SNAKEBITE: A CLINICAL PROFILE, EPIDEMIOLOGY, PREVELANCE, BLIND BELIEFS, MEDICAL TREATMENT, PROPHYLAXIS AND MORTALITY IN SAURASHTRA

THESIS SUBMITTED TO
THE SAURASHTRA UNIVERSITY, RAJKOT
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

by

DILIP A. ODEDARA

Registration No: 3087
Date of Registration: 3rd October 2003

Faculty: Science
Subject: Zoology

UNDER THE GUIDANCE OF

PROF. V. C. SONI

DEPARTMENT OF BIOSCIENCES
SAURASHTRA UNIVERSITY
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Dedicated to those

who died due to

snakebites

SAURASHTRA UNIVERSITY

DEPARTMENT OF BIOSCIENCES
RAJKOT

CERTIFICATE

This is to certify that the thesis entitled **"SNAKEBITE : A CLINICAL PROFILE, EPIDEMILOGY, PREVELANCE, BLIND BELIEFS, MEDICAL TREATMENT, PROPHYLAXIS AND MORTALITY IN SAURASHTRA"** is an original work submitted to Saurashtra University, Rajkot by ***Mr.Dilip A. Odedara*** **(Regd. No. 3087, Dated 3rd Octobar, 2003)** in fulfullment of requirement for the degree of Doctor of Philosophy.

I further certify that this work has not been submitted for any degree of diploma to any other University / Institution.

Date :

Place:Rajkot

Through

(V.C.Soni)
Prof. & Supervisor

Head
Department of Biosciences
Saurashtra University
Rajkot

DECLARATION

I, ***Mr. Dilip A. Odedara,*** the undersigned, hereby,solemnly declare that the work presented in the thesis entitle **"SNAKEBITE : A CLINICAL PROFILE, EPIDEMILOGY, PREVELANCE, BLIND BELIEFS, MEDICAL TREATMENT, PROPHYLAXIS AND MORTALITY IN SAURASHTRA"** is original and indipendent.

I further declare that this work has not been submitted for any degree of diploma to any other University / Institution.

Date :

Place:Rajkot

Signature of Candidate

(DILIP A. ODEDARA)

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Dilip. A. Odedara

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SUMMARY

Though, snakes are deeply rooted in Indian culture and tradition, exposure to a variety of venomous snakes and snakebite is an environmental health risk in India. However, there is no reliable national or regional statistic available on the magnitude of snakebite incidences in India. Therefore, present study was conducted in Gujarat and especially for the Saurashtra region to systematically collect the information on snakebite and analyze them to find out the magnitude of snakebite, the region with high incidence of and the section of population that is more susceptible to snakebite and evolve the strategy to reduce loss of human lives.

A total of 2087 snakebite incidences were collected between the year 2002 to 2005 from all over Saurashtra region which include seven districts. The data were collected from the Government hospitals at district levels, taluka levels and at Public Health Centers (PHCs) from rural areas. For each snakebite incidences, information on the name of the person (victim), age, sex, occupation of victim, were collected as per the availability of record. Data on whether victim believe on any orthodox method of curing snakebite such as treatment by witchcrafts (bhuva and tantric) etc. was collected to assess the prevalence of myth or blind beliefs in this region.

The analysis of the information collected showed that the average annual snakebite incidences in Saurashtra region (seven districts) were recorded to be 695.6 ±118 SE (n=2087) from 2002 to 2005 which ranged from minimum of 429 incidences in 2002 to maximum of 893 incidences in 2003. The data suggest that annually one person is subjected to snakebite out of every 19381 people of the total population of Saurashtra. However, in rural areas of Saurashtra region annually one person is subjected to snakebite per every 12007 persons. The data also suggested that every 96.0 km^2 one person is subjected to snakebite annually in Saurashtra region.

The annual average snakebite incidences were higher in the districts of Jamnagar (169), Junagadh (147), Rajkot (147) followed by Amreli (95), Bhavnagar (72), Surendranagar (55) and Porbandar (37). Of the total population of various districts, Jamnagar district showed that at every 11268 persons of the general population and 6320 of rural population one person is subjected to snakebite annually. This was followed by Porbandar district where one person per every 14380 of general and 7387 persons of rural population is subjected to snakebite. However, in Bhavnagar district, it was found that annually, one person is subjected to snakebite at every 34540 of general and 21463 of rural populations. The intensity of snakebite cases in terms of area per snakebite incidence was also assessed which was higher in Porbandar district where every 30.6 km^2 one snakebite incidence was recorded which was followed by Junagadh (72.3 km^2), Amreli (77.5 km^2), Rajkot (80.6 km^2), Jamnagar (83.6 km^2), Bhavnagar (156 km^2) and Surendranagar (190.7 km^2).

Maximum snakebite victims contributing 15.2% of total snakebite incidences were of age between 20-25 years. However, almost one third of the total victims i.e. 30.1% of snakebite incidences were of between 20-30 years of age. It was also noteworthy that, more than half of the victims contributing 55.1% of the total snakebite incidences were of age between 15 –35 years. It was observed that snakebite incidences increases with the increase in the age class up to the age of 20-30 and again showed decreasing trend afterward till the age class of 45-50. However, 9% of the total snakebite victims were above 50 years of age. It was observed that 60.3% (n=2206) of the total victims were males and 39.7 % were females. The male snakebite victims were higher in almost all the age classes than the female victims.

Maximum snakebite incidences were observed to occur during monsoon (June-September) i.e. 47.82 %, followed by20.38 % during post monsoon (October-November), 18.7% during summer (March-May) and 10.05% during winter (December- February). Maximum incidences of snakebite were observed to occur in the month of October contributing 14.2% of the total incidences annually. During the months of July and September the snakebite cases were 13.3% each of the total snakebite cases occurred annually followed by 10.9% in August, 10.3% in June and 8.5% in the month of May. However, snakebite cases were observed to occur low in other months i.e. January to April and November, December, which contributed less than 6.5 % of the annual snakebite incidences.

Majority of the snakebite victims (n=218) interviewed during 2005 from seven districts were farmers (32.9± 2.5 %), agriculture laborers (31.3±3.6 %), other laborers (15.4±2.4 %), hose wives (6.8±1.0 %) and others were (13.6± 2.5%). The victims involved in agriculture related occupation i.e. farmers and agriculture laborers contributed to the major percentage (64.2%) of the total snakebite incidences in the region. The district wise analysis of occupations of snakebite incidences showed that in all the districts the farmers and agriculture laborers were the prime victims however, in the districts of Bhavnagar, Rajkot, and Surendranagar the contribution by the people involved in agriculture related occupation was relatively lower.

The study showed that there is a strong positive correlation (r =0.91) between the area (in hectors) under groundnut crop and the annual snakebite incidences in Saurashtra region. Junagadh, Jamnagar and Rajkot districts are found to be the major groundnut producing areas accounting for 67% of the total area under groundnut crop of Saurashtra region, these districts have also showed 64.1% of the total annual snakebite incidences of the Saurashtra region. However, there was no correlation between average annual snakebite incidences and area under cotton (r = 0.005), and there was negative correlation between area under millet crop (r = -0.33) and area under fodder cultivation (r = -0.33).

On the average 93.4 ± 1.2 % (SE, n=218 victims from 7 districts) of the interviewed snakebite victims were taken directly to hospital for proper medical treatment and 6.6 ± 1.2 % (SE) were taken to witchcrafts for initial treatment suggesting their belief in myth that witchcraft could treat the snakebite case. The prevalence of such misbelieve was higher in Amreli district as 11.4 % of the total annual victims were taken to witchcraft for treatment after snakebite incidences. However, it was followed by Porbandar with 10.5 % and Surendranagar 6.1% of the sampled victims believed that snakebite could be treated by witchcrafts. On the contrary majority of the snakebite victims from Bhavnagar (96.3%), Rajkot (94.3 %), Junagadh (95.0) and Jamnagar (96.6 %) districts were taken to hospital immediately for proper medical treatment.

