

Hornbill

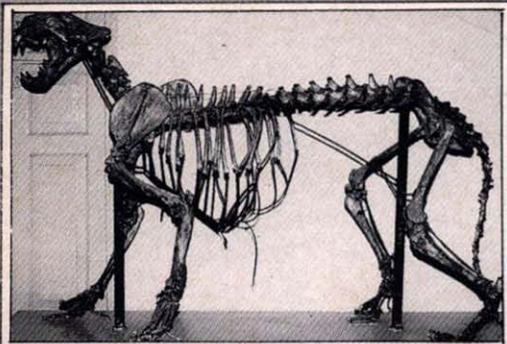
1993 (1)



BOMBAY NATURAL HISTORY SOCIETY



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EDITORIAL

Playing with numbers

Nothing seems to generate more heat in wildlife conservation circles in the country than the estimate of the number of tigers presently existing in India. It started from the time that E.P. Gee 'threw the bones' and came up with an estimate of 40,000 at the turn of the century in his book, *The Wildlife of India*, published in 1964.

The late Dr Salim Ali, while reviewing Gee's book, wrote: "Whatever the accuracy of these figures, the decline within recent years has certainly been cataclysmic and alarming. As no proper censuses have been taken and the author's present-day estimates must largely rest upon his own limited observations plus not too reliable local testimony, they must of course be taken with reserve and as purely subjective, as they are clearly meant to be. He may be right in feeling that *some* estimate based on reasonable premises is better than no estimate at all; but the reviewer cannot help admiring his courage in estimating the 'probable' populations of 50 years ago, for which even fewer and less reliable data are available. It is nevertheless the firm belief of the reviewer — and doubtless of others with experience of conservation too — that unless we have fairly dependable censuses, any measures for the preservation of a species are bound to prove shots in the dark".

The answer therefore centres around "fairly dependable censuses". In this issue Ullas Karanth cogently examines the methods used in the annual *mela*, where genuine data cannot be distinguished from manufactured data — yes, manufactured, by lower level forest officials too lazy to go out into the field. The blame rests largely with the governments, in their inability to accept populations except those which increase every year. In probably the first exercise to try and obtain population figures, I gave an estimate of less than 2500, based on a questionnaire circulated throughout the country (*JBNHS* vol. 67: 227-34). I was left with the feeling that continuous monitoring is the only viable method. I had since then often suggested that sight records of tigers be plotted, and maintained and updated on range maps in range offices; but this apparently is too much trouble.

However, whatever may be one's opinion on population figures, it cannot be denied that the tiger did prosper substantially under Project Tiger. Whether the momentum will be maintained in the face of the severe pressures now being faced by tiger populations will determine whether the tiger will continue "burning bright.. in the forests of the night," or rest in bottles in Chinese medicine shops.

J.C. DANIEL

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Tiger (*Panthera tigris*)
Painting by Dattatraya Padekar

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A photograph of two tigers resting in a forest. The tigers are lying down, facing forward, with their heads close together. They have orange fur with black stripes. The background is a dense thicket of trees and branches, with some light filtering through. The overall tone is natural and somewhat somber.

HOW MANY TIGERS? *Field censuses in India*

K. ULLAS KARANTH

The long-term prospects of the tiger surviving as a free ranging species depend largely on its chances of doing so in India. Indian tigers constitute over half of the estimated total wild population, and are distributed over a large area and a diversity of habitats. And the scale and scope of the Indian tiger conservation strategy seems to be unmatched elsewhere.

Photo: S. Nagaraj / DPA

THIS STRATEGY HAS two major thrusts. One is the spectacular Project Tiger. The other less publicized, but perhaps even more effective initiative was the Wildlife Protection Act of 1972. This resulted in the creation of many more nature reserves, covering an even larger area of tiger habitat, than Project Tiger. Though the inspiration for these strategies came from international and Indian conservationists, they were essentially formulated and implemented by India's foresters.

There was no dearth of constraints — growing human and livestock populations, public apathy or hostility, lack of funds, difficult working conditions and a lack of tradition in wildlife management. In spite of these hurdles, Indian foresters have been effective — far beyond expectations — in controlling poaching of tigers and their prey, and protecting their habitats from the ravages of excessive fires, stock grazing and wood removal. There are detailed (if somewhat anecdotal) accounts by Indian wildlifers of increased instances of tiger sightings, reproductive success, intraspecific aggression, cattle killing and even manslaughter — all attesting to an increase in tiger densities at many localities.

Indian wildlife managers have tried to quantify this increase in the tiger population using periodic censuses. The censuses show a phenomenal increase over the years almost throughout the country: from 1,827 tigers in 1972 to 4,334 in 1989 (the 1992 figures are even more controversial than earlier censuses). But how accurate are the numbers? And what do they reflect on Indian wildlife management?

WHEN TIGER CENSUSES began in the early 1970s very few studies had been done on the ecology of large carnivores in south Asia. Today the situation is qualitatively different. Long-term studies in Nepal and India have considerably enhanced our knowledge of the tiger, its co-predators and its prey species. With this somewhat clearer understanding of tiger ecology, an attempt can be made to examine the ecological and management implications of Indian tiger censuses. I believe such a review is urgently needed for three reasons.

Firstly, the population boom reported from field censuses seems to have generated some public complacency that the tiger has a more or less secure future in India. Secondly, in the context of increasing

man-tiger conflicts around a few reserves, people have begun to question the need to protect more habitats when tigers are apparently abundant. And thirdly, the 1982 census data from Bandipur Tiger Reserve, an area I have been familiar with for over a decade, has shown some disquieting discrepancies.

The objective of this review is not to put down the outstanding efforts by Indian wildlife managers. It is only to critically evaluate the census data and the methodology employed, so that more objective and practicable systems of monitoring tiger populations can evolve.

FOUR QUESTIONS are important. Are the official numbers of the tiger and its large co-predators (leopard and dhole) sustainable on the basis of the published data on populations of their major prey species? Are the numbers of tigers reported from diverse habitats consistent with recent findings about their ecology and social organisation? Are the reported increases in consonance with observations of population dynamics of tigers at other localities? What are the weaknesses of the present method of monitoring tiger populations, and what improvements can be made?

Taking the question of prey — how much does a predator eat? On an average, a tiger needs about 3000 kg of live prey a year; a leopard needs 1000 kg, and a dhole 490 kg a year. The numbers may sound large, but in fact, these predators usually take only about ten per cent (sometimes less) by weight of the total available prey (or the total standing biomass, if you prefer jargon).

Does the prey base in our tiger reserves seem sufficient to support the official predator population? In several Project Tiger areas, decidedly not. Take Periyar for example. According to the 1983 figures, the total prey biomass in the reserve was 175,000 kg. If ten per cent of this amount was taken each year by the three large predators, that would be 17,500 kg of available prey. Again according to the census figures, there were 41 tigers, 15 leopards and "50 packs" of dhole, constituting about 500 of these pack hunters. Together, they would require 383,000 kg of prey each year — *twenty* times the available prey.

At Bandipur (1984 figures), the predators, had they been present, would have required more than

seven times the available quantity of prey. Similarly, in most reserves (Sariska is an exception) the biomass of prey reportedly available for cropping falls far short of the prey that would be required if the reported number of predators were present.

Looking at it another way, are the predator-prey biomass ratios consistent with those obtained in other studies? Biologists at Serengeti National Park in Africa obtained a ratio of 1:250, and at N'Gorongoro, 1:100. In a 20 sq km study area in Bandipur it was 1:124. The ratios at some of our reserves are likely to be off the mark, for example particularly at Periyar (1:15 in 1984) and Bandipur (1: 42 in 1983).

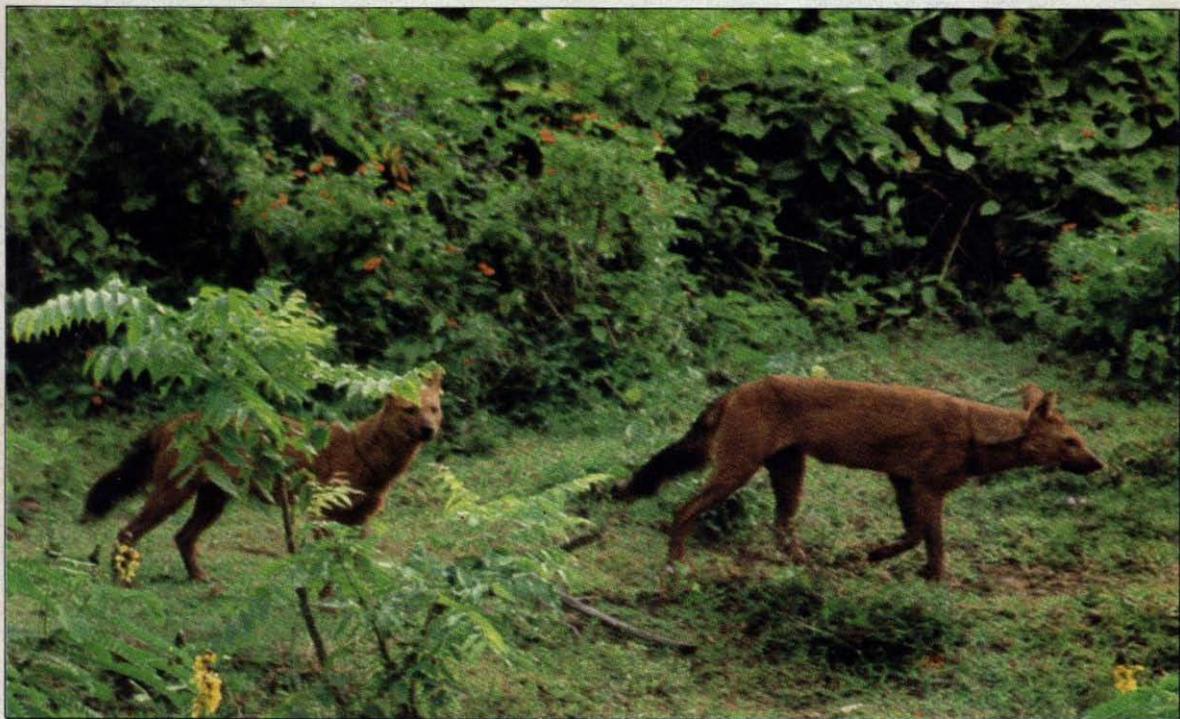
WHILE IT COULD be argued that small prey and livestock cover a part of this deficit, this will not account for the total shortfalls. These can only be attributed to over-estimates of predator populations, under-estimates of prey populations or a combination of the two.

The methods of counting prey seem to vary widely and are not reliable in *any* reserve; under-estimation of prey is entirely possible. But considering various factors such as habitat quality, estimates of

ungulate prey biomass made in India and elsewhere, etc. the problem in several reserves (particularly Bandipur, Periyar and Sunderbans) is more likely to be over-estimation of predators rather than under-estimation of prey.

The over-estimation of predator numbers is evident when the figures for density of tigers are examined. The relative densities of tigers in different habitats depend on two factors. Firstly, the availability and vulnerability of suitable prey species, which again depend on several environmental parameters (tiger densities are likely to be higher in habitats with greater densities of ungulate prey). Secondly, relative abundance of competing predators like leopard and dhole. In general, the fewer the number of competing predators, particularly dhole, the higher the density of tigers, and vice versa.

Open deciduous forests, which are good habitats for a coursing predator like the dhole, are likely to be poorer habitats for the tiger when compared to areas where the dhole is not a major predator. However, the density of tigers calculated for many Indian reserves — Bandipur, for example — are not in



The dhole is perhaps the tiger's biggest competitor. In some areas, the resident tiger has been known to move away from the area for several weeks when a hunting pack moves in.

E.R.C. Davidar



conformity with these ecological observations.

The census-based figures can also be compared with figures derived from studies in Kanha by George Schaller during 1964-65 and in Nepal by the Smithsonian Tiger Ecology Project during 1974-1985. These study areas included habitats with very high prey densities and low numbers of leopards and dholes — in other words, near optimal tiger habitats. These studies showed that really superior tiger habitats can support tigers at densities of 11-17 sq km per tiger.

The Project Tiger figures in several cases seem to be too high even for good tiger habitats. The extreme over-estimates appear to come from the Sunderbans, a habitat conspicuously lacking an adequate prey base. The explanation that Sunderbans tigers survive chiefly on aquatic creatures is as absurd as the suggestion that lions in savannas survive chiefly by eating grasshoppers!

ANOTHER CONTROVERSIAL point about the official censuses is the constant, almost relentless increase in tiger populations year after year. How fast do populations of tigers increase in the wild? Fairly slowly, according to studies conducted elsewhere. Following his Kanha study, Schaller suggested that "tiger population appears to be self limited, with perhaps a social spacing mechanism keeping numbers of animals in an area relatively constant, regardless of abundance of prey".

Charles McDougal, who monitored the tiger population closely in Chitwan for over a decade, observed an "impressive stability" — the number of breeding adults, which was nine in 1975, increased to only 14 by 1985. In Chitwan, as in Indian reserves, the tiger population was responding to vastly improved protection efforts after 1974.

When environmental factors improve, there could be a rapid but short term increase until populations reach saturation densities. Thereafter, populations may fluctuate around this saturation density.

Several reasons have been put forward for this stability in populations. Although tigers are prolific breeders, more than half of them die before they

Quite unlike other cats, tigers love water, spending long periods cooling off in a pond or stream, particularly in summer. They can swim several kilometres if necessary.

THERE'S A METHOD IN THIS MADNESS

Tigers are censused using the pugmark method, which essentially assumes that each tiger can be identified individually from the tracings or plaster casts of its tracks. Generations of shikaris have followed tiger tracks, and the art often flourished under royal patronage. Many hunters like Jim Corbett claimed that it was possible to determine the sex, age and even physical condition of a tiger from its tracks.

Often, tigers with very distinct pugmarks could be individually recognised. However, it was S.R. Choudhury who argued that *every* tiger could be individually identified from its pugmarks. He devised the present system of censusing wild tigers based on pugmarks, which was later refined by H.S. Panwar, now Director of the Wildlife Institute of India.

