight this geological control, a superimposition of past Asian, present Indian, African, and East African lion distribution over relevant soil maps have been made (Fig. 43,44,45,46 & 47). Interestingly, a majority of the lion distribution falls on soils associated with intense planation surfaces.

These planation surfaces are characteristically gently undulating or nearly flat, having typical soil associations, and provide an ideal habitat for the lion, affording it greater visibility, airiness, large tracts of land without any natural hurdles, providing ample space to chase and hunt.

To establish these terrain controls over the lion's habitat, a superimposition of the physiographic maps on game reserves having lion population in East Africa (Fig. 48) was made. It is observed that nearly all of the reserves are located predominantly on planation surfaces (lateritic plateaux). The soils associated with these planation surfaces are (i) ferruginous soils, (ii) ferralitic soils - plateau catenas, (iii) ferralitic soils (ferrisols), and (iv) vertisols - locally called 'black cotton soils' (associated with mottled grey loamy sands containing groundwater laterite. The formation of all these soils varies with the degree of slope and drainage. In fact, the various ferruginous soils mentioned above are found occurring as plateau cappings on low hills and gently undulating terrains, supporting grasslands, savannas, etc. due to their resistance to erosion, good granularity and permeability (Valdiya, 1987).

There are some exceptions to this rule, with some national parks being located in mountainous or hilly areas. But, a major part of such national parks include peripheral low lying, gently undulating to flat lands, providing the ideal hunting grounds for the predators.

Such gently undulating or flat lands area ideal lion country, since a rugged terrain would be unsuitable for chasing prey which would then have the advantage of making a quick getaway. Chadwick (1983) has described the Etosha National Park, Namibia, as "where the landscape is so lean and level, there is truly a kingdom of animals". This is relevant and pertinent to the many national parks in Africa having heavy lion populations viz. Etosha, Serengeti, Manyara, Masai Mara, Tsavo, etc.

Terrain of the Gir

The present extent of the Gir Sanctuary is a combination of, geomorphologically speaking, rugged hills (Gir National Park), highly and moderately dissected plateaux, buried pediments and pediplains (along the periphery), and valley fills (Fig. 13). The scenario is that the Gir National Park is supposed to be the `Sanctum Sanctorum´, but it is in fact highly rugged, whereas the peripheral areas are rolling to gently undulating. When the ruggedness of the `Sanctum Sanctorum´ is compared to the flatness of the Gir lion´s `parent country´ i.e. Africa, the habitat is contrary to that of an ideal lion country.

TERRAIN SUITABILITY

The Gir lion does not differ much in habits from its counterpart (African lion), since, they prey mainly on game

and cattle, finding the latter much easier to kill then the wild ungulates which constitute their natural prey (Rashid, 1983). The lion population in the Gir, declined from about 250 in 1965, when 46% were found in the low lying gently undulating forest lands outside of, but adjacent to the rugged sanctuary area, to 177 in 1968, when 17% were found outside the sanctuary (Joslin, 1973). The decrease in lions can be correlated with the loss of ideal habitat viz. the peripheral gently undulating forest area which was cleared for grazing and cultivation.

Sinha (1987) has shown that the home-range of Gir lions essentially comprised flat to gently undulating areas along the periphery of the National Park and adjoining flat areas outside the sanctuary. Discussions with the forest officials as well as local villagers revealed an overwhelming agreement on the fact that lions are abundant in the peripheral low lying and gently undulating areas (Fig. 17) and scarce in the heart of the Gir (National Park area) which is highly rugged.

The possible reasons are :

(i) Scarcity of surface water (Fig. 37) due to the ruggedness of the terrain which is inconducive for water retention, and affords high run-off.

(ii) Stringent conservation measures in the National Park area has resulted in the dense growth of vegetation (including 5′ high grass-Plate : 38).

Plate 38 - 5′high grass which is so common in the national park area.

This has resulted in :

(a) Scarcity of natural prey species which feel insecure owing to poor visibility and the degree of difficulty in fleeing from the predators.

(b) Sinha (1987) has indicated that Spotted Deer (Chital) and livestock are the dominant prey species for the lions. After the declaration of a 258.71 sq.km central core area as the 'Gir National Park', the Forest Department has resettled the maldharis and their livestock outside the national park area. This created scarcity of the easily available domestic livestock. Moreover, Khan (1990) notes that Chital (another dominant prey species) achieved its maximum density (based on vehicle count, 1987) in sanctuary-west (63.4 + 7.8%) as compared to National Park (45.4 + 7.4%) and sanctuary-east (20.3 + 9.4%). Diversity of habitats, an abundant food supply in terms of palatable Acacia and Zizyphus species, year round availability of water and flat areas, are some of the factors which makes the sanctuary-west an optimum habitat for chital in Gir.