Based on the data and analysis the present study recommended that 1) the magnitude of snakebite incidences needs to be regularly quantified and monitored 2) there is an urgent need for developing and implementing a comprehensive awareness-razing package for highly susceptible section of the population i.e. males of age between 15-35 years, particularly in intensive groundnut producing districts in monsoon and post-monsoon needs to be targeted on priority bases to educate and made aware to prevent snakebite 3) the awareness campaign should be conducted during monsoon and post monsoon seasons using of various media 4) there is a need to build capacity of the Government hospitals to be able to handle snakebite cases efficiently, which may need trained staff, infrastructure and enough stock of antivenom in the region.

CHAPTER: 1
INTRODUCTION

Snakebite is a serious public health hazard in many regions, particularly in tropical and subtropical countries (Warrell 1992; Chippaux 1998; Swaroop and Grab 1954). The burden of snakebite envenoming causing both morbidity and mortality still has a great impact on the population and on health-care systems, especially in Africa, Asia, Oceania, and Latin America (Theakston *et al*. 2003). However, there is very little hard evidence of a numerical nature to enable us to understand the issue in detail and assess the magnitude of mortality and morbidity. Unfortunately, public health authorities, nationally and internationally, have given little attention to this problem, relegating snakebite envenoming to the category of a major neglected disease of the 21st century.

In the tropical developing countries where snakebites occur most commonly, there are few reliable incidence data. One serious attempt to assess global snakebite mortality was the survey undertaken by Swaroop and Grabb in 1954, which was based largely on hospital admissions (Swaroop and Grab 1954). Subsequent work has revealed gross underreporting of deaths for example, in Nigeria (Warrell and Arnett, 1976) and Thailand (Warrell 1992 and 1995). One reason is that records of patients treated by traditional methods are missing from official databased statistics, and deaths reported at the hamlet or district level may not be sent on to the higher levels. Accepting these limitations, the fragmentary evidence available suggests that several million bites and envenomings occur worldwide each year, with tens of thousands of deaths (Chippaux 1998; Swaroop and Grab 1954). The reasons for the high levels of snakebite mortality

in tropical developing countries include scarcity of antivenoms, poor health services, and difficulties with rapid access to health centers (Theakston and Warrell, 2000). Large numbers of victims survive with permanent physical and psychological sequelae mostly due to the tissue-damaging effects of snake venoms.

Of the 2500-3000 species of snakes distributed worldwide, about 500 are venomous. The major families of venomous snakes include atractaspididae, elapidae, hydorphidae and viperidae. Most severe cases of snakebite envenoming are inflicted by species of the family elapidae (Cobras, Kraits, mambas, Australasian species, and sea snakes) and the family viperidae (rattlesnakes, lance-headed Pit Vipers, and true vipers). The species causing the largest numbers of bites and fatalities are *Echis* sp. (Saw Scaled Viper) in northern Africa, *Bothrops asper* and *B. atrox* (Lance-headed pit vipers) in Central and South America, and *Naja* sp. (Cobras) and *Bungarus* sp. (Kraits) in Asia (Warrell 1995a; Warrell 1995b; Gutiérrez 1995; Fan and Cardoso 1995). Many other species, although not responsible for a large number of cases worldwide, constitute a serious problem in specific regions.

There are about 250 species of snakes are found in India of them 52 species are known to be venomous. However the majority of snakebites and consequent mortality is attributed to only 5 species in India, which includes King Cobra (*Ophiophagus hannah*), Common Cobra (*Naja naja*), Russel's Viper (*Vipera rusellii*), Common Krait (*Bungarus caeruleus*), and Saw Scaled Viper (*Echis carinata*). However in Gujarat and Saurashtra region there are only four species of venomous snakes found which are

mentioned above excluding king Cobra. Though the number of venomous snake species is small, snakebite cases are quite often encountered in Saurashtra region and it remains as one of the major public health problems.

It is estimated that the true incidence of snake envenomation could exceed 5 millions per year and about 100 thousand of these develop severe squelae globally (Bhetwal *et al*. 1998). Snakebites are estimated causing deaths to 50000-100000 people worldwide per year (McNamee 2001). Sometimes this illness can be of the leading causes of deaths in an area (McNamee 2001). However, it is difficult to be precise about the actual number of snakebite incidences occurring in a region. The global disparity in the epidemiological data reflects variation in health reporting accuracy as well as the diversity of economic and ecological conditions. Accurate records to determine the exact epidemiology or even mortality in snakebite cases are also generally unavailable (Philip, 1994). Hospital records fall far short of the actual number owing to dependence. On traditional healers and practitioners of witchcraft etc. it has been reported that in most developing counties major portion of the individuals bitten by snakes first consult traditional practitioners before visiting a medical center and resulting delay in transportation leads to mortality. Swaroop and Grab (1954) reported about 200,000 bites and 15,000 deaths in India due to snakebite poisoning. Based on an epidemiological survey of only 26 villages with a total population of nearly 19,000 individuals in Burdwan district of West Bengal annual incidences of snakebite 0.16% and mortality rate of 0.016% were reported per year (Hati *et al.* 1992). Gaitonde and Bhattacharya (1980) reported 70 bites per 100,000 population and mortality of 2.4 per

100,000 per year. Large numbers of snakebite cases have been reported in Tamil Nadu, Uttar Pradesh and Kerala (Philip 1994).

Properly designed population surveys are likely to give a far more accurate picture of snakebite incidence, morbidity, and mortality (Gutiérrez *et al*. 2006). However, there is no information available on the magnitude of snakebite incidences in Gujarat and especially for the Saurashtra region though the death record due to snakebite is more often reported in regional newspapers. Hence there is need to systematically collect the information on snakebite and analyze them to find out the magnitude of snakebite, the region with high incidence of and the section of population that is more susceptible to snakebite and evolve the strategy to reduce loss of human lives. The present study was conducted in order to assess the magnitude of snakebite cases in Saurashtra and the major objectives of the study are given bellow.

Objectives:

1. To assess the magnitude of snakebite cases in Saurashtra region.
2. To assess public awareness and prevalence of myths associated with snake and snakebite in the region.
3. To analyze the snakebite cases by sex, age, occupation, time and habitat wise and identify the group of people or section of population that is more susceptible to snakebite.
4. To identify the regions with high magnitude of snakebite cases in Saurashtra.
5. To suggest the measures to reduce snakebite cases in the region.