The method involves obtaining on a glass sheet, accurate tracings of the rear paw imprints from tracks in the field. Substrate conditions and probable date when the tiger made the tracks, stride length of the tiger as well as any noticeable abnormalities in the tracks are important. The best season for obtaining tracings should be selected and the field work carried on intensively for a week or so.

It is claimed that, based on this analysis, experienced persons can identify each individual tiger with a high degree of reliability. The reliability of this method has been questioned in the past, but since detailed reasons for the skepticism were not advanced this census method is still used exclusively.

disperse into new territories. There are only a few 'slots' for resident breeding animals in prime habitats. The young dispersers usually linger around as transients along with tigers past their prime, in poorer habitats on the peripheries, until they are able to evict a resident breeder.

In this process a large number of transients perish due to conflict with human interests or with resident tigers. Consequently, populations remain fairly stable (even if prey availability increases), with only minor changes in the number of breeding residents.

In sharp contrast, Indian census data show *long term* exponential increase rates of tiger populations in practically every reserve. Bandipur, for example, was said to have 10 tigers in 1972 and 50 in 1989. Kanha had 43 in 1972, 48 in 1976 and 100 today...

and so on. There are other minor discrepancies too — the increase rates reported for larger geographic regions such as states are also very high, in some cases exceeding those of tiger reserves!

To summarise, the analysis of census data from several Project Tiger reserves in terms of three factors — relative numbers of larger predators and their prey; densities and biomass of tigers; and long term population dynamics of tigers — indicates that the census figures based on the pugmark method are likely to be over-estimates. Therefore, the census method itself merits a critical review.

FROM MY EXAMINATION of 'tiger censuses' in Karnataka, particularly in Bandipur Tiger Reserve, several weaknesses in the present method of monitoring tiger populations are perceived. The method assumes that each individual tiger in a given population can be identified from its pugmark tracings by the average reserve manager in India. As far as I know, these assumptions have not been validated on a population of known tigers anywhere in India.

I carried out a blind test on six 'experienced' wildlife managers who had actively classified pugmarks in census operations (see box). The test results indicate that the assumptions underlying the census method are unlikely to be valid under field condi-

COUNTING DOUBLE

I carried out a blind test on six wildlife managers to try and judge the accuracy of pugmark-based censuses. Each had between four and six years of experience with tiger censusing; one had twelve years' experience.

Four captive tigers were involved in the test. I made 33 pugmark tracings in all, on two different substrates, and asked the respondents to identify for each tracing the sex of the tiger and the paw (whether hind or fore, left or right); and also to estimate the total number of tigers. About 75 per cent of the answers were correct about the sex of the tiger. The performance was much poorer when it came to guessing whether it was the left paw or the right, and still worse in guessing whether it was the front or the rear paw. *Not one tiger was identified correctly.*

And the estimates for the total population (which was actually four tigers) were 6, 7, 13, 23 and 24 tigers, with one respondent unwilling to commit himself.

tions in most cases. However, it is possible that through long-term, systematic monitoring of pugmarks a few individual tigers (particularly long-term residents with unusual track patterns) can be identified in a given population. This has been done in Chitwan, but even these identifications were validated through separate photographic and visual identifications.

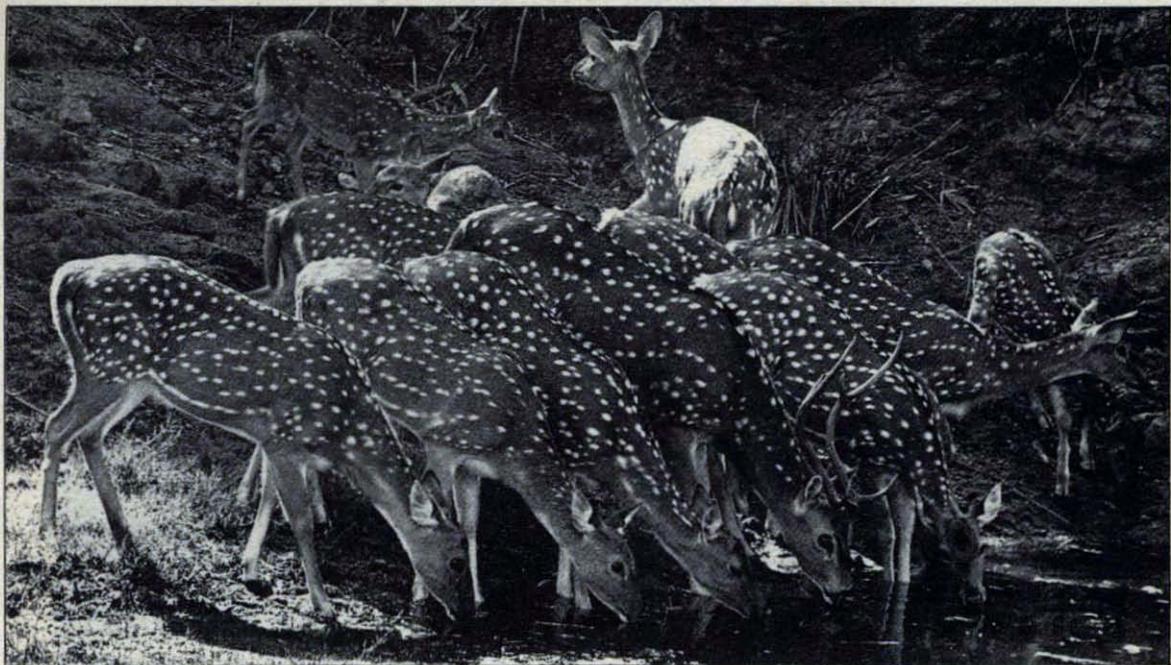
CLEAR IDENTIFICATION of the breeding residents in a tiger population is critical to understanding their long-term dynamics. Yet this information is not available in the census records for any tiger population in India. Given the underlying assumption that each tiger (whether resident or transient) is known from its pugmarks, this surprising omission can only mean that the 'individual identifications' based on the pugmark tracings are not clear enough to segregate residents from transients in any tiger population, even after 20 years of censusing experience.

In a few reserves (Ranthambore, Kanha and Corbett) where tigers are relatively easy to see, some individual tigers and their home ranges have been identified, both visually and from tracks. But these are exceptional cases, and cannot be considered a part of the official strategy to monitor tiger populations.

In view of this failure of the census methodology to distinctly identify even resident animals (and their home range), the claim that the technique can identify each tiger, including transients, seems highly questionable. Under these circumstances many of the 'individual tigers' presumed to exist are likely to be multiple counts of pugmarks of a smaller number of tigers.

MULTIPLE COUNTS can occur due to several reasons. Differences in substrate conditions (soil type, moisture content, slope, etc.) can result in large variations in the pugmarks of even the same paw of a given tiger. The fact that, due to morphological differences, imprints of all four paws can be different from each other — even under identical substrate conditions — further complicates matters. The pace at which the tiger is moving also causes substantial differences in the shape of the tracings.

Tigers can cover large distances in 24 hours,



M. Krishnan

Chital have excellent senses of smell and hearing, but are often unable to pick out a tiger crouching motionless and upwind. In many areas, chital form about half of all tiger kills.

cutting across administrative boundaries of forestry management units. This is particularly true of transient individuals in habitats criss-crossed by forest roads.

It is quite likely that these individuals are counted twice or thrice in adjoining reserves or even adjoining states. The shape of the tracing can vary depending on who made the tracing. In actual field conditions a complex interplay of these factors can result in the failure of the census method, usually leading to over-estimates whose magnitude cannot be judged.

I do not believe that the recently announced, much touted computer identification of pugmarks using multivariate statistics is any solution. The new method still does not address the basic reasons why tracks differ, and the results of such computer analysis may end up as an example of the classic 'garbage in, garbage out' syndrome.

Another flaw in the present census method is its exclusive concentration on the total numbers of tigers in an area, neglecting other more important aspects, including a determination of the physical extent of tiger habitat available, quality of the habitat in terms of prey abundance and the extent of livestock and wild prey in the diet of tigers.

PERHAPS THE ROOTS of these problems are partly socio-cultural. Perhaps there were expectations that Indian wildlife managers would produce concrete evidence that Project Tiger was succeeding. In the early 1970s, Indian knowledge of modern wildlife biology and management were weak. This may have resulted in managers relying solely on a highly subjective, census method to establish total numbers of a thinly distributed, shy, forest dwelling, nocturnal species like the tiger over the entire country.

One result of these censuses is that the actual population status of wild tigers in India is unknown. Simpler, practical and more objective methods of monitoring tiger populations have not been developed, possibly impairing our ability to manage tiger populations wisely in the years to come.

But there is hope yet. At the recent international symposium on tigers, we heard, for the first time, official acknowledgement that we need to know more about tiger biology, and that this knowledge can come only through rigorous research. ■

Ullas Karanth is a field biologist at the Centre for Wildlife Studies, Mysore, and is studying tigers for his Ph.D. He earlier worked on tigers, leopards and dhole at Nagarhole National Park, where he is an Honorary Wildlife Warden.

MAN-EATERS

A Geographical and Historical Perspective

CHARLES MCDUGAL



Peter Jackson

ALTHOUGH MAN AND the tiger evolved in Asia at roughly the same period (the Pleistocene), human beings do not constitute part of the tiger's natural prey. The normal tiger exhibits a deep-rooted aversion to man, with whom he avoids contact. At some stage during the tiger's prehistorical interaction with humans, avoidance of bipedal man probably became an adaptive behavioural strategy. Although the advent of modern firearms may have reinforced this behaviour, it was not the cause, which stems from deeper in the past.

So why do some tigers turn man-eaters? Man-eating is essentially a situation in which man and

tiger come in conflict, during the course of which the natural predator-prey balance is disturbed — almost always by human interference. There are certain regions where the conflict has been historically minimal, and cases of man-eating comparatively rare, such as the Caspian region and much of south-east Asia. In other areas (the Indian subcontinent, south China, Singapore and Manchuria), the problem has persisted for many years, with varying degrees of severity.

MAN-EATERS APPEAR to have been almost non-existent among the Caspian, or Turanian, race of the tiger, at least in Iran. Around the turn of the century, man-eaters were unknown in Mazanderan (just south of the Caspian Sea), the stronghold of the tiger in that

Above — Difficulty in catching normal prey is a key factor in man-eating. This man-eater (fortunately, killed and stuffed) had badly broken teeth and was in poor physical condition.

region. In those days the coastal plains consisted of marshy reed-beds where prey, especially wild boar, was abundant. By the middle of the present century almost all of the tiger's preferred habitat had been reclaimed for cultivation. The survivors retreated to the mountain forests, where the last recorded Caspian tiger was shot in 1959. Although tigers preyed on domestic livestock during the final phase of their existence, man-eating was never a problem.

Instances of man-eating in Burma were sporadic and in some areas almost absent. Local people had no qualms about wandering around alone in the heart of tiger habitat. In 1877, when human fatalities attributed to tigers in British India (excluding the princely states) numbered 798, only 16 people were killed in Burma. There was a local outbreak in the Arakan region during World War II, when tigers that fed on the corpses of soldiers who perished during the 1942 retreat, subsequently killed and ate humans.

THAILAND AND VIETNAM were also by and large problem-free, except for occasional local outbreaks. But during the Vietnam war there were instances not only of tigers scavenging corpses on the battlefield, but also of attacking live soldiers.

Malaya — in 1930, the beginning of a decade when more than a thousand fatalities were recorded each year in British India, there were only 15 fatalities in the entire Malay Federated States. The few man-eaters that did surface were promptly hunted down. Only two cases were recorded in 1985, none in 1984. Similarly for Sumatra: during the 1880s tigers were abundant in certain areas, but man-eating was rare. During the 1920s tigers killed barely a dozen people per year throughout the island, and a three-year survey of Sumatra in the early 1970s could confirm only three cases of man-eating.

The situation in Java is less clear. No data is available prior to the second half of the 19th century, by which time tiger habitat had disappeared from most of the island. Man-eaters were present, but they were usually abruptly terminated by the local people, hundreds of whom apparently turned out to hunt down the culprit.

With the exception of Java, therefore, tiger habitat was extensive in all these problem-free areas. Natural prey was plentiful, human disturbance was

relatively low, and loss of tiger habitat to cultivation was gradual, thus minimising conflict.

HISTORICALLY, there are four places — south China, Singapore, Manchuria and the Indian subcontinent — where man-eating was a serious and persistent problem. It was eventually resolved either by eliminating tigers or by confining them to remote areas with low human population density. As early as the 13th century, Marco Polo relates that in the northern part of what is now Fukien Province in south China, tigers (he calls them lions) "... of great strength and ferocity, are a danger to wayfarers." The neighbourhood of the city of Fu-chau was "infested" with them.

By the first quarter of the present century tiger habitat in Fukien had been reduced to a few wooded ravines in otherwise barren hills bordering cultivated land. Attacks on livestock and humans, especially children, were common — 60 people were killed in one village during the course of a few weeks in 1922. Very little natural prey remained, and tigers had become so bold that they sometimes entered houses to secure prey.

Time was running out for this remnant population, forced by the almost complete destruction of its habitat to depend largely on domestic livestock and human prey. Against all odds a few representatives of *Panthera tigris amoyensis* still survive.

When Raffles first visited Singapore in 1819 he found it entirely covered with swamps and jungles, aside from a tiny Malay settlement of 100 houses. As Singapore rapidly expanded, and more and more land was reclaimed for plantations, conflict between man and tiger grew. By the early 1840s an average of 200-300 people, mainly Chinese labourers, were killed each year. On the small islands lying between Singapore and the Malay mainland man-eaters claimed 600-800 victims per year.

The high incidence of man-eating was ascribed to the scarcity of both natural prey and domestic livestock. 15 people were killed by tigers in Singapore as recently as 1929. The problem persisted for 20 more years, until tigers were brought under control by the payment of bounties, the use of pit-traps, and the sharpshooters of the 'Tiger Club'.