Thus, both the preferred prey species are scarce in the national park as compared to the sanctuary area.

Even if the natural prey is present, the lions find it difficult, except near water sources, to hunt due to

the highly rugged terrain which affords a swift getaway for the nimble and lightweight herbivores.

(c) The dense vegetation does not afford the lion extended visibility, airiness and large tracts of land without natural hurdles to enable it to chase and hunt.

(iii) Schaller (1967) has marked that the movement of predators have been shown to be influenced by the abundance of the prey species.

In the Gir, the abundance of chital outside the national park in the flat areas, is probably controlling the habitat occupance of lions. Moreover, as domestic livestock is not permitted into the national park and are allowed to graze in the peripheral flat zones (coinciding with the natural habitat of chital), the lions tend to follow these easily available prey.

DISCUSSION

Historical records have shown that lions in the Gir preyed on the domestic livestock of the maldharis, as proved by the classical studies of Joslin (1973) and Berwick (1974). These studies showed that nearly 75% of the lion's food came from domestic stock. In contrast to this, Sinha (1987) has shown that 48% of the kills were of domestic stock. The reason for

this large value difference could be the fact that in 1970, there were 129 nesses with an abundant livestock within the sanctuary and the wild ungulate population was only 6502; while in 1985 (due to better protection & management) there were only 50 Nesses with > 13000 cattle population and a rising population of 16905 ungulates, thereby providing a large number of natural prey for the lion (Plate. 39). Another reason could be that the '80s was a decade of water scarcity and caused heavy concentration of ungulates along scarce water sources, thereby increasing the probalility of a natural prey being killed by lions.

However, Khan (1990) maintains the fact that the domestic livestock still contribute significantly to the lion's diet in western Gir and totally dominates in eastern Gir. The reason for this could be the fact that the maldhari settlements (Nes) are located along valleys, in flat to gently undulating terrain, coupled with the fact that the domestic livestock are ponderous in their movement, providing an easy kill, whereas the wild herbivores being much swifter may escape into the rugged zone.

This behavioural pattern of Asiatic lion/Gir lion is very peculiar when a comparision of the predator- prey ratio of Gir and other African national parks was made (Table : 26). The ratio nearly equals that of Etosha, which is supposed to have one of the highest predator-prey ratio (Berry, 1983). In

Table - 26

Predator-Prey ratios

(excluding competitors like Cheetah in Africa and Panther in India)

AFRICA

National Park/ Sanctuary	Predator-Prey Ratios	Area (in sq.km)
Etosha	1 : 72-105	22,268.82
Kruger	1 : 57-149	N.A.
Manyara	1 : 174	N.A.
Serengeti	1 : 250-300	14,500

(Berry, 1989; pers. comm.)

INDIA

Gir Wildlife Sanctuary Area = 1412.13 sq.km

Year	Predator-Prey Ratios	Lions	Natural Prey-species
1970	1 : 34	190	6502
1974	1 : 54	180	9847
1979	1 : 73	205	14964
1985	1 : 70	239	16905
1990	1 : 115	284	32792*

(* based on road count; source : Forest Dept.,1990).

Year	Lions	Prey-species
1974	05.50% decrease	28.56% increase
1979	12.20% increase	35.61% increase
1985	14.22% increase	11.48% increase
1990	15.84% increase	48.45% increase

Plate 39 - Lions on natural prey kill.

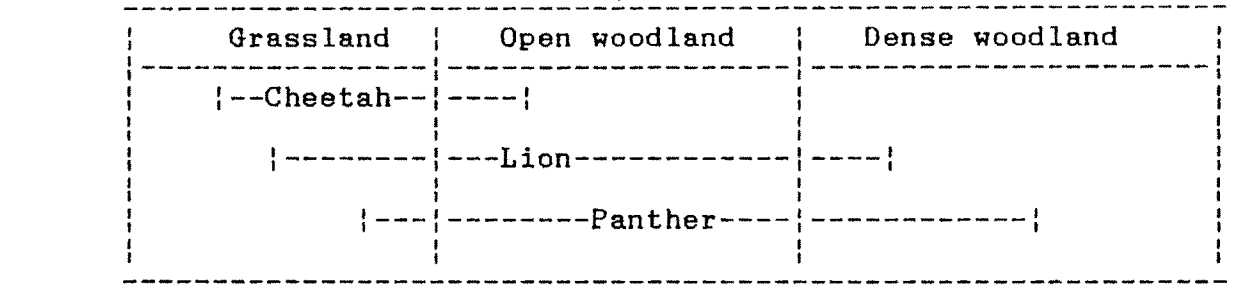
fact, Gir has too many lions in relation to the available prey species and sanctuary area. This is aptly supported by Berwick's (1974) statement that in the Gir forest the lions may be maintained at a higher than natural level because of the availability of domestic stock.