CHAPTER: 2

STUDY AREA

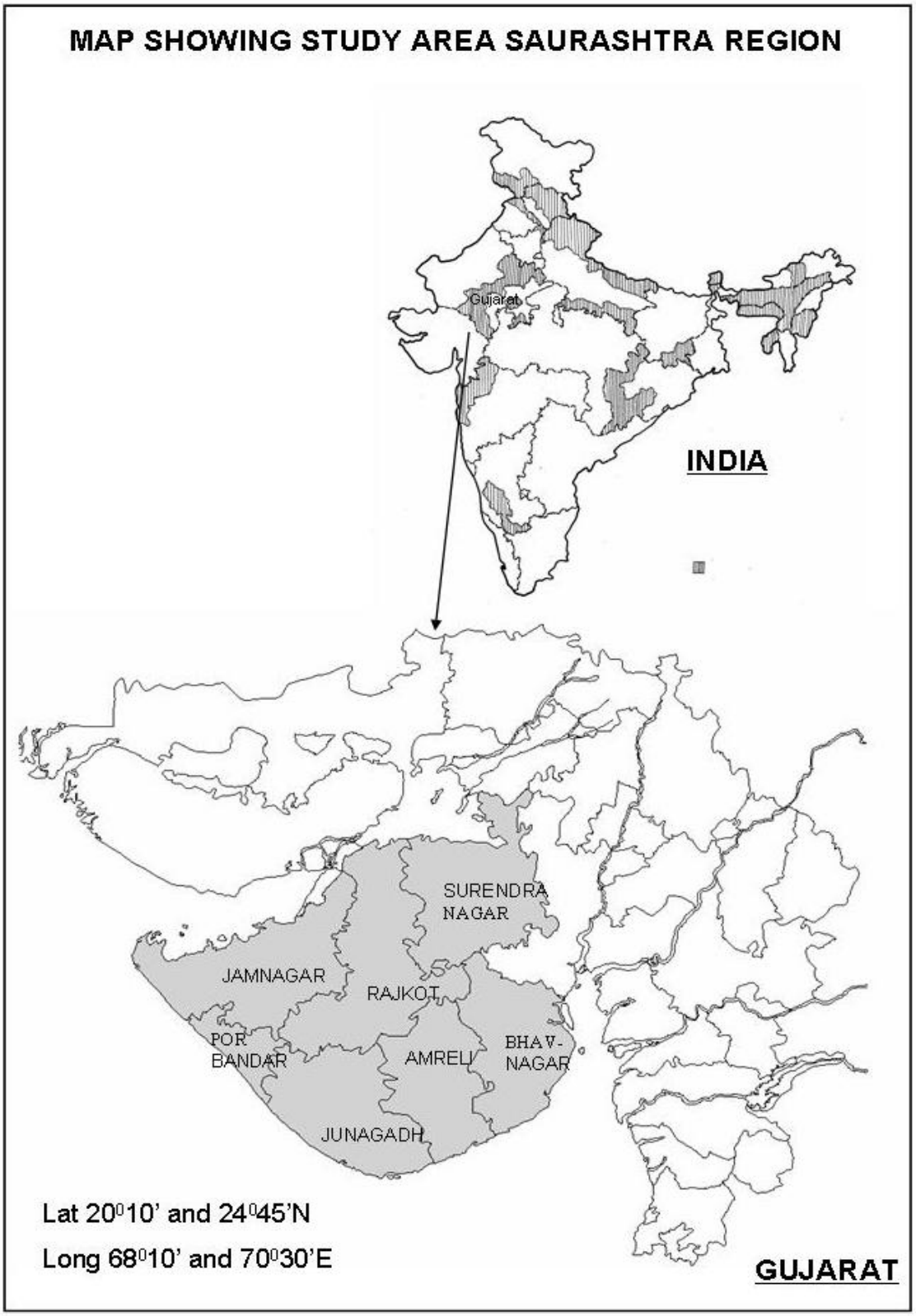
Location:

The current study was conducted in the entire Saurashtra (lat. 20° 10′ and 24° 45′ N, long. 68° 70′ and 70° 30′ E) region situated in southwestern part of Gujarat state in India. The Saurashtra region comprises of seven districts i.e. 1) Bhavnagar, 2) Amreli, 3) Surendranagar, 4) Jamnagar, 5) Junagadh, 6) Rajkot, and 7) Porbandar. Of these districts five districts are situated on the coast of Gujarat. The region is located between two gulfs. The northwest is bounded by gulf of Kachchh and the southeast boundary is lined by gulf of Cambey (Plate-1).

Climate:

The climate in the study region is very hot and dry. Three different seasons can be distinguished as winter (November-February), summer (March - June) and monsoon (July- October). The winter temperature ranges from 1°C to 38°C in winter. Rare showers (locally known as *'Mavthu'*) sometimes occur during winter. Summer is relatively hot day temperatures ranges between 37° C and 44° C but can be as high as 48°C. In summer dust storms, hot wind called *'loo'* and mirage are common midday feature in the region. The rains are highly erratic, both in intensity and frequency; with average annual rainfall is 700 mm. The climate is supporting typically dry deciduous forest ecosystem and majority of the region support rain fed agriculture. The districts headquarters are developed urban cities and they are well connected with good road networks.

Plate:1. Map of study area.



District wise discretions of study area:

The district wise details of location, area, population, climate and humidity are given for each of the seven districts of Saurashtra (Annexeure-1 to 7).

Amreli:

Location- This district located in the southern part of Saurashtra peninsula the district is encompassed by north latitude 20°45′ to 22°15′ and by east longitude 70°31′ to 71°45′. It is bounded in the north by the Rajkot district in the east by the Bhavnagar district, on the west by the Junagadh district and to the south by the Arabian Sea. From the viewpoint of geography it is not a compact one as between Kodinar taluka and the remaining part of the district in a taluka of Junagadh district is situated.

Area and population- The district has an area about 6760 km^2. The population of the district was 1393918 which includes 701593 male and 692325 females. The total rural population of district according to 2001 census was 1080960 and urban population of district was 312958 (Annexeure-1).

Climate: The climate is characterized by general dryness except during the southwest monsoon season and a hot summer. The year be divided into four season winter from December to February is followed by summer up to middle of June. The period from mid June to about the third week of September constitutes as monsoon season. The succeeding period lasting till the end of November may be termed the post monsoon period**.**

Humidity: During monsoon the relative humidity is generally over 60 percent. Rest part of the year is generally dry the driest time being the summer with the relative humidity in the afternoon being less than 25 percent.

Bhavnagar:

Location: Bhavnagar district is situated in the southeast corner of the peninsular region of Gujarat known as Kathiawar or Saurastra. It lies between 20°18′ and 22°18′ north latitude and between 70°15′ and 72°18′ east longitude. The district is bounded by Surendranagar and Ahemdabad district. On the north Rajkot and Amreli districts on the west, Arabian sea and part of Amreli district on the south and the Gulf of Cambay on the east. Earlier Bhavnagar district known was as Gohilwad.

Area and population- The district had an area of 11155 km^2. The population was 2469630 which includes 1274920 males and 1194710 females. Rural population of was 1534592 and urban population was 935038 (Annexeure-2).

Climate: Climate is characterized by summer and general dryness except in the coastal regions. The year may be divided in to four seasons. The winter from December to February is followed by the summer from March to May. June and September is the southwest monsoon season and the two month October and November form post monsoon season.

Humidity-During the monsoon the relative humidity is generally high, being over 60 percent in the northern parts of district and over 80 percent in southern part near the coast. In the rest of the year the air is comparatively dry and the relative humidity in the

afternoon especially in the northern and interior part of the district ranges between 20 to 30 and about 50 to 60 percent in coastal part.

Jamnagar:

Location: Jamnagar district is located between 21°47′ and 22° 57′ north latitude and 70° 37′ west longitude in the peninsular region in the north west of Gujarat known as Kathiawar or Saurastra. The district is bounded on the north by the Gulf and Rann of Kachchh, on the east by the Rajkot district and south by Junagadh district and the western side by the Arabian Sea.

Area and population: The district measures about 128.75 km from north to south and about 167.37 km from east to west the area of district is 10,921 km^2. The population of district was 1904278 which includes 981320 males and 922958 females. The rural population of district was 1068022 persons living in 701 villages as against the urban population of 836256 spread over 15 towns (Annexeure-3).

Climate: Climate of this district is characterized by a hot summer and dryness in the monsoon season. The year may be divided into four season from December to February is followed by the hot season from March to May. The south west monsoon season is from June to September and October and November form post monsoon season.

Humidity-Air remain humid throughout year. The relative humidity is on the average about 80 percent during southwest monsoon and about 60 to 75 percent in the rest of year.

Junagadh:

Location: The Junagadh is one of the districts of Saurashtra region of Gujarat state. The district is known for the presence of mount Girnar which has highest mountain peak in the State. The district lies between 20°44′ and 21°40′ north latitude and 69°40′ and 71°5′ east longitude. It is surrounded on the east by the Amreli district and on the north by the Rajkot and Jamnagar districts. It is bounded on the south and west by the Arabian sea.

Area and population: The district has an about 10,621.1 km^2. The population of the district is 12,45,643 which includes 638296 males and 607348 females. Junagadh district is the largest of district measuring 10607 km^2. Total area of the reserved forest of Junagadh Gir is 1134.8 km^2 (Annexeure-4).

Climate-The climate of this district is generally pleasant, particularly in the costal tracts. The year may be divided in to four seasons. The cold season from December to February is followed by the hot season from March to May. The south-west monsoon season is from June to September, October and November constitute the post monsoon season**.**

Humidity- Relative humidity is generally over 80 percent in the southwest monsoon season. Air is generally drier particularly in the interior of the district.

Porbandar:

Location: Porbandar district lies between 20°44′ and 21°40′ north latitude and 69°40′ and 71°05′ west longitude in the peninsular region in the north west of Gujarat known as Kathiawar or Saurastra. The district is bounded on the north and north west by Jamnagar

district and west by the Arabian Sea and in the east it is bounded by Rajkot and south east is bounded by Junagadh districts.