The problem was almost as severe in Manchuria and neighbouring Korea during the late 19th and early 20th centuries. Marauding tigers caused week-

ly markets to shut down, and interfered with the collection of fuelwood for the winter. Man-eaters sometimes entered huts to carry off Chinese and Russian settlers. A regiment of Cossacks was deputed to protect railway construction workers during the 1890s. A tradition of tiger hunting also presumably contributed to the conflict — during the latter half of the 1850s an average of 50 tigers per year were still being killed by hunters in Northern China.

This was a time of rapid development. New railroads opened up access to once remote areas, and huge tracts of forest were cleared for settlement. Man-eaters appeared frequently, but were usually eliminated before accounting for many victims. Gradually the tigers were pushed back into the remotest areas, and only 20-30 were left in Russian territory by the end of the 1930s. (Wildlife reserves were set up in the U.S.S.R. only in the 1950s.)

No recorded cases of man-eating occurred in the U.S.S.R. between 1917 and 1962, and two isolated instances in 1976 and 1981. But some Russian researchers suggest that though the conflict is at present minimal, it will probably increase in the near future. And they may well be right — in March 1986 a tiger was shot on the streets of Vladivostok.

THE INDIAN SUBCONTINENT has served as a stage for intensive man-tiger confrontations. This is hardly surprising — the best tiger areas often contained concentrated (and rapidly expanding) human populations. In 1923, Dunbar Brander wrote, "At the beginning of the last century, in parts of India tigers were so numerous that it seemed to be a question as to whether man or the

tiger would survive." The government began paying bounties to encourage the killing of tigers. Simultaneously, large tracts of tiger habitat were converted to farmland.

Together, these two factors ensured that the tiger problem was solved fairly quickly in many areas. For example, in Khandesh district of the Bombay Presidency, 500 people and 20,000 cattle were killed by wild animals, chiefly tigers, in 1822. But by the 1880s man-eaters were considered rare in Khandesh. The situation was similar in Mysore and Hyderabad.

Nevertheless, in two regions in particular — Bengal and the Central Provinces — the conflict continued unabated throughout the 19th century and well into the present one. By far the worst affected area was Bengal (including present West Bengal and Bangladesh). High stockades were built around villages to keep out tigers. Casualties were heavy on both sides — 426 tigers and upwards of 500 people, in 1877 alone. These figures represented a very large part of the toll in the whole of British India: about one-third (nearly half in some years) of human fatalities, and about one-fourth of tiger deaths. The most notorious part of Bengal was the Sunderbans delta, where an estimated 60-70 people were killed each year in the late 1800s.

SECOND ONLY TO Bengal were the Central Provinces (including present Madhya Pradesh and part of Maharashtra). Three districts, Mandla, Chanda and Seoni, were especially hard hit. In Mandla, an estimated 200-300 people were killed by tigers annually in the middle of the last century; and as late as 1906 a special forest officer was appointed for the sole purpose of destroying man-eating tigers.

In both these areas, scarcity of natural prey was believed to be a key factor. Most man-eaters were females, who possibly had to provide for cubs in marginal habitats or during periodic droughts. One notorious man-eating tigress, operating on the Jabalpur-Nagpur road in the early 1900s, was reported to have killed 700 people before she was destroyed.

Man-eaters appear to have been most common in areas where development (roads, railways, human settlement and agriculture) was most rapid. But if development was the cause, it was simultaneously the solution as well; once an area was completely



Rita Ganguli



M. Krishnan

Tigers rarely prey on adult gaur. But young ones are fair game, especially when they stray too far from the herd.

over-run by man, there would be no more tigers, and no more problem!

IN MOST AREAS, man-eating could generally be explained in terms of prey availability. But what of the *terai* belt in the foothills of the Himalaya? Prey was abundant, and man-eating practically non-existent. Then the problem surfaced abruptly. One of the first two cases on record is that of the Mandla tigress, which suddenly appeared in 1876 in the hills of the Dehra Dun district, in a locality where tigers had hitherto been unknown. She frequented a ridge nearly 3,000 m in elevation, where natural prey was not only scarce but also difficult to hunt.

The first attacks were on flocks of sheep and goats. In 1880, when she had three almost full-grown cubs, she began to prey on humans, eventually becoming so bold as to enter the shelters of herdsmen in search of victims. When finally shot in 1889, all but one of her canines were worn down to stumps, and she was generally in miserable condition. Another man-eating tigress appeared in the Garhwal district at about the same time, and was destroyed in 1881.

The first of the Kumaon man-eaters, later immortalised by Jim Corbett, was the Champawat tigress, which crossed over from Nepal (where she had already claimed 200 victims) in 1905. Before her career was ended she added another 236 in India. Man-eaters continued to appear from time to time in these hills till World War II. They were in fact most numerous during the 1920s and '30s, and during this period there were two, the Talla Des and Lohaghat tigresses, each of which accounted for approximately 150 victims.

WHY THE SUDDEN advent of man-eaters in the hill tracts, and why the increasing frequency of their appearance? One possible explanation is that these tigers were pushed into marginal habitats by more vigorous animals. The prime habitat was bordered on the south by cultivation; the dispersers had no choice but to move north. There was a ready incentive for migration, in the form of livestock herds that wintered in the plains but returned to the hills in spring. Perhaps the tigers followed the herds, and were left without prey when the herds dispersed to their respective villages.

These tigers were the old, the young and the disabled. Of 16 notorious man-eaters of the period, ten were females. All suffered from some disability, usually caused either by gunshot wounds or porcupine quills (they probably only attacked porcupines out of desperation, when other prey was scarce or difficult to hunt).

The reason why these migrants to the hills became more numerous is that the well-managed habitat in the lowlands facilitated good reproduction. According to a report on forest administration in the United Provinces for 1935-36, tigers were "tending to increase in numbers and it is almost inevitable that... there will be a migration of surplus tigers into the surrounding forests."

UNTIL WORLD WAR II the human death toll from tiger attacks remained high. During the nine-year period 1902-1910 fatalities per year averaged 850, reaching 1000 in some years. Then, during a five year period in the early 1920s nearly 7,000 deaths were reported from all over British India, excluding the princely states. The drastic reduction both of tigers and their habitat immediately following the war effectively solved the general problem of man-eating, except in certain relatively unaffected localities such as the Sunderbans. In the states of Kerala, Tamil Nadu, Rajasthan, Assam and Bihar, no man-eating cases had been reported for the last 34 years; there had only been one from Andhra Pradesh; and none in Karnataka since 1959.

A new situation is now developing. For well over a decade tigers have been fairly well protected in sanctuaries and national parks, and in many cases these have become reproductive centres, from which there is dispersal to surrounding forests. The trouble is that these surrounding forests are usually degraded, and contain little natural prey; and so the dispersers attack first livestock, and eventually man.

In Kheri district of Uttar Pradesh, 128 people were killed by tigers during the seven year period 1978-1984, during which time ten tigers were destroyed and two others captured. This, together with the Sunderbans, are the only places in India and Bangladesh where man-eating remains a persistent problem.

So we have, as the key factor, the scarcity of natural prey, either due to the disturbance of tiger

habitat by humans or the dispersal by tigers into areas of peripheral habitat. A common sequence is that from natural prey to domestic livestock to man. The partial dependence on cattle not only increases the tiger's familiarity with man, but also makes humans, in the form of herdsmen, immediately available as alternative prey.

Disability and consequent handicap in capturing natural prey may also be a contributory factor, although many disabled tigers never become man-eaters and many man-eaters have no obvious disabilities. Hunger is most likely the factor which overrides the tiger's aversion to man.

THE ONE REGION where man-eating has been endemic since the earliest times is the 10,000 sq. km Sunderbans delta, which harbours the largest single, contiguously distributed (including Bangladesh) tiger population in the subcontinent, possibly as many as 300 adults. The ferocity of the Sunderbans man-eaters, that even board small boats in search of human prey, have been described for three centuries.

The point is that this behaviour dates from a time when the Sunderbans was little frequented by man. Even in the mid 1880s, when natural prey was abundant, its tigers, "have the reputation of being the most fearless and confirmed man-hunters and man-eaters of any in India." The rhinos and wild buffaloes that were once common in the mangrove swamps have disappeared, but chital and wild boar are still plentiful.

Studies on the man-eating problem in the Sunderbans (what is now the Bangladesh portion) showed that there seemed to be two kinds of man-eaters: the confirmed, or dedicated ones, that go out hunting especially for human prey, and the opportunistic ones that do not go out of their way to search for humans, but will, if they encounter a man, attack, kill and devour him. The dedicated man-eaters, constituting only one per cent of the total population, are distributed uniformly throughout the Sunderbans.

The opportunistic man-eaters, on the other hand, constituting 30 per cent of the total tigers, increase in frequency from north-east to south-west. Their distribution varied not with the density of their main prey species (chital and wild boar), but with the height of the water level and the degree of salinity



Once bitten, twice shy. Electrified dummies were introduced in the Sunderbans in 1983, and have proved remarkably effective in reducing tiger attacks.

H.K. Poladia / PORPOISE

in the water. In those areas where opportunistic man-eaters are found, the killing of humans is correlated with their availability; most victims are claimed during the honey gathering season.

One theory (which has not been proved, nor widely accepted) is that the salinity of the water may result in physiological changes, causing tigers resident in such highly saline areas to become more ferocious and prone to attack humans. Another hypothesis is that the high tide level interferes with tiger communication (chemical signals and visual marking). The tigers are then forced to resort to more overt methods of demarcating territory, and consequently are more than ordinarily aggressive. Most of the man-eaters recorded during the study were males (10 out of 13), and they accounted for 86 per cent of the victims.

In the Indian Sunderbans the man-eating problem has been tackled fairly successfully by the Project Tiger authorities, using electrified dummies and fences, and by providing freshwater supplies in saline areas. This has resulted in a sharp decline in human fatalities, from an average of 45 per year between 1975 and 1982, to an average of only 22 during the years 1983-85.

STUDIES IN CHITWAN National Park in Nepal revealed another, quite unexpected, factor: competition between males. Historically, man-eating in Nepal has been only sporadic. Man-eaters were usually quickly dealt with by the Narayani Shikar Phant attached to the Royal Palace. No cases were recorded in Chitwan prior to 1980. But since then 13 people have been killed and eaten in the park and its immediate environs. Man-eating appears to have been opportunistic and most of the tigers concerned were males which had lost territorial battles to other males.

One male, number 127, was involved in five cases of man-eating, two of them in association with a tigress (she was destroyed after the third killing). During the period, 127 was gradually being displaced westward by a large male. The latter appropriated part of 127's former range, and an adult female with which he had regularly associated. Each successive human kill took place some distance to the west of the last, reflecting 127's shift in that direction.

All these took place in prime riverine habitat, containing a variety of prey animals at high density. Subsequently, 127 established a stable home range,

including two reproductive tigresses, and killed no more people for the next ten months (after which he suddenly disappeared), despite the fact that his area was frequented by grass-cutters.

Another male, Kanchha Bhale (who replaced 127 after his disappearance), faced a similar problem. He had maintained the same home range from early 1982 until late 1985. Then came trouble from the west, in the shape of a larger male. They fought three battles in late '85 and early '86, and the large male began to associate with the three tigresses formerly monopolised by Kanchha. After being injured in the last encounter, Kanchha left his home range and remained near some villages at the edge of the park, where in three weeks he killed nine cattle and buffalo, before claiming the first of three human victims.

When competition among males escalates, they apparently become more aggressive, even towards humans, the more so if wounded. Both 127 and Kanchha Bhale had been worsted by rivals. The human victims were probably just at the wrong place at the wrong time. Almost all were grass-cutters, who routinely enter areas of dense cover and are therefore easily picked off.

HISTORICALLY, THEREFORE, man-eating has been correlated with inadequate supply of natural prey and loss of habitat. In some areas tiger habitat has been completely destroyed without man-eating becoming a problem, for instance in Iran or in parts of the lowlands of Nepal following resettlement of hill people. In such cases the tigers were killed off at approximately the same rate that their habitat was removed, and there was no breeding reservoir of tigers to restock the peripheral habitat being created by human activities.

A high incidence of man-eating has been associated with situations in which tigers from good habitats (where their numbers were increasing) were forced to occupy marginal habitat. In Bengal, for example, not only was the habitat being rapidly reduced but large numbers of tigers were being killed at the same time. Nevertheless, so long as there was sufficient good habitat for tigers to reproduce and multiply, peripheral areas were restocked and man-eating persisted. In the United Provinces, tiger numbers were increasing in the

lowland habitat which was bounded on the south by cultivation. Dispersers had nowhere else to go except into the hills.

Availability of natural prey was the main limiting factor. Wherever tigers found their natural food in short supply, they supplemented it with domestic livestock and also humans. In such cases a tigress with cubs to feed, or a disabled tiger, suffered an additional handicap. The ultimate limiting factor in these cases, of course, is space, the lack of which caused tigers to move into sub-optimal habitat.

OPPORTUNISTIC MAN-EATING that takes place in localities where natural prey is plentiful, is a more complex situation. Some reason, or combination of reasons, causes the tiger to subordinate its normal inclination to avoid man and make it more prone to attack him. There is no hard and fast line between the opportunistic man-eater and the dedicated one, since the former can turn into the latter.

"Of the many man-eaters I have known none have been aged or decrepit animals driven to feed on human beings because they could not obtain other food. They lived in a country full of game and where cattle were plentiful; but had lost their fear of man." So said Eardley-Wilmot, whose served in the Indian Forest Service for the last quarter of the 19th century.

Familiarity breeds, if not contempt, then at least a greater propensity to attack man. Man has been penetrating tiger habitat since time immemorial, and nowhere in the Indian subcontinent are tigers unfamiliar with man. It is probably a matter of degree: more human intrusion (and more familiarity) in some areas, less in others. Increased frequency of contact not only makes man more available as alternative prey but also reduces the tiger's reluctance to attack him.

As the existing habitat outside parks and reserves, where tigers are multiplying, becomes progressively fragmented and degraded owing to ever greater human encroachment, we may expect an increased incidence of problem tigers. ■

Charles McDougal is a Research Associate at the Smithsonian Institution, and has a Ph.D. in anthropology and an abiding interest in big cats. He spent 12 years at Chitwan National Park in Nepal, studying tigers and leopards. This article is adapted from a paper he presented at an international symposium on tiger research.