The national park area, as mentioned earlier, is hilly and rugged and is bereft of human population and their domestic livestock. While the ruggedness of terrain makes it difficult for the lion to hunt the natural prey, it is not impossible, as the prey would be available at waterholes located in the intermontane valleys. If the prey regularly escaped due to the rugged terrain, the lions would have to leave the rugged area and move to the peripheral zones where domestic stock was easily available. In fact, in the past, the peripheral gently undulating forested area used to serve as an ideal hunting ground for lions mainly due to the flatness of terrain.

Like the Cheetah and Panther, the lions also require flat plains, grassland or open woodland for hunting (Table : 27). In the Gir, the conversion of the peripheral gently undulating forest lands into agricultural fields, forced the lions to take shelter in the rugged Gir hills bordering the plains, while making frequent forays into these peripheral zones for hunting the domestic stock (Table : 28).

Table - 27

Ecological separation among the major carnivores



(after Lamprey, 1963).

In the last three to four years, frequent reports indicate that the Gir lions have started wandering from what is supposed to be the "only abode of the Asiatic Lion". The attraction of a particular habitat for any animal may have different origins. So, in reality, the present behaviour of the Gir Lions, is nothing but a deep rooted stimulus searching for a more ideal habitat. A further arguement is the male territory availability in Gir. The sanctuary area comprises of only 1412.13 sq.km with each male requiring a territory of nearly 40-50 sq.km or even more. This would mean that an area of nearly 5000 sq.km would be required to satisfy the territorial needs of all the males in Gir. Considering that lions live in prides (and if about 50 male leaders are considered) then also at least an area of 2500 sq.km of flat, natural savanna/open woodland is essential to prevent the spill-over which has become a common feature.

Table - 28

Kills made by lions outside Gir Sanctuary during 1980-82

Taluka	No. of villages	Livestock Killed				Number of human beings mauled	
		80-81		81-82		80-81	81-82
		No.	%	No.	%		
Mahuva	133	013	02.0	009	01.2	1	-
Khambha	36	016	02.4	015	02.0	1	-
Maliya	63	032	04.8	048	06.3	-	4
Kodinar	64	037	05.6	056	07.3	-	-
Dhari	88	065	09.9	039	05.1	-	-
Una	187	079	12.0	145	19.0	-	2
Visavadar	98	095	14.4	097	12.7	3	2*
Mendarda	46	123	18.6	137	17.9	1	-
Talala	96	200	30.3	213	27.8	2	-
Savarkundla	81	-	-	004	00.5	-	-
Veraval	102	-	-	001	00.1	2	-
Jafrabad	44	-	-	001	00.1	-	-

(after Sinha, 1987) * 1 person killed.

APPLICATION

The increased population has intensified territorial competition and conflict among the lions in the Gir. The capacity of the Gir to harbour increasing lion population has now reached a saturation point or in other words, as Chavan (1982, pers. comm.) puts it "the Gir lions have already crossed the carrying capacity". The per capita territory for the lions has shrunk as the area is too small. Since, the Gir has become congested, the lions are frequently migrating to new areas in search of accomodation in form of forested grooves. There are about 284 lions in the Gir staying in just 1412.13 sq.km. With exploding lion population, new prides are coming up. No two prides can share a common territory. Territorial conflicts are occurring between the lions, and only those who are stable and strong are able to retain their territory, with old prides being displaced. The displaced lions are moving out of the Gir in search of fresh territory. In fact, the lions virtually want to regain 2560 sq.km of their territory which they occupied in 1956, when the population was 290.

The recent spill-over of lions in the Gir has prompted officials into looking for an alternate home for them. The Barda Sanctuary (Fig. 50) has been quoted as one of the possibilities. But, this could be an excercise in futility as the terrain would be hilly, making it unamenable for lions to live in.

Wildlife experts and forest officials are frequently faced with the problem of finding an alternative home for wildlife species due to varied problems. The main aspects considered while finding a suitable alternative abode are vegetation, prey base and availability of water. It would be worthwhile to consider the terrain affinity of the various wildlife species to be translocated in conjuction with floral, faunal, and hydrological parameters, as discussed above.