Area and population: The district measures about 1141 km^2. The population of district was 536835 which include 275821 male and 261014 females. The rural population of district was 275460 and urban population was 261375 (Annexeure-5).

Climate: Climate of this district is characterized by a hot summer and dryness in the monsoon season. The year may be divided into four season from December to February is followed by the hot season from March to may. The south west monsoon season is from June to September and October and November form post monsoon season.

Humidity-the air is humid throughout year. The relative humidity is on the average about 80 percent during southwest monsoon and about 75 to 85 percent in the rest of year.

Rajkot:

Location: Rajkot district lies between 20°58′ and 23°08′ north latitude and 70° 20′ and 71° 40′ east longitude has a total area of 11882.87 km^2 and population of 3,169,881 souls. It is bounded on the north by the Gulf of Kachchh and little Rann of Kachchh, on the north east by the Surendranagar on the east by Bhavnagar district on the Amreli district on the west by Jamnagar district on the south and south west by Junagadh district. Rajkot district was formally called Madhya Saurastra district as it occupied the central part of Saurastra peninsula. It was formed of the former princely state of Gondal, Jetpur, Rajkot, Wankaner and Morbi when Saurastra state came to existence in 1948.

Area and population: The area of district is about 11882 km^2. The population of district was 3169881 which includes 162018 ales and 1527863 females. The rural population of district was 1527863 and urban population of district was 1625862 (Annexeure-6).

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Climate: Climate of this district is characterized by hot summer and dryness in the monsoon season. The year may be divided in to four seasons. The cold season from December to February is followed by the hot season from March to May. The south west monsoon season is from June to September and October and November form post monsoon season.

Humidity- During the southwest monsoon season the relative humidity is generally 60 percent. In the rest of the year the air is comparatively dry with afternoon humidity ranging between 20 to 30 percent.

Surendranagar:

Location: The Surendranagar is one of the districts of the peninsula of Saurastra. It lies between 22°08′ and 23°03′ north latitude and 71° to 72° east longitude. It is bounded on the north by the Rann of Kachchh and the Banaskanth district. In south are parts of the districts of Ahemdabad and Bhavnagar. On the west, it is bounded by the Rajkot district and on the east by the Ahemdabad district.

Area and population-The district had an area of 10,458 km^2. The population was 1515148 which include 787650 males and 727498 females. Rural population of this area was 112700 and urban population of this area was 402448 (Annexeure-7). .

Climate- The climate of this district is characterized by a hot summer and general dryness except during south-west monsoon season. The year may be divided in to four seasons. The cold season from December to February is followed by the hot season from March to May. The period from June to September constitutes the southwest monsoon season. The period from October to November is the post monsoon season.

Humidity: The relative humidity is generally over 60 percent in the southwest monsoon. In the rest of the year the air is comparatively dry especially in the afternoons during the period November to may when the relative humidity varies between 20 to 30 percent.

Agro climatic conditions:

The agriculture is mainly rain dependent in the entire Saurashtra region. The soil is black loamy and supports variety of crops. This semi arid part of the region receives most of the precipitation through southwest monsoon. However, some part of the 'Gir' and 'Girnar' region in Junagadh district and the peripheral area of 'Barda' hills forest in Porbandar district have certain pockets of irrigated agriculture where the water table is higher. However, the '*Bhal'* are of Bhavnagar district is saline, flat and dry with very low agriculture productivity. The *'Ghed'* area in the Junagadh district is relatively less productive in the district where agriculture is purely rain dependent. The major crop in the region includes groundnut, cotton, millet, castor, sorghum, maize, fodder and vegetables etc. The coastal area has coconut production.

People and Occupation:

Patel, Ahir, Maher, Rajput, Khshatriya, Koli, Bramhins and Muslims are the communities representing majority of the population in the region. Agriculture and related occupations are the major occupations of people in the region. However, the other occupation involves animal husbandry, labors and jobs in industrial, mining and government sectors. The coastal communities such as Kharva, Maher and Vaghers are the major communities involved in fishing in Arabia Sea.

CHAPTER: 3
REVIEW OF LITERATURE

Studies on snakes in India:

The first ever study on snakes in India was carried out by Petric Russels (1726 - 1805). He is the founder of snake study in India who published his work in two parts i.e. first part in 1796 and second part in 1801 to 1809. Later on Hardwicke (1756-1835) published the work of Francis Hamilton (1762 - 1829) in the form of a book titled "Illustration of Indian Zoology" in 1830 which included notes, illustrations and diagrams of reptiles. Thomas Cantor (1809 - 1860) published notes on Indian serpents. Edward Blyth (1810 - 1873) published notes on reptiles in Journal on the Asiatic Society of Bengal. In 1856 Thomas Jerden published catalogue of reptiles inhabiting southern India. In 1874 Sir Josph Fayrer published Thanatophidia of India. After all these, William Theobalel (1829 - 1908) published a descriptive catalogue of the reptiles of British India. William Sclater published notes on list of the reptiles including snakes in the Indian museum in 1891. In 1878 Joseph Ewart published a book titled "The Poisonous Snakes of India." Thereafter, Colonel Frank started research on Indian snakes and published number of papers in the Journal of Bombay Natural History Society. Towards the end of British rules in India, Smith (1943) published a book titled "Fauna of British India" in three parts, which is considered authentic and referred even today. From 1900 to 1970 many snake were killed with the purpose to prepare various articles from their skin. In 1972 with the enforcement of the Wildlife (Protection) Act some control was gained however, illegal trade of snakeskin is still operating. In the tropical developing countries where snakebites occur most commonly, there are few reliable incidence data. A survey

to assess global snakebite mortality was undertaken in 1954, which was based largely on hospital admissions (Swaroop and Grab 1954). Subsequent work has revealed gross underreporting of deaths for example, in Nigeria (Warrell and Arnett, 1976) and Thailand (Warrell 1992, 1995).

Snakes in mythology:

Since the inception of human civilization, the snakes have remained objects of fear, superstition and also respect and veneration. The subject of snakes is often an emotive one. It is a topic that at once fills many people with fear and loathing and these are feelings that are very real; a phobia that is caused by very few other animals. This situation is farther enhanced when it is more that many of these creatures that move so mysteriously without the aid of limbs can also deliver a fatal bite.

Snakes have always held a great fascination for people, which has often bordered on an obsession. Since prehistoric times, snakes have been shrouded in mysticism and superstition. This fascination is due at least partly to their very strange shape and motion and their ability to strike unexpectedly with deadly accuracy. With such inhuman and 'unnatural' attributes people consider them to be supernatural and superhuman.

Myths and legends about snakes abound, and they have been worshipped and used in ceremonies and rituals all over the world and also are viewed as one of the evil. In the Bible, Adam and Eve are tricked by the serpent in the Garden of Eden into eating fruit from the tree of knowledge and thereby view of the serpent is one of evil.

The Graeco-Roman God Of Medical Art, Aesculapius carries with him a snake as an important attribute. The snakes are wound about the staff held by the God. This form of representation has today become the international accepted symbol of medical profession. The Emblem of the medical profession is a staff with two entwined snakes.

The serpent is one of our most ancient and most grandiose mythological motives. It is the image of primordial, autonomous, impersonal life energy underlying and creating existence and consciousness. It is the image of the instinctual life will, of desirousness, hunger for life, and the urge to taste life, to learn and grow through tasting life.

Master Hahnemann referred to it when he prefaced his Organon "Aude Sapere: Dare to taste and understand." Sapere means both taste and understand. The snake force involves us in life and living by deeply emptying the cup. It is the force, which is wrapped around the tree in the story of paradise, which led to the fall from the paradise but also to life's healing forces in the staff of Aesculapius. The image of snake, which eats its own tail, the arborous, is the symbol of infinity of life.

Cleopatra, the queen of Egypt renowned for beauty and wisdom and notorious for her involvement in political, intrigue made an end to her life, so tradition tells us; by committing suicide with the venom of possibly an Egyptian Cobra or poisonous viper.