A HUNDRED YEARS AGO

KENNETH MACKENZIE



E. P. Gee

The shikaris of yesteryear were not merely hunters; many were thoroughbred naturalists. Times and values have changed, but their legacy of information on India's wildlife — and the power of their prose — remains.

This article was written a hundred years ago, almost to the day — in April 1893 — and appeared in the 1893 volume of the BNHS Journal

THE FOLLOWING ACCOUNT of a day's sport in Berar some few years ago, when game was more plentiful than it is now, may be of interest to some of the readers of our Society's *Journal*.

The writer's duty, as a District Officer, led him one day to the neighbourhood of a deserted village, Dharur, situated on the banks of a mountain stream which, coming down from the Satpurahs, sweeps the base of the hill on which stands the fort of Naruallha. Dharur, in the days I am about to write of, was just lovely in its solitude. Mixed jungle clothed the small

valley down which ran the stream on the banks of which the ruins of the village stood, and for about three miles of its course both banks of the stream were densely clothed with 'Sendi', or the date palm, with here and there small open patches of grass.

On the day of my arrival a 'kill' was reported by a herdsman who grazed cattle in the vicinity. The marks on the kill — a large female buffalo — indicated that one, if not two tigers had their home among the date palms. As it was impossible for a single gun to command the jungle, a message sent in to Ellichpur soon fetched out two friends —

General (now Sir Harry) Lumsden of Punjab frontier fame, and his Brigade-Major, the late Colonel Hugh Watson. With them came as escort officer Resaidar Beg Mahomed, a typical specimen of our splendid irregular cavalry.

AFTER A CAREFUL reconnaissance, we selected a position on a mound of earth at the foot of a big mohwa tree, which stood at the centre of one of the larger aforesaid patches of grass in the centre of the Sendi-bund, about two miles upstream. Here the General, Colonel Watson, Beg Mahomed and the writer stood shoulder to shoulder, with a servant behind each carrying a spare rifle. Up the mohwa tree, in the shade of which we gratefully stood, was posted a shikari as look-out.

The troopers of the escort were placed at intervals along either bank, outside the denser jungle, as stops, falling in with the beat as it came along. The beat itself, mainly composed of hill-men villagers, with an elephant in the centre to give direction, formed line at the village, and, provided with tom-toms, horns and rattles, started about noon. It seemed an age before anything showed up.

Presently, putting us on the *qui vive* well in advance of the approaching beaters, came a hare or two; then some jungle cat, and finally peafowl. After all these had passed, there was another seemingly endless interval of suspense — that interval during which, as all shikaris know, strung to the highest pitch of excitement, one hears and feels the beating of one's own heart, just as a steamer quivers to the pulsations of its screw. But the feeling passes away in a second, as the quarry comes into view.

In our case the view was *five* full-grown tigers 'mooning' along close together almost in line, unconscious that their way was barred by man. 'Mooning' is the only suitable expression, for they came along quite slowly, heads down, with a bored expression of countenance, as if they felt the heat, and thought the hustling of them by the beat behind most inconsiderate and unkind.

WHEN THEY FIRST broke into view, about 30 yards separated us. It was a never-to-be-forgotten sight, but the position was in a way critical. There was no time for counsel, but the General, without a moment's hesita-

tion, whispered, "Take the big fellow," expressing the necessity we each had instinctively felt of concentrating, not scattering, our fire.

"Let them come on," was Watson's immediate reply. He probably felt that we required a brief moment for selection. As a matter of fact, when the General spoke, the tigers seemed much of a size, and it required some fineness of discrimination to say on the spur of the moment which was the biggest.

But the matter was settled for us, Watson's voice evidently reached foe as well as friend, for one of the tigers stopped dead and looked up at us in a startled and surprised fashion. Instinctively we all banged at her (her sex, of course, we only subsequently discovered), and then there was a sight for the gods. It is really impossible accurately to describe, and it was all over in a second or two.

But the sound of our rifles and the roar of the wounded tigress woke the other four tigers up (so to speak). They raised their heads, looked at us, jumped to one side, and roared in concert. The untouched tigers were evidently momentarily quite undecided what to do — whether to try and get past us, or to face the din and row behind them, which had very appreciably increased as the sound of our shots reached the beaters.

While these tigers were thus seemingly debating what to do, the female we had fired at made a bound towards us as if to charge home; but her heart failed her, and she turned sharp to her left and to our right, making for the shelter of the jungle. As she went across us, we gave her the contents of our second barrels, and she fell out of sight into a small nallah. As she did so, the rest turned back in the direction of the beaters. We reloaded rapidly, knowing they would soon be headed off and return, but this time prepared for us.

PRESENTLY I SAW a tiger trying to sneak past to our left, and called out, raising my rifle at the same time to indicate the direction to my companions. "Fire if you see him," shouted the General. Our voices had the effect of making this tiger stop and take a good look at us; as she was doing so, I fired. She instantly responded with a roar and charged straight down on to us. I call her 'she', as subsequently we discovered that she too was a female, and a very lively and determined female. I failed to stop her with my second barrel, and it



seemed to me that my three companions had emptied both theirs equally ineffectively.

At this critical moment, when she was within a few yards of us — near enough for us to see her ears back, teeth showing, a savage gleam in her eyes, and blood streaming down one shoulder — when it looked as if one of us must be knocked over in her next bound, our gun-bearers from behind jumped up the mound on which we stood to hand us our second rifles. In their excitement they shoved Resaidar Beg Mahomed and the writer over the crest of the mound, and we, losing our footing, slid down the mound in a sitting posture with our rifles in our hands.

FOR A MOMENT IT seemed as if one of us must be seized, for the tigress was now quite close to us; but in that moment Watson, who was a very steady and cool shot, fired, hit her between the eyes, and in fact brained her. Instead of continuing to come on, she spun round and round twice or thrice and fell dead close in front of us.

While this little scene was being enacted, the other three tigers had, it seems, come into view and again turned back. But they could not face the row the beaters were making, and again they turned towards us to force a passage through. One was passing to our left, two to the right; we fired at and wounded the former, and he doubled back on the beaters. As he did so, the other two tigers faced the stop and broke past us to the hills behind.

We at once stopped and withdrew the beaters and sent for the elephant to look the wounded tiger up. It would have risked an accident to let the beaters come on with a wounded tiger in their front. The elephant was a very unsteady one; if he saw a tiger,

he invariably charged it, and it was difficult to shoot off him. In such jungle, however, we had no choice but to mount him, and we went first to look up tiger number one.

As we approached the nallah, where the look-out indicated she had fallen, we heard a growl, followed by a faint attempt at a charge; she was put out of pain immediately. Number three gave us a lot of trouble. He was a cowardly sneak. Nothing would draw him; he kept retreating from one thick and almost impenetrable patch of 'Sendi' to another, and dodged about, till eventually he dodged us altogether; and we had to return to camp with two tigers only, which the General photographed.

THIS ENDED FOR us a very eventful day. As to excitement, the day has doubtless been often matched in the annals of shikar of earlier times, but it is not readily to be matched in these more prosaic days, which is my excuse for presenting an account of it to the pages of the *Society's Journal*.

As for tiger number three, subsequent information led me to believe that he died under a thick bush while we were hustling him. As it was impossible to put in men on foot and we had no dogs, and the elephant could not penetrate everywhere, we did not unfortunately know it in time.

The place I speak of is no longer a home for tigers; the jungle has given place to fields with cover barely sufficient for a hare. ■

Colonel Kenneth Mackenzie
Chikaldah, Berar
28th April 1893

THE STATUS OF THE TIGER

PETER JACKSON

The overall range of the tiger once extended from eastern Turkey through southern Asia and the islands of Sumatra, Java and Bali, to the eastern shores of Asia on the Sea of Okhotsk. There were eight subspecies (Amur, Bali, Bengal, Caspian, Indo-Chinese, Javan, South China and Sumatran). Today, India is the western limit as a result of the extinction of the Caspian tiger about 1970 and the earlier disappearance of the tiger from areas which are now part of Pakistan.

Painting by Carl D. Silva





THERE ARE STILL TIGERS throughout south-east Asia, in China and the Russian Far East. But the Bali and Javan tigers are extinct, and elsewhere forest habitat has been fragmented, isolating tiger populations and greatly reducing overall numbers.

Loss of habitat and illegal killing are the principal threats to the tiger. Loss of habitat is the result of conversion of forest and grassland to agriculture and other purposes, much of it necessary to meet the needs of the growing human population. It may involve outright destruction, degradation through encroachment for grazing, collection of wood and other products, and mining. Fragmentation also occurs, breaking links between tiger populations, making them more vulnerable to illegal killing and leading to inbreeding in small populations, which can result in genetic deterioration.

According to an FAO report, moist forests in Asia shrank from 3,345,000 sq km in 1980 to 2,875,000 sq km in 1990 — a deforestation rate of 47,000 sq km a year. The figures may be different for other habitat types, but the trend is similar. India's forests in 1989 included closed forests covering 385,008 sq km or 11.71 per cent of the country, and open forests (10-40 per cent crown cover) another 249,930 sq km or 7.6 per cent, according to the official State of the Forests report. Fragmentation of forests is seriously affecting wide-ranging species, such as tigers and elephants.

Rajaji and Corbett reserves are linked only tenuously, Kanha and Bandhavgarh not at all. Sariska is isolated; Ranthambore is cut off from the Madhya Pradesh forests. The pressure on forests is understandable when you consider that the human population of India has increased by nearly 50 per cent since Project Tiger was inaugurated in 1973.

IT IS IMPOSSIBLE to quantify illegal killing of tigers. Tigers may be poisoned when they threaten (or are perceived to threaten) livestock, and there is deliberate poaching for gain. In the first case, the killing can act as a control on the natural expansion of healthy tiger populations, and does not represent a serious threat. Poaching, however, can become, and almost certainly is, a major threat, especially to small, fragmented populations — once a population falls below a critical level it is doomed.

And even if poaching is halted immediately, it will be several years before populations respond. In Chitwan (Nepal) for example, the removal of a dominant male led to prolonged conflicts over territory and access to females, and cub survival markedly declined for the following two years. It should be noted that even the Indian census estimates of 1989 (which were challenged as being exaggerated) included only one reserve, the Sunderbans, with more than 100 tigers, although several reserves are connected to forests with more tigers.

In past times, poaching was primarily for furs. This has diminished as a result of public campaigns against furs in Europe and North America and international trade controls. However, recent seizures in India and the skins seen in markets throughout tiger range show that skins still have considerable value. But now the emphasis is on bones, which are smuggled mainly to China and Taiwan, where they are highly valued for use in medicines. Supplies can only come from elsewhere because China's fewer than 100 tigers are hard to find, while Taiwan has never had tigers.

Chinese sources say that leopards, snow leopards and golden cats are also killed for bones, which are accepted as substitutes for tiger bones. Many so-called 'tiger bone medicines' contain bones from other non-feline animals.

ILLEGAL TRADE in skins is risky because the contraband can easily be identified. But bones carry little risk because cover is provided by the legitimate trade in domestic animal bones for fertilizer, glue and gelatine. Only experts can identify tiger bones, and the bones could easily be mixed with legal bone shipments. (The hackles of grey jungle fowl, which are in demand for fishing flies, have been smuggled out of India by concealing them with chicken and duck feathers.)

Known tigers have disappeared from Chitwan, and officials have reported finding sacks of tiger bones in post offices. Bones are openly available in south-east Asia for Chinese and related communities. Reports have just come of the poaching of 20 Amur tigers in the Lazo reserve near Vladivostok; the bones are probably being sent to China across what is now an open border. There have also been reports of Amur tigers being killed so that their skins could be exchanged for foreign cars.

BENGAL TIGER *Panthera tigris tigris*

India, Nepal, Bhutan, Bangladesh, western Burma, possibly extending into south-eastern Tibet and Yunnan

Only in India has there been an attempt to obtain an accurate census of the tiger population, but the all-India estimate of 4334 in 1989 has not been accepted. Based on circumstantial evidence, most experts put the number far lower, perhaps about 3000. About one-third are in the 19 special tiger reserves. The rest are scattered mainly among a countrywide network of national parks and sanctuaries.

The Wildlife Institute of India has confirmed records of tigers in many parts of the country, but reckons that only 12 areas have the potential for long-term viability. They are connected to the tiger reserves of Corbett, Manas, Namdapha, Sunderbans, Simlipal, Bandhavgarh, Kanha, Melghat, Indravati, Nagarjunasagar, Bandipur and Anaimalai.

Estimates of 250 in three populations in Nepal and at least 150 in Bhutan may also be exaggerated and certainly include tigers which range across the border into India. In Bangladesh, tigers are confined to the Sunderbans, where there may be about 200. These, too, are part of a population also found in the adjoining Indian Sunderbans. There are no estimates of the tiger in Burma, which also has the Indo-Chinese subspecies east of the Irrawady, but there are certainly some. All this suggests that the total number of Bengal tigers may be in the region of 3000-4000.

INDO-CHINESE TIGER *P. t. corbetti*

Eastern Burma to Vietnam and Malaysia

Although estimates up to 2000 have been published for the number of Indo-Chinese tigers, there is no evidence to either support or challenge this figure. The only reasonable country estimate was of about 250 tigers in Thailand in 1991 - just half of earlier claims. There are said to be about 600 tigers in Malaysia. Elsewhere in the range there are only reports of scattered sightings, which indicate that tigers still survive in Burma, Laos, Cambodia and Vietnam. Further evidence that there are some tigers is to be seen in fur markets throughout the range.

SOUTH CHINA TIGER *P. t. amoyensis*

Central and South China

The South China tiger was brought to the verge of extinction by an official campaign in the 1950s and '60s to wipe it out because it was considered a pest. At least 3000 tigers are known to have been killed during this period.

A 1991 survey produced evidence of pugmarks and scrapes, which together with reports by local people confirm the survival of some South China tigers and of breeding. There were no sightings. The tigers were mainly in the mountainous regions of Hunan, Jiangxi, Fujian and Guangdong provinces. There are occasional newspaper reports of cubs or skins being brought to markets. Chinese specialists put the number at 30-50, widely scattered and critically endangered.

The loss of this subspecies, which seems almost inevitable, would be particularly tragic as it has primitive skull features which indicate that it is the stem from which other subspecies have evolved.

SUMATRAN TIGER *P. t. sumatrae*

Sumatra

During the last 20 years, estimates have not been higher than 1000; Indonesian specialists recently proposed 400-650 in five disjunct protected areas. Vast tracts of tiger habitat have been lost because of settlement of several million people from Java and Madura.

Although the Javan tiger is considered extinct, the last records being of 3-5 in the eastern reserve of Meru Betiri in 1981, scratches on a tree trunk which experts believe could only have been made by a tiger, were found in the reserve in 1990. An attempt is being made to confirm the existence of tigers, but even if some individuals survive, the subspecies is virtually extinct.

AMUR TIGER *P. t. altaica*

Russian Far East, China and North Korea

A reliable estimate for the number of tigers in Primorye and Khabarovsk provinces (north of Vladivostok) is 300-500. In China, the number is put at less than 50, while reports of a few in North Korea have never been confirmed. Now reports are flooding in of heavy poaching of tigers and prey species as a result of the general breakdown of law and order after the collapse of the Soviet Union. At the same time, the Hyundai Corporation of South Korea has been granted extensive logging concessions, even of protected forests.



M. Y. Ghorpade

It is obvious that the poaching and smuggling that comes to light is only the tip of the iceberg. Illegal wildlife trade networks are well organised, as we know from revelations about ivory and rhino horn. Skilled hunters exist throughout tiger habitat and their poverty makes them easily available cheap local labour. Local communities which are hostile to reserves and wildlife conservation have little incentive to provide information to the authorities. Furthermore, lack of official support and the lenient attitude of the courts towards poachers discourages police and wildlife staff.

THERE HAS ALWAYS been a trade in tiger bones for Chinese medicine. Why has it become a serious problem? Since China has so few tigers and must have exhausted any stocks from the thousands of South China tigers which were slaughtered, it clearly has to rely on supplies from other countries. We are now witness-

ing the same sequence of events that affected the African rhinos 20 years ago.

Many rhinos began to disappear mysteriously in Kenya. Then it was discovered that horns were being shipped in large numbers to North Yemen to be carved into handles for decorative daggers, which young men, made rich from work in Saudi oil fields, could now afford. Chinese importers had to match the escalating price of horn and started to stockpile.

Now, despite all the international publicity and millions of dollars expended to stop poaching, Africa's rhinos have been reduced to below one-tenth of their 1970 population. The poaching has swept in a wave from Kenya southwards, wiping out population after population. A last ditch battle is now being fought in Zimbabwe.

HANGING ON — JUST ABOUT

	Maximum estimate	Minimum estimate
Bengal tiger	4,000	3,000
Caspian tiger	Extinct 1970s	—
Amur tiger	500	300
Javan tiger	? Extinct 1980s	—
South China tiger	50	30
Bali tiger	Extinct 1940s	—
Sumatran tiger	600	400
Indo-Chinese tiger	1,500	1,000
TOTAL, worldwide	6,650	4,730

MY BELIEF IS that the end of the tiger is in sight, possibly within 10 years, although some may linger on for a time. We have been complacent because of the success of tiger conservation in India and Nepal in the '70s and early '80s. The recent disappearance of many of Ranthambore's world-famous tigers — the exact number is not important — and the seizure of large numbers of contraband skins means that the alarm bells should start ringing now — and loudly.

In sum, the future of the tiger looks grim; the 21st century may see only the last few survivors. It is up to us to alert the international public and the authorities throughout the tiger lands so that that scenario does not come true. ■

Peter Jackson is a world authority on the big cats, and Chairman of the Cat Specialist Group of the IUCN.

WALKING

Female land tenure

JAMES SMITH, CHARLES MCDUGAL

MALE TIGERS ARE territorial animals. A male defends his territory from other males, but shares it with one or more females. The key factor behind this territorial urge is thought to be competition for mates; one indication is that territorial behaviour is most pronounced when females are in oestrus. Females too are territorial, but probably for a different reason. They need territories to compete successfully for food, cover and a secure place to raise young.

We studied the land tenure system in female tigers at the Royal Chitwan National Park in Nepal for 11 years (January 1974 to June 1985). 11 tigresses were captured and radio-collared, and then tracked on foot, and from elephant back, vehicle and aircraft. In addition, the movements of seven uncollared and four radioed females were monitored from their tracks.

There were four main indications that tigresses are in fact territorial. There was little overlap between adjacent ranges; tigresses used scent marking (by depositing urine or faeces) to delineate territory boundaries; there was strong site fidelity throughout the breeding life — no female left her range to establish a breeding territory elsewhere, although several shifted so that part of their range was acquired by their daughters. And lastly (the strongest indicator of territoriality), they used aggressive behaviour to maintain or obtain exclusive territories. There were several instances of aggressive interactions between females, causing the 'loser' to either shift her range boundaries or leave the area altogether.

Territories were acquired in two ways. Some females dispersed and became established away from their natal area. The majority, however, established territories adjacent to those of their mothers. Animals of both sexes remained within their natal area after the birth of a new litter. When the new litter was approximately two months old the subadult litter mates (by then almost two years old) dispersed. Over a period of several months the ranges of a mother and a daughter progressively separated.

Typically a mother shifted her territory so that a daughter acquired a portion of her range (or sometimes nearly all of it). Often there was still some territory overlap when a daughter's first litter was born, but by the time the daughter's offspring were approximately one year old and regularly travelling with her, there was typically very little overlap between the territories of mother and daughter.

FEMALE TERRITORIES are, on the average, just 40 per cent the size of male territories. Male territories at Chitwan ranged from 19 to 151 sq km, those of females from 10 to 51 sq km. Territory size depends mainly on two factors: prey abundance and territory turnover. The more abundant is the prey in a territory, the smaller the territory size required to sustain the resident tigress. Territories located in riverine habitat, for example, were smaller than those in open sal forest, where prey was less abundant.

The territory turnover factor is slightly more complicated. When a female dies, a young animal often establishes a range in the vacant area. We recorded three cases where the incoming female acquired essentially the same range as that occupied by

HER BEAT

system in tigers

AND MELVIN SUNQUIST

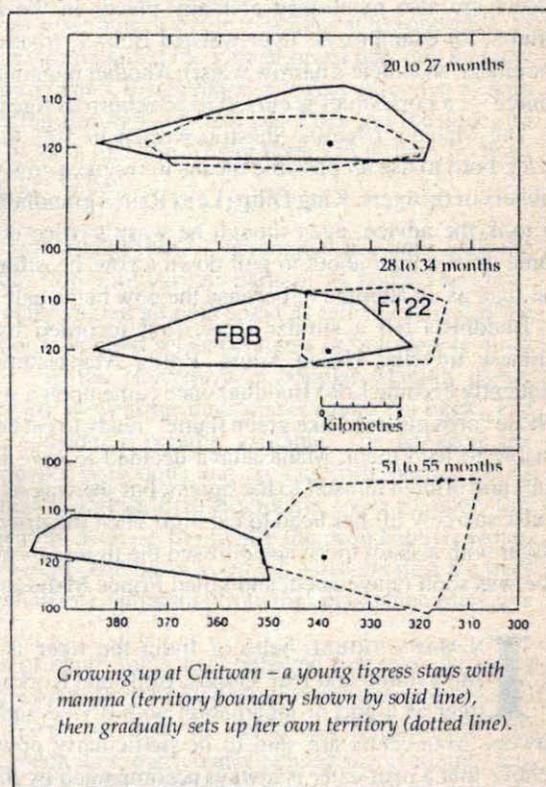
the former female. Territory expansion was restricted by the presence of adjacent females, and no territory holder expanded her range to include a vacancy.

Both aggression and marking are used to establish and maintain territorial boundaries. It is hard to say which of the two is more important. But the high rate of scent marking when territories are first established and the infrequency of fights (indicated by the lack of wounds on immobilised females) suggest that marking may be somewhat more vital. Once a border between neighbours is established there are disadvantages to invading a neighbour's territory — for example, you have to hunt in an unfamiliar area.

IT HAS BEEN suggested that mothers may help their daughters acquire adjacent territories. However, it is also true that the strongest competition is between close neighbours, who will probably be kin. Tigresses allowed their daughters to establish territories adjacent to them, but as the process of acquisition progressed there appeared to be a gradual increase in the level of aggression between mother and daughter, and a gradual reduction in territorial overlap between their ranges.

The function of female territorial behaviour is probably to ensure exclusive access to food, cover and other resources that a female and her offspring need for survival. Of the 14 females that became territorial, all but one successfully reproduced; the one that did not produce cubs was removed before she had a chance to breed. And there were no non-territorial breeders.

Neighbouring females are often closely related (either mother and daughter, or sisters, or half-sisters fathered by the same male from different females). The genetic implications of this high degree of relatedness are unclear. The movement of male genes through the population is restricted because females that males mate with are likely to be related. Thus, male genes will not spread through the population as rapidly as they would if males mated with a random sample of females from the population. The genetic structure of the Chitwan population therefore reduces the effective population size and increases the potential for inbreeding. ■



Growing up at Chitwan — a young tigress stays with mamma (territory boundary shown by solid line), then gradually sets up her own territory (dotted line).

The authors are internationally recognised mammalogists, specialising in the ecology of large carnivores. They were part of a Smithsonian Institution team that worked at Chitwan, and completed what is probably the most comprehensive, long term wildlife study ever conducted in the subcontinent. This article is adapted from a paper presented at an international symposium on tiger research.

TALES OF THE TIGER

NARESH CHATURVEDI

REFERENCES TO the big cats are sprinkled throughout ancient Indian literature. The lion's share belongs to *simha*, as *Panthera leo* is known in Sanskrit. But the tiger, too, though it is believed to have entered and colonised India much after the lion did, is very much a part of Indian culture. The tiger is the *vahana* or mount of the Goddess Durga, who is also known as Shera-wali. The Sanskrit name for the tiger is *vyaghra*, or one who lacks a sense of smell (that is in fact untrue, though a hunting tiger depends more on sight and hearing than on smell).

In the Rig Veda the author of a hymn is referred to as Vyaghrapad. Tigers are also mentioned at many places in the Mahabharata: Bhima, for example, is "tiger-waisted Bhima" (massive chest and shoulders, an athlete's narrow waist). Another nugget from the same source — a horse-thief is cursed to be reborn as tiger.

The Manava Dharma Shastra, written in 500 A.D., urges the twice-born to use all possible means to rescue a cow threatened by robbers or by tigers. King Dilip (Lord Ram's grandfather) apparently took the advice, even though he wasn't twice-born. When he came upon a tiger about to pull down a cow, he offered himself to the tiger as an alternative because the cow had a calf to feed.

Buddhists tell a similar story, first recorded by the famous Chinese traveller Hsuan Tsang. Prince Mahasattava (who subsequently became Lord Buddha) once came upon a starving tigress whose "orbs gleamed like green flame", ready to eat her cubs as was unable to feed them. Mahasattava decided to save the life of the cubs and offered himself to the tigress, but she was so weak that she could scarcely lift her head to eat him. Then the prince pierced his finger with a sharp thorn and allowed the tigress to suck his blood. She was soon rejuvenated, and killed Prince Mahasattava.

IN MANY TRIBAL belts of India the tiger is a subject of superstition and fear. Gonds, Bhils and Korkus worship the tiger as a god or incarnation with divine and supernatural powers. Man-eaters are said to be particularly powerful. Gonds believe that a man-eater is always accompanied by the spirit of his last human victim, who not only warns him of any impending danger, but also guides him to prospective victims.

One story goes that a hunter was watching a corpse from a tree top when the tiger returned to resume its feast. The corpse raised its hand and pointed at the hunter in the tree, and the tiger retreated. The hunter climbed down and tied up the pointing hand. A little later the tiger returned. The corpse warned him again, pointing with the other hand, and the man-eater turned back into the jungle. The hunter then tied the other hand as well; and when the tiger returned



Rita Ganguli

CLAY, CANE AND BAMBOO

One day (in the days when tigers didn't eat boars) the boar said to the tiger, "My friend, let us fight, and decide once and for all who will fear the other. Now what will you take to protect yourself?"

"I will take cane and wind it around my body", replied the tiger. And the boar said he would smear clay all over himself. They decided that the fight would take place six days later.

For six days the boar did nothing but smear layers of clay all over himself, letting it dry after each coat. The tiger, likewise, did nothing but cut lengths of cane and wind them around his body. When the six days were up, the fight began. Whenever the tiger flew at the boar and bit him, all he got was a mouthful of clay. But the boar, whenever he attacked, bit through a piece of cane, till he had bitten them all through one by one, and finally killed the tiger.

The boar swaggered away after his victory but ran into a thin stem of bamboo. Terribly annoyed (for he was now lord of the jungle, and no one was permitted to impede his progress), the boar seized the bamboo in his mouth. But it was so thin, and so sharp, that it sliced through his tongue, killing him on the spot. He lay there for a day, till another tiger came upon the body, and being hungry, ate it.

And from then on, tigers have always eaten boars. But because the tiger could not beat the boar when they fought fairly, a tiger still cannot catch a boar unless he bides his time. He must stalk it carefully, and then spring before the boar knows he is being followed.

Old Lhota folk tale

THE TIGER AND THE WAGTAIL

The tiger and the wagtail were good friends. One summer, the wagtail had plenty to eat, but the tiger went hungry, for in those days he was an honest but stupid animal who knew nothing of stealth and concealment. The wagtail decided to help her friend, and suggested a game of hide and seek.

When she hid herself, the tiger could not find her, but when it was the tiger's turn to hide, the best he could do was to stand in the middle of the path. There happened to be a monkey in front of him. The wagtail sneaked up and caught the tiger violently around the waist; the tiger was so startled that he jumped into the air and landed on top of the monkey, killing him on the spot. Then, being terribly hungry, he ate the monkey. And that is how tigers learnt to leap onto their prey.

The Myths of Middle India

for the third time, the corpse was unable to warn him, and the hunter succeeded in killing the tiger.