The story of the original poisoning of mankind, the injection of something foreign to his original nature, from which stems all the subsequent story of mankind, is known to us all

from Genesis. Here it is seen in the form of fertilization and conception when the serpent sperm penetrates the ovum and disturbs the quiescent sleep.

Ancient literature, epics and even in Indian Puranas and Hindu mythology are full of many references on snakes. Snakes of the Cobra species have been associated with the Hindu Gods such as Lord Shiva, Lord Vishnu and Lord Ganesha.

Lord Shiva - also known as 'Neelkanth' adorns his neck by wearing the Cobra as necklace. The neck portion appears bluish in color, as it is known to hold venom extracted by 'Samudra-Manthan'. 'Manthan' means agitation or turmoil. According to human psychology due to a sort of agitation in mind or emotions various instincts are evolved out of which the evil wills like jealousy, envy, malice, revenge, aggressiveness, etc.(the animal instincts) are likely to become prominent. Lord Shiva conveys a philosophical message for mankind as to hold all the venoms produced of agitation in throat - not to digest it as it may harm your health; and not to /spit it out as it may harm others. (As such 'spitting' here should be understood by the use of tongue in respect to speech - not to manipulate by words as to hurt others - again the forked tongue of the serpent!!!). But as far as modern human psychology is concerned nowadays we are spitting these venom out through our eyes in the form of envy, suspicion, jealousy, etc. and there by ruining others life and our life too.

Lord Krishna vanquished the Kali Nag, which means to conquer the evil wills within us. Lord Vishnu reclining on seven headed Cobra - 'Sheshnag'; Lord Ganesha wearing the belt of snakes; worship of snakes on days like Naga-Panchami, 'Rahu'- according to

astrology - also symbolized by a serpent, etc. all are the various references where serpents play a significant role in our life.

According to 'Yoga' the Kundalini Shakti lies like a serpent coiled at the lowest portion of spinal cord. To liberate the hidden powers one has to go on the path of meditation and yoga - by which this coiled serpent gets aroused and the person is bestowed upon by certain spiritual and yogic powers, which helps him in liberating from the cycle of birth and death.

In brief, the serpent is being portrayed as a symbol of evil tempter and seducer, the very personification of deception and intrigue. The snake has always been perceived as a dualistic force, a source of strength when mastered, but potentially dangerous and often emblematic of chaos and corruption when yielded to. The snake venom has been used in the preparation of several life saving medicines especially Anti-venom Serum, for cure of thrombosis; as a pain-killer as well as to prevent excessive bleeding during surgery.

Snakes are frequently hated as symbols of malevolence, duplicity and cunning and feared as an actual or alleged danger to man. The very wildly held feeling of revulsion for snakes can in most cases be attributed to remarkable lack of knowledge about biology of this group of animals.

Evolution, adaptation and behavior of snakes

Snakes are the animals that are members of a highly specialized group excellently well adapted to their various biotopes, which are in no way distasteful and repugnant.

Generally a snake is being described as a creature with an elongate body with absence of limbs, extra ordinarily flexible in movement, covered by a skin composed of scales with a fixed gazed look of eyes and a long, slender, deeply forked tongue which flickers to and fro with extra ordinary mobility.

It belongs to the class of reptiles under the order Squamata that means covered with scales. This large order has two suborders, Ophidia (the Serpents or Snakes) and Lacertilia (the Lizards). In spite of considerable differences of form the members of Squamata are characterized by many common features, which are sufficient to indicate to their common origin. Snakes can be distinguished from lizards only by a combination of characters. Briefly, these are, absence of fusion between two halves of lower jaw, which are united by ligaments only, and are therefore movable independently; the absence of eyelids, external ear openings and of limbs. A few primitive forms have vestigial hind limbs.

The division within the group of Squamata in to the lizards and snake probably occurred in course of Jurassic, for the earliest fossils of true snakes that have been found belong to Cretaceous period - the great age of dinosaurs. It was not until after the end of dinosaurs, 65 million years ago, that snake started to diversify and even today their evolution is still progressing. In geological terms, the snakes are still a new group, but with some 2700 varied species around the world. Looking back into murky depths of history it reveals that snakes have been evolved from lizards, the pivotal evidence being a Bomean Lizard, which has many similarities to snakes of today.

In the era that began some 135 million years ago, great changes came over both the landscape and the dinosaurs in it. Mountains were thrust up by underground forces, and as a result the hot, humid weather typical of low lying regions gave way to milder climates. Much of the tropical and subtropical vegetation died off, and flowering plants evolved spread in its place. Over the next 70 million years or so, the forests and swamps became essential as they are today.

While the climate and landscape were changing, another event important to the future of reptiles was taking place: the snakes began to appear. Just who their ancestors were is one of the most controversial questions in the history of reptiles. They must have come from some of the early amphibious lizards, possibly legless ones. In any case, there is no doubt that an efficient system of getting about has taken the place of limbs. The boas and pythons and several other small groups, have vestigial remains of hind limbs in form of small spurs.

When snake abandoned legs they also could grow in length, since they no longer had to be supported on only four limbs. Serpentine movements replaced footwork. The snake's body became suited to constricting - killing prey by wrapping its coils around the victim and squeezing it - and to climb trees, where its long body could be made to look like a vine or branch. Loss of limbs and the longer, narrower body also permitted snakes to go into places like holes and crevices where four legged animals could not enter. In modern snakes the lack of legs is no handicap. On a straight line over a smooth ground most men

can move faster than most snakes, but if a landscape is wooded, rough or scrubby and snake is a whip snake or a racer a whole posse of men will be left in the chase.

In evolution, of course, there is nothing novel about lines becoming extinct. Extinction is the rule, and survival is the dramatic exception. This also explains the ability of certain snakes to kill prey by injection of poison. In the venomous snakes certain of salivary glands have been converted into poison producers. Several hypothesis exist which offer differing views as to the origins of snakes. One popular theory is that the early snakes were fossorial, or burrowing forms.

Examples of burrowing snakes exist today - the blind snakes (Typhlopidae) are typical burrowers. The primitive characteristics of contemporary bun-owing snakes vary in degree; for example, some groups posses important characters of skull and lung structure, and this is an indication that these groups have evolved a stage further. However: while it is true that these fossorial snakes exhibit various stages of evolution, they differ very little in their actual habits. There exists also some variation in sizes, but bodily form of all these species suggests a snake that is adapted to a subterranean way of life. The most obvious external characteristics found in burrowing forms are the reduced eyes and the reduction, of absence of the ventral plates (gastroteges).

Pre-historic times have witnessed snakes undergoing a burrowing life for a considerable length of time, as climatic conditions prevailing then were unsuitable to them. As they took to the deep bowels of the earth their bodies underwent significant changes. Their

limbs, which became obstacles to them while burrowing were foregone; they lost their ears as the ears did not serve them any purpose. Sight was crucial, but while burrowing, mud particles clogged their eyes resulting in poor eye sight. However an adaptive solution was formed. They lost their eyelids and developed a fixed transparent cap called brille to protect their soft eye tissues and also gave them their famous hypnotic look, though they do not possess any hypnotic powers as believed to be. The body structures change as all internal paired organs where either arranged in a 'one by one' form or were lost, to be accommodated in their long and sleek form. Finally, when better climatic conditions permitted them to crawl out, they emerged, as victors, having won their struggle against all odds and to pursue their struggle for existence on land along with other beings. However these terrestrial victors found themselves helpless against other vicious predators and in turn, to survive, sought to adopt new environs. This change that took place in them was more behavioral then physical. Some snakes took to aquatic life, some took to arboreal life, while some return to their formal habitat as some remain stoically wherever they were and began to develop defense mechanisms. The saliva of these creatures slowly turned toxic and resulted in a super saliva or better known as venom. Non-venomous snakes are still in the process of turning venomous as some scientists researching in snake venom state that certain non-venomous snakes have toxic saliva, which kills the prey immediately after the bite.

Snakes have evolved into efficient predators that have successfully colonized the varied habitat forms found in most part of the world. Poisonous snakes probably represent the most advanced forms, but it does not follow that they are the more successful or efficient

of the world's snake species. The lightning strike of rattlesnake, for example, is quite spectacular, but many nonpoisonous snakes obtain their food with an equal lack of effort. Snakes that constrict comparatively large and active prey are always at risk from bites, or injury, received from prey species during the early stages of constriction. To subdue prey efficiently a constricting snake must first seize the prey in the right place.