Sometimes a 'Tiger House' is built in the depths of the forest as a place where the lord of the jungle may rest. In many parts of Vindhya-chal the tiger is known as Bagheshwar (Tiger God). Bhopa and Barga tribals have a magic chant which they address to Lord Krishna and Lona Chamarin, a witch. This, they believe, protects them from tiger attacks, and even allows them to safely enter a tiger's den. It has to be chanted seven times, every Tuesday: "Bind the tiger, bind the tigress, bind her seven cubs. Bind the road, the footpath and the field through which they wander."

The tiger has found an important place in the folklore of the Naga and Lepcha tribes of north-east India, and in Nepal and Sikkim. In parts of Nepal a *jatra* is organised to propitiate Bagh or the tiger, where men dressed as tigers perform a dance mime. Buddhists in the Himalaya considered the tiger as their protector — many monasteries and *gumpas* have a statue of a tiger at the entrance. In Nagaland, when a tiger is killed the village priest declares that day as a day of penance. The Changs practice a very effective system of tiger conservation through superstition. They are forbidden to touch a tiger or python, and if a Chang does kill a tiger, he must undergo penance for 30 days.

THERE ARE SUPERSTITIONS associated not only with the tiger but also with various parts of its body. The claws are greatly valued all over India as talismans, and often mounted in gold or silver and set as pendants or bracelets to ward off the 'evil eye'. In the Harivijaya, a popular Marathi poem, Krishna is described as wearing tiger claws round his neck. The collar bones are considered equally valuable. The whiskers are supposed to be deadly poisonous and are carefully burned off as soon as the animal is killed. British shikaris frowned upon this particular superstition, because frequently the proud hunter would find that his gun bearers had burnt away the whiskers (lest the tiger came back to haunt them), detracting from the appearance and value of his trophy.

In some parts of south India it is believed that tiger whiskers endow their possessor with unlimited power over the opposite sex. Powdered tiger bones are used in China and Singapore as ingredients in folk medicines, particularly aphrodisiacs (another key ingredient is the plastron of terrapins). In Burma and Malaya people occasionally eat tiger flesh, which is said to give you the sagacity and courage of the tiger.

Tiger skins are sacred too — yogic meditation and chanting of mantras are traditionally performed while seated on a tiger skin. The most solemn oath of a Santhal is on a tiger skin. ■

Naresh Chaturvedi is Deputy Director (Collections) at the BNHS. An entomologist by specialisation, he also collects references to wildlife in Indian literature and mythology.

PROJECT TIGER

ARIN GHOSH



E. P. Gee

PROJECT TIGER is 20 years old. It was launched in 1973, with just nine areas under its command. Today, it has grown to cover 19 areas spreading over 29,716 sq km. The journey has been eventful and to a large extent satisfying. It has not only been able to bring back from the verge of extinction that supreme predator, the tiger, but has also evolved a concept of total conservation as an effective mode of management, rather than a simplistic effort directed towards one particular species.

Although the first few national parks and sanctuaries were set up nearly 60 years ago, it was only in the late 1960s that growing concern about environmental degradation led to the establishment of a network of protected areas. This network has now grown to about 66 national parks and 421 sanctuaries, occupying just over four per cent of the country's geographical area. These areas are the repository of India's unique biological diversity, harbouring diverse biological communities and species, some of which are already highly endangered.

It was in the early 1970s that Project Tiger was conceived in response to the global concern about the rapid decline in tiger populations. The Project

aimed at not only conserving the tiger in selected areas but also adopted a holistic approach to the rejuvenation of ecosystems. Project Tiger has been hailed the world over as a success. Fortunately, success did not lead to complacency — fortunately, because today the tiger again faces danger.

THERE ARE A number of serious problems to resolve: In the last 20 years, 300 million people and 100 million livestock have been added to the population numbers. This is a serious strain on our natural resources. The Far Eastern trade in tiger bones continues. And with tiger populations diminishing elsewhere in the world, there is a renewed demand for Indian tiger 'products'. While our tigers are relatively safe in the Project Tiger Reserves, poaching is a serious problem outside the reserves. The breakdown in law and order is another problem. Armed activists in some areas have made wildlife management practically impossible. And lastly, human intrusions into the natural system have steadily increased, with more tourism by both wildlife enthusiasts and pilgrims.

All these problems need immediate intervention. New strategies are being tested before being applied widely. Eco-development, new management and re-

search initiatives and a collective approach by the Government, NGOs and concerned individuals — only if all these go together can we herald a new era in tiger conservation.

THE TIGER CENSUS figures have come in for criticism from all quarters. There has been no improvement in the methodology. We still depend on pug-mark analysis (where subjective factors are a major element) to arrive at population figures. We have been working to improve the methods, for example by using computers, but I must confess that these efforts are still in a very nascent stage. Future censuses of tigers and other cats would attempt to correlate census results with the available prey density, which apparently at the moment is the only way to check population figures.

Tiger Reserves will henceforth be censused once in two years, and an all-India tiger census will be carried out every four years beginning from 1993, instead of once in five years as was being done till now. We have also decided to involve non-govt. experts (institutions and NGOs dealing with wildlife management) in the census process.

Though I hate to get into the game of numbers, population figures are still a convenient yardstick to measure success. In addition, we are trying to look for other coordinates of population dynamics which could be useful management tools. The 1989 figures reveal an estimated 4300 tigers, out of which about 1300 are in Project Tiger Reserves. 60 per cent of the world's tigers are in India — and if the tiger is to survive, India must play a vital role in its conservation.

DESPITE CONSTRAINTS in management and funding that all projects in developing countries suffer from, we have been able to initiate certain programmes in Project Tiger which are worth mentioning. We have found an alternative home for the rhino in Dudwa, where the reintroduction programme has been doing pretty well. Gharials and crocodiles have been accorded special protection and are now off the endangered list in this country.

The hard ground barasingha in Kanha is thriving and the people in Sunderbans have rediscovered the existence of *Batagur baska*, a freshwater terrapin which comes over to the beaches for egg laying. In

addition, a very large number of plants, insects and other invertebrates have been re-established through the efforts of the Botanical and Zoological Surveys of India.

In the days after the promulgation of the Wildlife Protection Act, wildlife management was based — quite rightly — on the concept of fines and fences. A major policy shift has been introduced to make management more participatory, allowing the people living on the fringes to coexist with parks. I am talking of eco-development programmes. Briefly stated, eco-development is a site-specific, conservation-friendly package of measures for the people who have traditionally subsisted on the forest.

It further envisages empowering such people to mobilise and become social actors rather than passive subjects, to manage forest resources, make decisions and control the activities that affect their lives. Our initial response to even the very small input that we have been able to manage so far has been very encouraging. This we call the second phase of Project Tiger.

EXPERIENCE OF two decades of managing these areas has shown that conservation and management of biological diversity is a multi-disciplinary task, requiring expertise from a large number of specialists. There is now an urgent need for all the institutions involved in the management of natural resources both in the Government and outside, to come together and evolve a cohesive and comprehensive approach, pooling their resources for the conservation of biodiversity. The tiger may be a loner, but its management cannot be left in the hands of any single institution or agency.

On the occasion of the 20th anniversary of Project Tiger, we have for the first time brought out a series of publications covering the status of the tiger and its habitat, a critical review of Project Tiger, lists of flora and fauna in the Reserves, etc. This information will form the benchmark for future conservation strategies.

As we prepare to step into the 21st century, it will be our collective effort to ensure the safety of our protected areas and our tigers. And if we are successful, there will always be hope for the tiger. ■

Arin Ghosh is Director, Project Tiger. He was earlier Field Director at the Sunderbans Tiger Reserve, where he helped to dramatically reduce man-tiger conflicts.

RAJAJI-CORBETT

Tigers, elephants and man

A.J.T. JOHNSINGH AND JUSTUS JOSHUA



E. P. Gee

IT WAS 5TH APRIL 1992. Spring had given way to summer, and bird song and the flowering of plants were at their peak. We were driving from Ramnagar to Paterpani in Corbett Tiger Reserve, with our faces glued to the window of the vehicle to make sure we didn't miss the animals. We didn't — numerous sightings of barking deer, chital and sambar; a tiger lazing in a river bed; and eight elephants rummaging through the understorey of stately sal forest.

The Corbett trip was part of the Wildlife Institute curriculum for our M.Sc. students, to allow them to study first hand the management practices at the reserve. The field work included quantification of weed abundance in the Dhikala grasslands and elephant damage to trees, and data collection on the population structure of elephants. We wound up our work on the 11th and drove back from Paterpani to Dehra Dun through the forests across Kalagarh

reservoir, Sonanadi Wildlife Sanctuary, the Rajaji-Corbett corridor and Chilla.

The five hour drive gave us a picture of the sole (but still expansive) tiger and elephant country in north-west India. Thus far it could be considered as one habitat extending from the Kosi river in the east to the Yamuna in the west. Like any other wildlife area, it has its problems. But it also has enormous potential for large mammal conservation and ecotourism. We name this Rajaji-Corbett Reserve, and its area is between 2500 and 3000 sq km.

AHUNDRED YEARS ago the *bhabar* and *terai* forests extended for several tens of kilometres from the present southern boundary of Rajaji-Corbett. The northern boundary (see map) was formed by two distinct habitat types — between the Yamuna and Ganga by valley forests dominated by sal; and between the Ganga and Kosi

by the Outer Himalaya, which had unbroken goral habitat. Sambar, barking deer and leopards abounded in this mountainous terrain and the stray tiger found a comfortable home here. Huge shoals of giant golden mahseer lived in the sky blue, clean, cold waters of the Ganga and Ramganga rivers. King cobras up to four metres long were common.

Teeming populations of hog deer and barasingha (both rare now) lived in the *terai*. And because the *terai* had heavy rainfall and consequently deadly malarial climate for five months of the year (May to September), man stayed out. The area was a hunter's and fisherman's paradise. F.W. Champion in his book "With a camera in Tiger-land", first published in 1927, writes that during five years in Lansdowne Division 42 tigers, 32 leopards, 98 sambar and four crocodiles (now extinct) were shot.

This wildlife splendour has almost become a thing of the past. Gone are species such as the rhino and wild buffalo, which should have occurred here even as late as the middle of the last century. Over the years much of the area, particularly the *terai* belt (as a result of control of malaria) has been lost to agriculture. Human and cattle populations have shot up; villages and small towns have grown in size. Consequently the pressure on the forest for fodder, firewood and timber has gone up manifold.

Grasslands, which are important habitat components for chital, hog deer and barasingha, were considered wastelands and planted with *Eucalyptus*, *Acacia catechu*, *Dalbergia sissoo* and *Ailanthus excelsa*. Only minuscule mahseer now survive in the Ganga; their populations have been decimated by gill-netting, their habitat modified by the construction of barrages and diversion of water. Fortunately, they still thrive in the Ramganga.

THE 1960S SAW many development projects carving chunks out of prime tiger and elephant habitat. When the 90 sq km Ramganga reservoir filled up with water in 1974, the regular elephant migratory route to Adnala and Sonanadi (Hathi kund) ranges of Kalagarh forest division was totally cut off. A few elephant groups eventually found a way to the bamboo-rich Kalagarh forests across the hills north of the reservoir, but the migratory patterns and habitat use of elephants in Corbett have changed. Tigers have lost 40-60 sq km of excellent alluvial flood plain habitat dominated

by *Arundo donax* and *Phragmites karka* grasses and tenanted by an abundance of chital, hog deer and wild pig.

The devastating impact of development projects on Rajaji-Corbett is obvious on both sides of the Ganga. The 14 km long Kunaun-Chilla power channel, built in the early '70s, runs parallel to the left bank of the river, and has drastically reduced the access of elephants from Chilla to the mighty Ganga. Nearly 15 sq km of habitat (including at least 8 sq km of grassland) has also become inaccessible to elephants. Fortunately the power channel is not an impediment to tigers — they use the aqueducts under and the bridges above the channel. What discourages the tigers from ranging freely across the Ganga between Chilla and Motichur forests are the mushrooming development projects on the west bank, leading to habitat loss and more pronounced habitat fragmentation.

The biggest among these projects on the west bank are the Indian Drugs and Pharmaceuticals Ltd. factory, Raiwala army camp and Raiwala army ammunition dump. 25 families evicted from the Tehri dam were also settled in the area — bang in the middle of the only remaining patch of forest between Motichur and the Ganga.

AS A RESULT elephant groups and tigers, which avoid highly disturbed areas, have apparently stopped crossing the Ganga. Only an occasional elephant bull moves between Chilla and Motichur during summer and winter and brings about genetic exchange between the populations on either side of the Ganga. And if the disturbances grow further in the corridor area, even this movement of bulls will cease.

On the west bank of the Ganga is an isolated population of 10-15 tigers, beleaguered by loss of habitat and increase in human disturbance. Rajaji is the best tiger habitat on the west bank; Motichur and Shivalik forest divisions are seldom used by tigers. The forests west of the Yamuna (in Himachal and Haryana) only have stray tigers. Only time will tell whether this small tiger population in Rajaji will survive in isolation.

Over the years most forest areas within Rajaji-Corbett have shown serious signs of degradation as a result of over-use of habitat by the Gujjars, a local pastoral community, and the surrounding villages.



Sambar in velvet

Eric D'Cunha

Gujjars came to the Shivaliks from Jammu several hundred years ago as part of the dowry of the princess of Nahan in Himachal Pradesh. They keep large numbers of buffaloes and feed them by lopping trees.

Wildlife benefits in three ways from the presence of the Gujjars. The lopped fodder is also eaten by wild ungulates. Gujjars are a hospitable community; wildlife guards often rest in Gujjar *dheras* (hutments), which are scattered throughout the forest, while on patrol duty. And thirdly, the Gujjars dig waterholes in the river bed in late winter and summer, when the *bhabar* tract becomes dry, providing water to wild animals including elephants.

But this is a mixed blessing — creation of waterholes in a dry habitat during summer is not advisable because ungulates, contrary to their usual dispersal pattern in summer, may aggregate around waterholes and thereby seriously damage the surrounding vegetation. (But on the other hand, if water is not available inside the forest the animals may stray outside to seek water in the crop fields, creating a conflict with human interests.)