Based on their morphological characteristics including arrangement of scales, dentition, osteology, myology, sensory organs etc., snakes are categorized into families. The families of venomous snakes are atractaspididae, elapidae, hydrophidae and viperidae. The major families in the Indian subcontinent are: elapidae which includes common Cobra, King Cobra and Common Krait, viperidae which includes Russell's Viper, Pit Viper and Saw Scaled Viper and hydrophidae (the sea snakes). Of the 52 poisonous species in India, majority of bites and consequent mortality is attributable to 5 species viz. *Ophiophagus hannah* (King Cobra), *Naja naja* (Indian Common Cobra), *Daboia rusellii* (Russell's Viper), *Bungarus caeruleus* (Common Krait) and *Echis carinatae* (Saw Scaled Viper).

Thus the snakes as such are of four principal families - the boidae, the colubridae, the viperidae and the elapidae. The first of these, and the most primitive, includes the New World boas and anacondas, and the pythons of African and Asian tropics. They are constrictors; that is, they kill their prey by wrapping themselves around it and squeezing. Though it has same small members, the boidae family includes the world's largest snakes. There are records of 1127.7cm anacondas, 975.36cm pythons and 548.64cm boa constrictors.

The second major snake family, the colubridae, contains about two thirds of the world's snakes. These are the venomous snakes with rear - fangs. The third group falls in the major family of viperidae - the family in which poison production and injection have become very refined and efficient. This family embraces some one hundred and sixty species found throughout both the New and Old World with the exception of Australia. A large group of venomous snakes distributed over Africa, Asia, the southern parts of North America, Central and South America and Australasia falls under elapidae - consisting of almost two hundred and twenty species.

Snakes are highly specialized of all reptiles in existence and the poisonous snakes are the zenith of their specialization. Not only have their limbs completely disappeared and the bony girdles which support them been completely lost, but a fantastic modification has also taken place in almost all parts of their body. The lungs and liver become elongated and salivary glands which other and animals secrete saliva for the digestion of food gets modified in poisonous snakes to secrets virulent venom. This virulent venom is rich concentrate of digestive enzymes and serves as highly toxic protein for all living systems. The fatal poison of snakes, their silent lurking habits, coupled with agility, compels us to consider poisonous snakes as deadliest enemies of mankind. The internal organs have also become adapted to accommodate an elongate form. Most snakes possess only one lung; only some primitive species have retained both lungs. The heart is simple and consists of a left and right auricle and a single ventricle. Most snakes feed on large prey, which they swallow whole, and for this reason the gullet is capable of great distension to

allow the passage of large items of food. Similarly, the long tubular stomach has the capability of accommodating large food items.

The Snake:

The elongate body of the snake is remarkably supple and is able to make twisting and other movements impossible for other vertebrate animals. The arrangement of the backbone does not give much latitude for vertical movements, and vertical undulatory movements are impossible for snakes. Lateral movements are the typical snake movement. The scales on the body of the snake are imbricate, that is they overlap in the manner of tiles, and form patterns which are characteristic of the species. The skin, and the scales on it, are so constructed that stretching is possible to an enormous degree, enabling snakes to swallow large prey. The skin is shed periodically and the shed skin is often unbroken, and maintains its form to a remarkable degree.

The mouth is armed with numerous teeth which are not embedded in sockets. There is a continuous succession of teeth, those that are lost being immediately replaced by successor teeth lying below. The teeth are recurved and serve to hold the prey, and thus assist in swallowing, which is virtually done by the two halves of the jaw alternately "walking" over the prey and pushing it down the throat. Two types of fangs occur in harmful snakes. In the back fanged snakes, the last two or three teeth of the upper jaw are large and are grooved. The groove is connected by a duct to the poison glands. In snakes with fangs in the front of the mouth, such as the Cobras, Kraits and the vipers, the groove has become a closed canal for the conveyance of the poison. The forked tongue in snakes

is an organ of smell rather than of taste, and serves to collect scent particles by its constant quiver and play. Snakes have no external ears and cannot hear noise carried through the air but they are able to feel, through their jaws, vibrations carried through the substratum.

Usually two fully operative canaliculate fangs on each side. These are shed singly at intervals. Fangs about 7 mm in length are small compared to viperine fangs, but are more solid. The bore of the fang opens widely at the base and by a small aperture at the tip. The poison glands are analogous to the parotid salivary glands in mammals and have the shape and size of an almond kernel. There is a visfiri fluid venom is a clear, viscid fluid resembling olive oil in appearance and consistency, which solidifies into an amorphous mass. The amount secreted varies with age, vitality and temper of the animal and the average discharge at a bite is about 211 mg dry weight. Comparative data on the basis of experiments on other animals gives the lethal dose for man as 15 to 17.5 mg for a weight of 60 kg. The poison can, however, be swallowed without ill effects, provided there are no internal ulcers. The poison acts mainly as a neurotoxin and blood and cell destroyer. The neurotoxin paralyses the respiratory center and is the chief cause of death. Other effects are loss of clotting power of the blood and destruction of red blood cells. The symptoms produced in man start with a stinging or burning pain, accompanied by swelling and oozing of blood-stained serum. The constitutional effects are a gradual but rapidly advancing paralysis commencing with the legs; the neck droops, the muscles of the tongue, lips, and throat are affected and speech becomes difficult. The lower lip falls and allows saliva to dribble, swallowing becomes difficult or impossible. Breathing becomes difficult, laborious and finally stops. Other symptoms are vomiting and

hemorrhage from the various orifices of the body. The bite of a Cobra is not necessarily fatal at all times, depending as it does on the quantity of venom injected, the natural resistance of the victim, the condition of the snake and various other factors. Records indicate that cases of recovery from a bite are equal to, if not more than, cases of death and there is always hope, however serious the symptoms. The Haffkine Institute's polyvalent serum is fully effective even when symptoms are far advanced. There is possibly species and geographic variation in the potency and symptoms of the poison. Neostigmine and other acetycholinesterase drugs reverse respiratory paralysis caused by Cobra venom.

The eye varies in size and effectiveness. In some snakes, including the blind snakes, the eye is hidden beneath a head shield. When visible, the eyes lack lids but have a transparent watch glass-like shield beneath which they move. The pupil may be circular, vertical or horizontal. Depending on the species of snakes, the food varies from insects to large animals. Some feed on other snakes. The majority of snakes lay eggs with a white or yellow parchment-like shell. Parental care in the form of brooding is seen in many instances. Many species are ovoviviparous and give birth to live young. Snakes are widely distributed in the Indian subcontinent from the seas to near the snowline in the Himalayas.

Classification of Snake

Classification of snake species are mainly based on scale, arrangement of bones, dentition etc. Recently DNA based classification is also established. There are total of 18 families of snakes in the world. Out of this 18 families 10 family of snakes are present in India.

1. Family - anomolepididae
2. Family - typhloeoidae *
3. Family - leptotyphopidae *
4. Family - anillidae *
5. Family - anomochilididae *
6. Family - uropeltidae *
7. Family - xenopeltidae *
8. Family - boidae
9. Family - bolyeridae
10. Family - acrochordidae
11. Family - cylindrophidae *
12. Family - loxocemidae
13. Family - tropidophiidae
14. Family - atractaspididae
15. Family - colubridae *
16. Family - elapidae *
17. Family - viperidae *
18. Family - hydrophidae

Snakes of families mentioned above with * mark are found in India.

Some venomous snakes of India and Gujarat:

Indian Cobra, *Naja naja* (Linn.): (Plate-2).

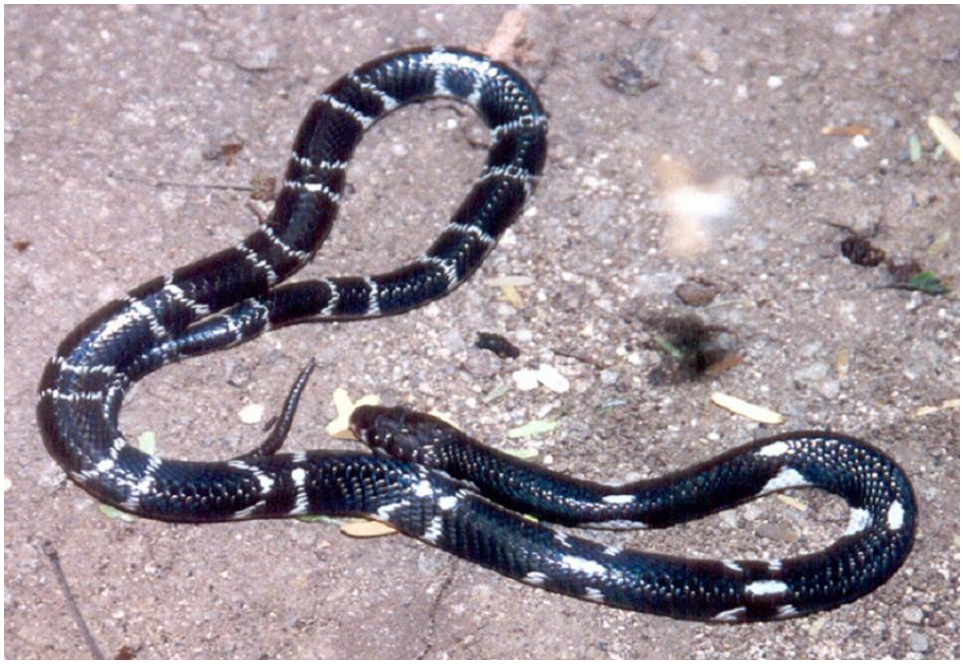
Local Names: In most parts of India derivatives of the Sanskrit Nag-, Bangia Naga gokurra (biocellete form), Keauthia (monocellate form); Pushtu Chajitiwalla', Tamil Nallapambu, Nagapambu', Kannada agara havlt', Malayalam Moorkan, Surpam', Singhalese Naya.

Size: Longest recordedd 2,250 mm, usually ranges between 1,371 to 1,625 mm.

Identification: The Cobra can be immediately distinguished from other land snakes by the presence of a small 'cuneate' scale between the 4th and 5th infralabials. Rarely two may be present and very rarely, the cuneate may be absent. Another distinguishing character is the preocular touching the internasal, a character seen in two other species of

Plate-2. Venomous snakes of Gujarat (Indian Common Cobra & Common Krait)

Indian Cobra (*Naja naja*)



Common Krait (*Bungarus caeruleus*)

Indian snakes also, but the Cobra can be separated from these in having the 3rd supralabial head scalation of *Naja naja.*

Key characters: Cuneate scale (Cun) between 4th and 5th infralabial (lower lip) shields. Preocular (Pro) touches internasal (Int). 3rd supralabial (upper lip shield) touches eye. The hood is formed by the elongated ribs of the 3rd and the following 27 vertebrae, the 9th on the left and 10th on the right are the longest, the preceding and succeeding ribs shorten progressively, giving an oval outline to the expanded hood. At rest, the ribs lie along the length of the body, the overlying skin is but loosely attached. When erect the dorsal skin is stretched, making the hood markings conspicuous, and the head, bent strongly at the atlas (1st vertebra), is carried at right angle to the hood. The hood when dilated is diagnostic, more so when the markings are visible. The markings may be absent and in death the hood may not be demonstrable. The king Cobra has a well developed hood and many other snakes have the ability to flatten the neck area to a more limited degree. Head depressed with short, rounded snout. Nostrils large, pupil round, an obvious swelling at the temporal region over the underlying poison glands. Head shields glossy, body with a more or less distinct groove down the spine.

Coloration: Extremely variable in coloration and markings. Three species are recognized on the basis of the hood pattern: The 'Spectacled' or Biocellate Cobra of peninsular India (*Naja naja*) yellowish, brownish or black above, with or without a black and white mark on hood, a black and white spot on the inside of the hood with one or two black crossbars below hood. Sri Lankan and south Indian Cobras are usually of shades of brown with well defined hood marks. Cobras from the north are more often black and the hood pattern may not be well defined or may be absent. Monocellate Cobra (*Naja kaouthia*)

differs in having only a single yellow or orange O-shaped mark on the hood. General color olive, brown or black. This is the Common Cobra of eastern India and eastwards of India. Black Cobra (*Naja oxiana*) occurs in the extreme northwest. This snake is light grey or brown above. It has dark crossbars in the earlier stages when it is juvenile. Adult snake is usually brown or black..

Distribution, and Status: The Cobras are eclectic in habitat. Cobra are absent in arid deserts and in the hills above 1,800 m. They occur from Transcaspia in the north, through Indian subcontinent to southern China and in the east to the Philippines, in the south it occurs up to Andaman and Shri Lanka.

Habitat: Cobras are found in heavy jungle, open cultivated land; in populated areas where old masonry constructions form ideal refuge. White ant nests, holes in the ground or the tangle of roots at the base of a tree are particularly favored by Cobra snakes. This species of snake is frequently found near water and is also a strong swimmer. This species is usually not aggressive and often exceedingly timid, but occasionally fierce and aggressive when disturbed. Young Cobras are much more dangerous than adults, being more easily excited and ready to strike repeatedly and with determination. When alarmed, it adopts the well known pose with erect fore body and spread hood. The height to which the forebody is raised is -approximately one-third forms the effective striking range. While thus poised, the snake sways backwards and forwards, hissing in an explosive manner which is brief and high pitched during inhalation and longer, louder, lower pitched and intermittently explosive during exhalation. The throat is pouched more so during exhalation and the whole body is inflated. The tongue flickers in and out during inhalation and exhalation. The bite is often a mere snap, but it sometimes bites and hangs

on and the jaws have to be forced open. Occasionally when snake misses, the poison is ejected as a spray by the forceful thrust of the lunging snake. Usually more active and alert at night, though it hunts for food during the late afternoon and early evening.

Food: Cobra feeds principally on rats, frogs and toads, also takes birds, lizards, other snakes including other Cobras and is an invertebrate egg stealer. Eggs are swallowed whole and digested in 48 hours.

Breeding: Mating takes place in January and majority of eggs are laid in April/May, but clutches have been obtained up to August. The period of gestation is 62 days, but may extend considerably. Eggs hatch in 48 to 69 days. Twelve to twenty-two, in one instance 45 (36 fertile) eggs are deposited at a time. The eggs are soft-shelled, elongate, oval, measuring 49 X 28 mm. The parents cohabit before pairing and the eggs are guarded by one or both. Both parents known to incubate. Hatchlings measure 250-280 mm at birth. The poison glands are active from birth.

Common Krait *Bungarus caeruleus* (Schneider): (Plate-2).

Local Names: Urdu Kala gandait', Hindi Karait', Gujarati Kalo taro', Marathi Manyar, Kandar', Oriya Chitti', Tamil Kattu viriyan, Yennai viriyan, Panai viriyan, Yettadi viriyan', Malayalam Yalla pamboo (Malabar), Yettadi virien (Travancore).

Size: Largest measured 1.73 m. Specimens over 1.2m are not common. Identification: The enlarged hexagonal vertebral scales, entire subcaudals, uniformly white belly and the narrow white crossbars on the back, more or less distinctly in pairs, distinguish the species. Body of a Common Krait is long and cylindrical with neck not evident and eyes

are smaller with black iris and indistinguishable pupil. The scales of a Common Krait are shiny black in colour and its tail is short which is one- sixth to one-eleventh total length.

Coloration: The Common Krait is lustrous black or bluish black above, with paired narrow white crossbars indistinct or absent anteriorly. In young, the crossbars are well defined and conspicuous, even anteriorly. In old snakes, the white may be in the form of a series of connected spots with a particularly large spot on the vertebral region. A preocular spot may be present; upper lip and ventral body surface white. Two colour varieties are distinguished; with the transverse bars narrow, not usually widening on the sides of the body and without vertebral spots. In the race *sindianus*, the bars are distinct, wider on the sides and a vertebral spot is always present.