NEVERTHELESS, ALL THE benefits are nullified by the damage that Gujjars and their buffaloes cause to the habitat by lopping, over-grazing and over-utilization of firewood. In winter, from November to February, each *dhera* keeps a log fire burning throughout the night. As a result of lopping and over-grazing, the forests abound in weeds and the palatable tree species totally lack regeneration. Essentially, human activity (Gujjars and others) has severely depleted the quality of wildlife habitat.

In the past the Gujjars left the Shivaliks around April for high altitude pastures in the Himalaya, where they stayed till October. Now the local

graziers in the Himalaya find their meadows overcrowded, and have begun to resent the Gujjars. In some places Gujjars are now asked to pay huge 'royalties'. As a result of these problems many Gujjars are forced to stay in the Shivaliks throughout the year.

This has proved disastrous for the vegetation, soil and water regime. In summer, most waterholes are so polluted by their buffaloes that they are unfit for elephants to drink from. At the remaining springs, there is often conflict between Gujjars (who come to get their drinking water) and elephant herds that aggregate for water in the evenings. Usually the Gujjars shout and pelt stones at the elephants, and drive them away.

IN SPITE OF all these problems even the disturbed areas in Rajaji-Corbett show the potential for revival of plant and animal life. For example, Dholkand in Rajaji, an area of 6-8 sq km, is free from *dheras* and has enjoyed protection from cattle grazing and lopping for the last 15 years. Other areas of Rajaji have languished under these disturbances, but Dholkand abounds in wildlife including the tiger and king cobra. It is one of the few places in Rajaji where we drink from the springs without any fear of infection. Often we drink from the same spot at which tigers have drunk. But the growing disturbance all around Dholkand makes us wonder how much longer we will be able to savour this unique experience.

Four steps are urgently needed to foster Rajaji-Corbett as a unified, fine tiger-elephant habitat. The first priority is to create a corridor between Chilla and Motichur, for which land must be acquired from the army and the Tehri dam oustees. But army land can be acquired only if the Secretaries of the Ministries of Defence and Environment & Forests sit

together and sort out the problem. So far they have shown no signs of urgency, and meanwhile one of India's finest tiger-elephant habitats is becoming totally fragmented.

If suitable land and compensation is given, the Tehri dam oustees can be persuaded to leave the corridor area. Thereafter the one square kilometre of land between Motichur and the Ganga should be assiduously protected to allow vegetation to grow back. The islands on the Ganga — which are now summer camping grounds for illegal fishermen and cattle graziers — should also be totally protected, so that even the sambar and tiger would spend the daytime there.

Today, on summer evenings we see sambar crossing the river to feed in the islands; but when dawn breaks they return to Chilla. Only the nilgai, which is rather tolerant of disturbance, lives continuously on the islands. The one square kilometre Chilla-Motichur corridor is the easiest corridor the country has to create. It is sad that we have dilly-dallied over it for the last ten years.

The second important step should be the resettlement of Gujjars. They should be given sufficient land (at least one hectare per family) and involved with decision making in the resettlement process. Even the most ardent Gujjar supporter should know that their present life style is incompatible with the ecological process of the ecosystem in which they live. If this life style is allowed to continue, both the forest and the Gujjars will be doomed. An acceptable resettlement package must be offered to them. Other steps needed are eco-development programmes all along the forest boundary and control of poaching.

WILDLIFE CONSERVATION in India is passing through a crisis. Human population has almost doubled since the inception of Project Tiger in 1973 and is now close to 900 million. In many areas the lower level forest staff have to face local discontentment. In most places local people meet the majority of their biomass needs from the forest, and sometimes turn aggressive. Insurgents have taken shelter in some protected areas, threatening the life and property of the staff. As a result, staff morale in most areas is very low. We need programmes to involve local people and infuse confidence in the staff.

What Rajaji-Corbett really needs is a combined

programme under Project Elephant and Project Tiger, with the sole objective of reviving and maintaining the habitat to continue to support the present population of about 500 elephants, and build up the extant population of about 100 tigers. This conservation programme in fact would be the best way of saving the biodiversity of this area.

MOST WILDLIFERS ARE great dreamers. We dream of clean air, of lakes and streams that are free of pollution and full of fish, of forests teeming with wildlife. We dream of Rajaji-Corbett as one elephant-tiger conservation area managed by a committed, wildlife oriented officer of the rank of Chief Conservator of Forests, with the designation of Director of the Reserve.

Conservation programmes in the Reserve should be three-pronged: First, weed eradication, restoring habitat continuity and enforcing strict protection. The staff should be given basic facilities — uniforms, weapons, communication equipment, transport, accommodation, education facilities for children — and periodic training in wildlife censuses, habitat monitoring and resolving conflict with local people.

Secondly, we need to promote ecologically sustainable income generating ventures for villagers living near the Reserve, so as to reduce biotic pressures and win their support for conservation. The third aspect should be resettlement and welfare measures for the Gujjars.

The results would perhaps come slowly. But gradually, biotic pressures would disappear. Barking deer would reappear in once degraded areas, and the nights would ring with the alarm calls of the sambar, indicating that the big cats were on the prowl. Money for such conservation programmes is not very difficult to raise, and committed forest officers are available to implement such schemes. Will these dreams be realised? ■

Dr A.J.T. Johnsingh, Jr. Director of the Wildlife Institute of India, is a member of the IUCN Specialist Groups on cats, canids and the Asian elephant. He was the prime mover behind a number of landmark studies, including those on the dhole, Nilgiri tahr and Himalayan ibex. Justus Joshua is a Research Fellow at WII, and a crack birdwatcher. He did his Ph.D. on the grizzled giant squirrel in Alagarkoil valley, Tamil Nadu, and for the past four years has been studying the ecology of elephants at Rajaji National Park.

TIGER HAVENS

CORBETT

Total area 1134 sq km, core area 338 sq km. Estimated population 92 tigers.

Himalayan foothills of Uttar Pradesh, 300 km north-east of Delhi. India's first national park, and launching pad for Project Tiger in 1973.

Biodiversity unmatched outside the north-east. Both Himalayan and plains fauna; the mammals include the spotted linsang, recently reported. Over 550 species of birds, including at least 60 species of raptors.

Several major problems: disturbance due to the Ramganga Irrigation Project and its 8,000 staff. Heavy grazing pressure and human disturbance in some parts; relocation of villages proposed. Irresponsible VIP tourists. Some poaching. Extremist/terrorist activities already serious, and increasing.

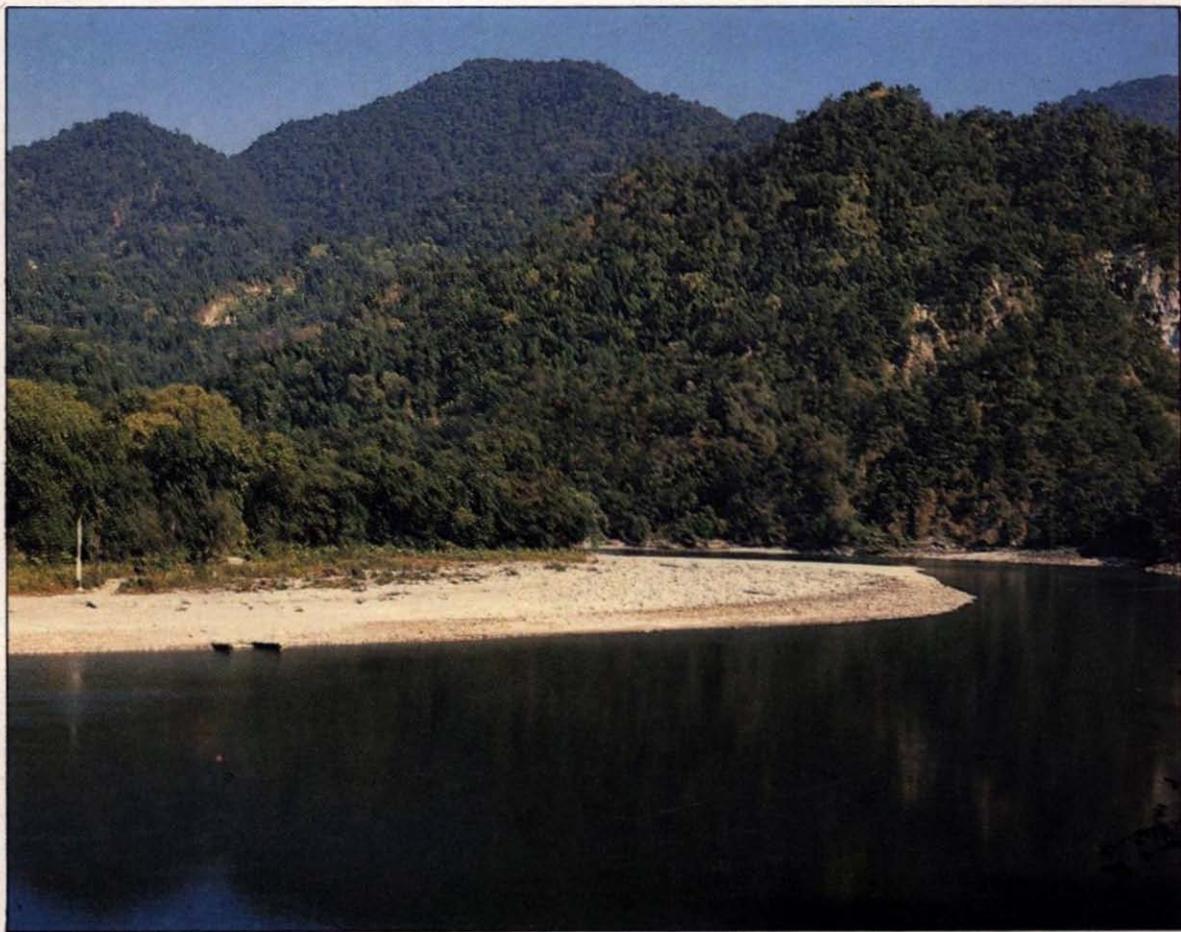
MANAS

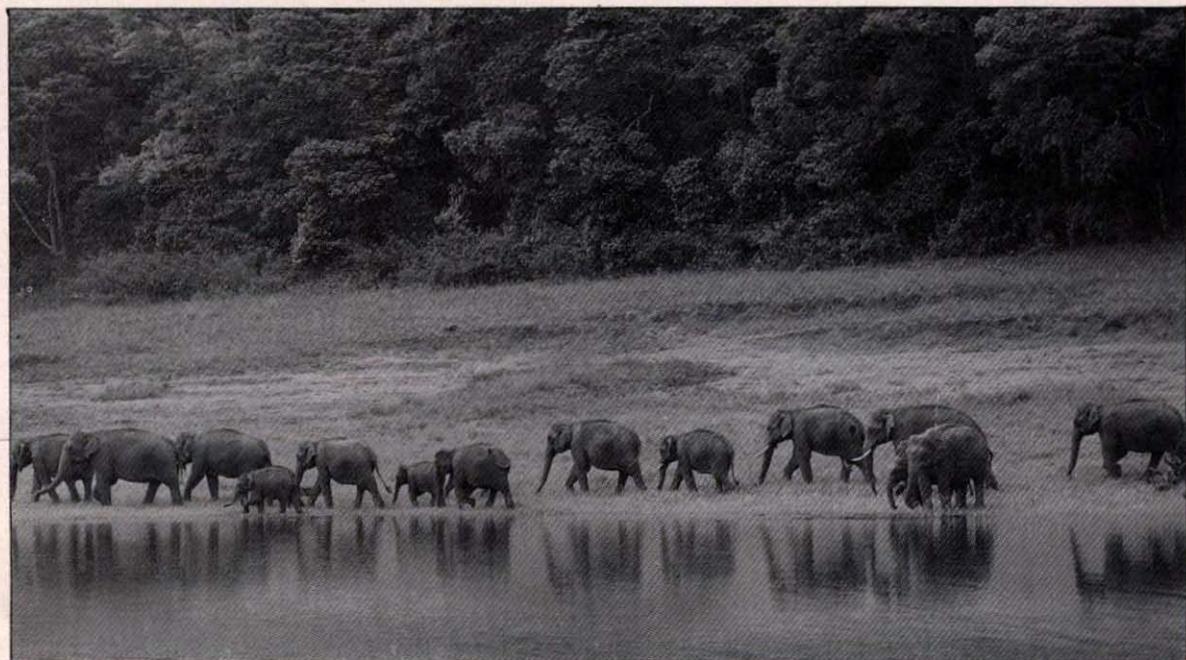
Total area 2837 sq km, core area 470 sq km. Estimated population (1988) 92 tigers.

Located at the foot of the Bhutan Himalayas in Barpetta district, Assam. Part of Manas lies in Bhutan. Declared a Project Tiger area in 1973. High rainfall and extremely varied habitat and frequent changing of course by the Manas river. Very high biodiversity, including 22 endangered species. Mammals include the endemic golden langur; the pygmy hog, which is now probably restricted to Manas; and wild buffalo, which are found here in their genetically purest form.

Major problems – Bodo agitation and resultant violence; poaching and till recently, large scale hunting for food.

Manas river, with Bhutan in the background.





M. Krishnan

Periyar's waterbodies harbour a substantial aquatic fauna, and provide excellent habitat for animals like elephants.

DUDWA

Total area 811 sq km, core area 648 sq km. Population estimate (1992) 101 tigers.

Lakhimpur-Kheri district, Uttar Pradesh, near the Nepal border. Included in Project Tiger in 1988, but final notification as a national park still pending. A moderately successful rhino rehabilitation programme, but swamp deer declining rapidly. Man-eating earlier a severe problem, but now under control.

Major problem – terrorists. Probably large scale hunting on the periphery, of animals straying outside. Disturbance from railway tracks and roads running through the park. An intrinsic problem is the boundary delineation of the park, which excluded many swamp, reed bed and grassland areas which are an integral part of the terai ecosystem.

MELGHAT

Total area 1597 sq km, of which 110 sq km is under cultivation; core area 308 sq km. Estimated population (1992) 72 tigers.

Amravati district, Maharashtra, in the southern reaches of the Satpuras. Final notification as a national park still pending.

Heavy biotic pressure from 59 villages in the buffer, containing 17,000 people and 21,000 cattle. Extensive crop damage by wildlife; relocation of six villages planned. Several schemes implemented for habitat improvement, particularly water availability.

PERIYAR

Total area 777 sq km, core area 350 sq km. Estimated population 46 tigers.

Idukki district, Kerala, in the Western Ghats. Declared a Project Tiger reserve in 1978, but legal status as a national park still pending. Mammals include tiger, elephant (estimated population 980 in 1989) and the endangered Nilgiri tahr.

Some poaching. Lakhs of pilgrims to the Ayyappa temple create large scale disturbance and pollution. Illegal exploitation of *Cinnamomum* trees for bark.

PALAMAU

Total area 928 sq km, core area 213 sq km, including original core plus a newly-designated 'satellite core'. 1991 estimate 54 tigers.

Palamau district in the Chhotanagpur plateau, Bihar. Brought under Project Tiger in 1973, declared a national park in 1989. Mammals include 100 + elephants, descended from 20 odd captive animals released in 1920.

Severe biotic pressure. 107 villages in the buffer, 3 in the core, with a human population of 65,000 and 45,000 livestock. A drought prone area, endemic poverty causing local resentment, encroachment, poaching and violence. Excessive weed growth and introduction of exotic grasses have caused decline or emigration of some herbivores.



Shashi Menon

KANHA

Total area 1945 sq km, core area 940 sq km. Estimated population 100 tigers.

Mandla district, Madhya Pradesh, in the Satpura range. Brought under Project Tiger in 1973. Substantial research work done, particularly on the tiger. Notable conservation efforts include the successful comeback of the endangered hard ground barasingha.

Local resentment (because traditional rights of access were banned) is a major problem. Major eco-development schemes planned.

BANDIPUR

Total area 866 sq km, core area 523 sq km. Estimated population (1989) 50 tigers.

Mysore district, Karnataka. Together with Mudumalai and Wynad sanctuaries and Nagarhole national park, forms about 2,500 sq km of contiguous habitat, harbouring south India's largest elephant population. Established as a Project Tiger Reserve in 1973-74.

Moderately heavy grazing pressure; sandalwood smuggling and ivory poaching. A national highway runs through the reserve.

NAMDAPHA

Total area 1985 sq km, core area 1808 sq km. Population estimate 49 tigers.

Tirap district, Arunachal Pradesh. Included in Project Tiger in 1983. Also a biosphere reserve. Altitude range from 200 to 4500 m, and extremely varied vegetation. Spectacular biodiversity with high endemism and a profusion of orchid species. The only area with four big cats (tiger, leopard, clouded leopard, snow leopard). Other mammals include the hoolock gibbon, takin and Namdapha flying squirrel, discovered in 1983.

Biotic pressure minimal because of remoteness and terrain. Frequent army patrols (in search of insurgents) and habitations on the periphery are possible problems in future.



Isaac Kehimkar / DPA

SIMLIPAL

Total area 2750 sq km, core area 846 sq km. Estimated population (1992) 95 tigers.

Mayurbhanj district, Orissa. Declared a Project Tiger Reserve in 1973. Large subterranean reservoirs ensure a perennial water regime

Heavy biotic pressure (encroachment, grazing, wood cutting and deliberate forest fires), mainly from the 850 villages on the periphery. The Akhand Shikar, an annual traditional hunt, involves 500 to 600 people (mainly tribals); at least 500 animals are killed each year.

SUNDARBANS

Total area 2585 sq km, core area 1330 sq km. Estimated population 269 tigers.

24 Parganas district, West Bengal. Declared a Project Tiger Reserve in 1974. Also a biosphere reserve and a World Heritage site. The only remaining mangrove swamp tiger habitat in India; consists of a cluster of islands amidst tidal swamps, contiguous with large, similar areas in Bangladesh.

About 40 people killed by tigers each year. Other problems are timber smuggling, increase in salinity and reclamation of the upper delta for agriculture.

SARISKA

Total area 800 sq km, core area 492 sq km, split into 3 non-contiguous areas. Most of the reserve still awaits final notification. Estimated population (1992) 22 tigers.

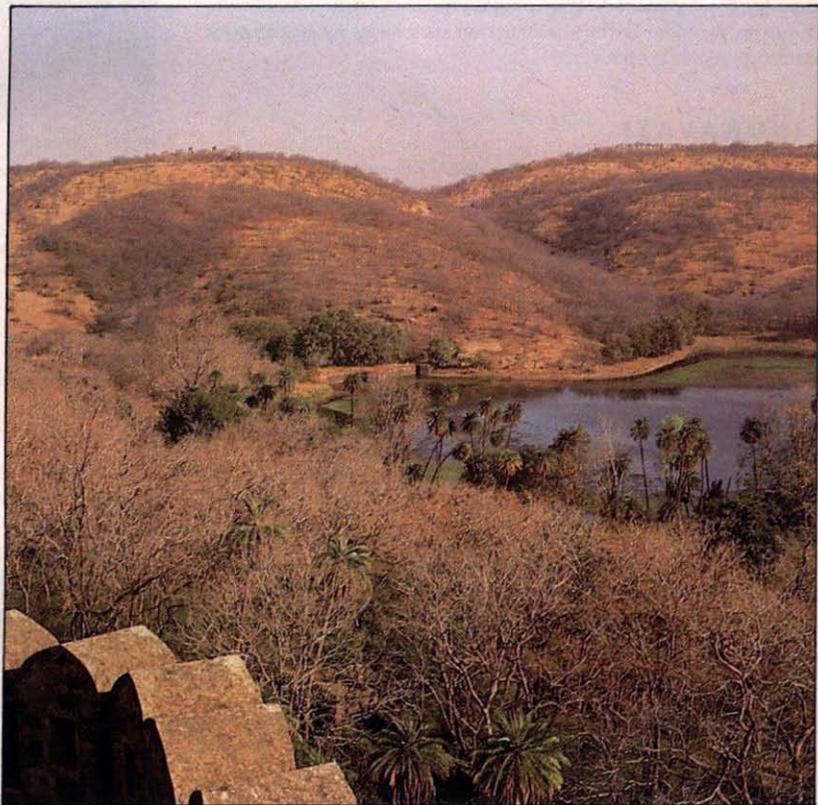
Alwar district, Rajasthan, in the Aravallis. 17 villages each in the core and buffer, with large livestock populations (10,000 cattle in the core). Alwar town and about 125 villages on the periphery. Two state highways pass through the reserve. Heavy disturbance from tourism. Over 200 dolomite mines within or just outside the park.

RANTHAMBHORE

Core area 392 sq km, of which only one-fourth is effective. Total area 1174 sq km, of which half is constituted by the Keladevi Sanctuary which was brought under the Project Tiger management last year. Estimated population 44 tigers in 1989.

Sawai Madhopur district, Rajasthan, at the junction of the Aravallis and Vindhya. Declared a sanctuary in 1955, included in Project Tiger 1973. Formerly the hunting grounds of the Maharajas of Jaipur. Unusually high visibility of tigers, hence world famous.

Heavy biotic pressures from 62 villages in the buffer, with 225,000 people and over 150,000 livestock. Tiger populations are declining, probably due to large scale poaching. Eco-development schemes launched in 1989, and shortly to be expanded.



Sunjoy Monga / PORPOISE

NAGARJUNASAGAR- SRISAILAM

Total area 3568 sq km, core area 1200 sq km. Population estimate (1989) 94 tigers; no subsequent census due to extremist interference.

In the catchment of the Krishna river in Andhra Pradesh. Included in Project Tiger in 1983. Approximately 150 bird species recorded; mammals include the rare pangolin.

Major problem - armed extremists. Heavy grazing pressure on the fringe areas, also firewood collection and timber smuggling. 36 tribal villages in the core, 1500 population. Future encroachment by non-tribals could be a serious problem. Administrative problems because the reserve staff are drawn from five districts. Low herbivore populations, and consequently high incidence of cattle lifting by tigers.

BUXA

Total area 759 sq km, core area 315 sq km. Estimated population 25-30 tigers.

Eastern Himalayan foothills of West Bengal, bordering Assam and Bhutan. An important corridor, linking north Bengal and Manas. Original forest cover fragmented and extensively modified due to timber logging and teak plantation. Included in Project Tiger in 1983, but under their management only since 1992.

Extensive forestry operations in the buffer. Biotic pressure from villages within and just outside the reserve, with human population 200,000, livestock 112,500. Resentment due to crop damage by elephants. Some dolomite mining within the reserve. A future problem is the construction of a large multi-purpose dam on the Sankosh river.

INDRAVATI

Total area 2799 sq km, core area 1258 sq km. Estimated population (1989) 28 tigers.

Bastar district, Madhya Pradesh. One of the few remaining natural areas in Bastar, and potentially an important corridor linking reserves in several states. Included in Project Tiger in 1983, but legal notification as a national park still pending. Mainly mixed deciduous forest with sparse undergrowth. Some evergreen forest, marshes and grassland.

The only tiger reserve apart from Manas that contains viable populations of wild buffalo. Also a possible relocation site for the endangered hard ground barasingha, now found only in Kanha. Plans to shift 76 villages (population 5,456), of which 20 are already deserted, from the core area.

Major threats - poaching, armed insurgents, tree felling, adverse effects of iron ore mining outside the reserve, and the planned construction of a series of dams on the Indravati.

KALAKAD-MUNDANTHURAI

Total area 800 sq km, core area 571 sq km. Population estimate (1989) 81 tigers.

Southern tip of the Western Ghats in Tirunelveli district, Tamil Nadu. Declared a Project Tiger reserve in 1988, but legal status as a national park still pending. The southern limit of tiger range in India. Varied vegetation and perennial water; correspondingly high faunal diversity. Mammals include significant populations of the endangered Nilgiri tahr.

Major problems - poaching and collection of sandalwood, cane cardamom and cinnamon.

VALMIKI

Total area 840 sq km, core area 336 sq km. Population estimate (1989) 80 tigers.

West Champaran district, Bihar, contiguous with Chitwan national park in Nepal. Included in Project Tiger reserve in 1990, but not yet notified as a national park.

Mammals include rhinos, some being migrants from Nepal.

Major problems - lack of administrative control (area is managed by the Forest Development Corporation, not by Project Tiger); poaching and smuggling. No villages in the core; eight villages with 32,000 livestock in the buffer.

PENCH

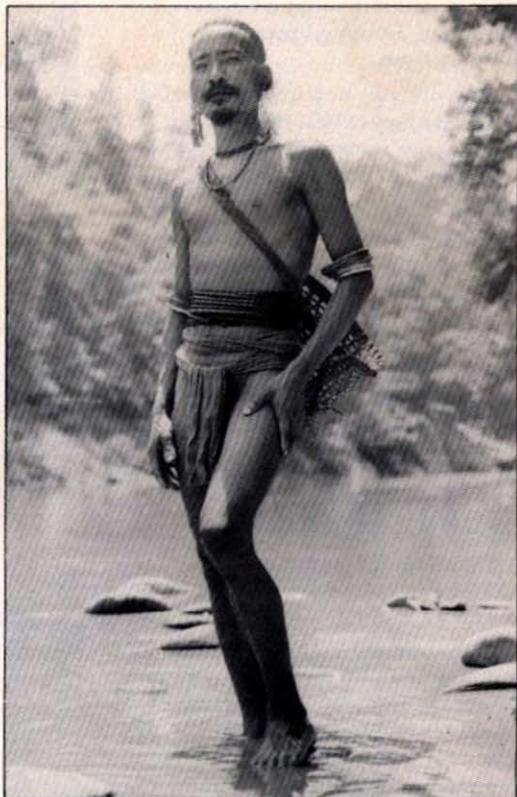
Total area 758 sq km, core area 293 sq km. Population estimate 25 tigers.

Seoni and Chhindwara districts of Madhya Pradesh, contiguous with forested tracts in Maharashtra. Included in Project Tiger in 1992.

Deciduous forest with a number of streams and nullas, mostly seasonal; several perennial water-holes.

Two villages in the core, are planned to be relocated.

Reserve areas and population figures courtesy Project Tiger Directorate.



Tribals like this Naga, who co-existed with the forest for centuries, have been displaced, alienated and impoverished, first by immigrant settlers, then by conservation policies that gave them insufficient control over their own future.

DONATIONS

BNHS members have always been supportive of the Society and its activities, contributing both by way of donations and by unstintingly giving of their time to help the Society's conservation message reach a wider audience. A few months ago, the Honorary Secretary, Dr. Ms Meena Haribal, made an appeal for donations, and our members responded magnificently. The list of major donors for the period January to March 1993 (listed alphabetically) is as follows.

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for financial support for the publication of Hornbill.

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The Bombay Natural History Society was formed 109 years ago, as a forum for exchanging information on natural history. Over the years, it has helped to shape the course of wildlife conservation in India. Its members and scientists have helped document India's diversity of wildlife; BNHS studies on little-known and highly endangered species have provided the basis for many conservation projects, and indeed for the establishment of some of India's best known sanctuaries and national parks.



A nine year BNHS study on elephants has provided new insights on the biology of these threatened giants.

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The use of a reference collection — recognised by the government of India as a National Heritage Collection — of specimens of birds, mammals, butterflies and reptiles, built up over more than a century.

Today, the BNHS is Asia's premier conservation organisation, with members in over thirty countries and an international reputation as an authority on Indian wildlife.

The Society's work is not restricted to wildlife research. Its publications wing has produced a series of books on natural history, many of which are standard works of reference. It runs a nature education programme of over fifty years' standing, propagating conservation through film shows, lectures and nature camps for students, biology teachers and the Society's members.

BNHS members enjoy a range of activities — film shows and lectures on natural history, regular weekend bird-watching trips, and the opportunity to participate in environmental conservation campaigns, and even field studies in wildlife sanctuaries and national parks.



The lesser florican is one of the world's most endangered birds. BNHS studies have focused on the critical factors involved in the conservation of such species.

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