Habitat, Distribution, and Status: Inhabits a wide range of biotopes in peninsular India from Sind (Pakistan) to West Bengal plains and south to the Cape Sri Lanka it is common.

Habitat: The Common Krait inhabits fields, low scrub jungles and is common in the vicinity of human habitation, often taking up residence inside houses. Frequently found near or in water. It is nocturnal and of a placid temperament, biting usually only under provocation during the day but alert, active and dangerous at night. Many instances are on record of people sleeping on the ground being bitten when unknowingly rolling on or placing a leg or hand in their sleep on a Common Krait moving near by.

Food: Feeds mainly on snakes including Common Krait s. Young feed more or less exclusively on blind snakes of the Family typhlopidae. Occasionally frogs, lizards, and small mammals are also taken.

Breeding: The male is longer in total length and has a longer tail. Mating is apparently in February and March. Kraits perhaps from their cannibalistic tendencies are wary and often carry out an examination of each other before settling down together. The secretion of the anal glands, which has a disagreeable smell to man, may perhaps help in recognition. The female is known to stay with the eggs. The clutch size varies from 6 to 15 and eggs measure 35 X 19 mm. Eggs hatch from May to July. Hatchlings measure 266 to 298 mm. The length doubles at the end of the first year and trebles at the end of the 2nd year. Smallest gravid female measured 890 mm. Poison: The Kraits are among the few snakes whose bite is fatal to man. The poison, secreted by glands in the temporal region of the head, is a clear, amber colored fluid when freshly secreted. The yield from a snake appears to depend on its condition, and the quantity is not necessarily related to the size of the snake. The secretion yields from 0.2 to 51.4 mg of dried venom. The Venom is more toxic than that of the Cobra and acts both as a neurotoxin and haemotoxin, paralyzing the respiratory centre, and centers concerned with the lips, tongue, throat and voice and phrenic nerves. The red blood corpuscles are destroyed, as also the lining of the smaller blood vessels. The major cause of death is asphyxia through paralysis of the respiratory centre. Krait venom is considered to be 15 times more virulent than the Cobra's and the Krait is one of the deadliest among the poisonous snakes of the world (Haast and Werner 1953). The lethal dose for man is considered to be the secretion equivalent to 1 mg of dried poison. Symptoms are a fiery pain at the site of the bite which disappears after some time, later violent abdominal pain, probably due to haemorrhage, and paralysis sets in. The eyelids and lower lip droop and the person is unable to walk or breathe. Often there is no immediate reaction and the bite is ignored, with fatal results.

Polyvalent serum should be injected, preferably intravenously, as soon as possible after the bite. Till medical attendant is available, the victim should be kept warm and given hot stimulating drinks. Alcohol should not be given. Death may result in five to twelve hours after the bite.

Russell's Viper *Daboia russelli* (Shaw and Nodder) (= *Vipera russelli*) (Plate-3).

Local Names: Hindi Daboia-, Sindhi Koraile-, *Bangia Bora, Chandra bora*, Urdu bora', Kashmiri Gunas', Gujarati Chitalo, Khadchitalo', Marathi Ghonas', Kannada Mandalatha havu, Kolakumandala', Malayalam Mandali, Ruthamandali', Tamil Retha aunali, Kannadi virian-, Telugu Kataka rehula poda', Burmese Mwe lewe', Sinhala Tic polonga.

Size: Specimens 1,500 mm and over exceptional. Usually about 1,200 mm. Maximum size recorded 1,675 mm.

Identification: Identified by a combination of characters; head covered with small scales and without shields, 27 to 33 costal at midbody; subcaudals divided. Body massive, cylindrical, narrowing at both ends, head flat, triangular with short snout, large gold flecked eyes with vertical pupil and large open nostrils. Neck constricted. Belly rounded. Tail short, about l/7th total length.

Coloration: Ground color brown of varying shades with three series of large ovate spots, one vertebral and two costal. Spots brown in the centre and margined successively by black and white or buff. The dorsal spots may coalesce and the side spots may be broken up. Smaller spots may occur between the dorsal and side spots. Head with distinct dark patch behind. A dark streak, margined with white, pink or buff behind eye. A dark stripe from eye to lip. A conspicuous white, buff or pink line from gape converges to form a 'V

above snout. Lips white, whitish or pink. Belly white, whitish or yellowish, with a few dark half-moon marks on the margins of the anterior ventrals.

Habitat, Distribution, and Status: Widely distributed but prefers open country. Indian subcontinent from Baluchistan in the west and Kashmir in the north to the eastern Himalayas and eastwards to Myanmar, Thailand, Indo-China, Formosa. Indo-Australian Archipelago and Sri Lanka. Usually in the plains but has been recorded up to 2,100m in south India, and 1,800 m in the western Himalayas. In some parts of the country it is very common, rare in others. It is abundant in the Punjab, very common along the west coast and its hills, and in south India generally and up to lower Bengal. Uncommon to rare in the Ganga valley. North Bengal and Assam. Abundant in Myanmar. It is not uncommon in inhabited areas, the attraction being the rodents commensal with man.

Habitat: Normally sluggish and does not strike readily unless irritated, when it bites with great malice. Usually it contents itself with hissing, which once heard is not easily forgotten, the volume of sound exceeding that produced by any other snake. When striking, it hurtles itself forward and may even leave the ground. The bite may be either a snap or the it may hold on for many seconds. Largely nocturnal, its movements are slow, never exceeding a crawl, and if disturbed often prefers to maintain its ground angrily hissing with heaving sides. The young are more prone to be aggressive and to bite. The main food is murid rodents. In captivity it has taken, in addition to rats and mice, squirrels, shrews, kittens, small birds, calotes and other lizards, and frogs. The young ones are often cannibalistic. In captivity, many adults do not feed and one was recorded as not having fed for nearly five months.

Plate-3. Venomous snakes of Gujarat (Russell's Viper and Saw Scaled Viper).

Russell's Viper (*Daboia russelii*)

Saw Scaled Viper (*Echis carinatus*)

Breeding: The Russell's Viper is viviparous. Fertilized eggs develop a white envelope like eggs of other snakes, but this envelope in advanced stages becomes a transparent membrane which ruptures prior to delivery, or the young may be born in a caul. The envelope in unfertilized eggs remains white as in the early stages and these eggs are frequently voided along with the young, giving rise to the belief that the snake is both ovi and viviparous. Sacs with young measure 43 x 20 mm. Gravid females have been obtained in all months of the year. The young are born between May and November with a peak period of birth in June and July. The gestation period exceeds six months. One of the most prolific of Indian snakes, frequently producing thirty to forty young. The maximum recorded is 63 young ones (Wall 1906), but instances of a single foetus or less than twenty are known. Length at birth varies from 215 to 260 mm. Smallest gravid female recorded 1,015 mm about three years in age.

Poison: The fangs attain their maximum size in this, the largest of Indian vipers average size is about 16 mm. There are two fangs to a side, with 5 or 6 reserve fangs lying behind. They are movable and can be erected when the mouth opens. The poison glands are small and present a corrugated appearance. The venom is transparent, acidic in reaction and tastes like gum Arabic. When dried, it retains its toxicity indefinitely and is readily soluble in water. The total yield may be about 145 mg and about 72 mg may be injected at a bite, considerably in excess of the 42 mg thought to be the fatal dose for man. The poison acts as a depressor of the vasomotor centre and a destroyer of blood. The blood pressure drops and heart weakens. Red blood corpuscles are destroyed, the clotting power of the blood is reduced and the lining of the blood vessels destroyed, leading to extensive internal haemorrhage with pain and vomiting and bleeding from the body orifices. In

experimental animals, massive doses of the venom result in extensive clotting of blood and death in a few minutes, owing to the action of a principle that clots blood and is only active in high concentrations. The symptoms in man are intense burning or stinging pain at the site of the bite, rapid swelling of the area, and constant oozing of a thin bloody serum from the puncture. The pulse becomes rapid and weak, and breathing rapid, irregular, accompanied by muscular weakness, nausea and vomiting. Pupils become dilated and insensitive to light. Unconsciousness may result. The skin becomes cold, often bedewed with sweat. Bleeding from body orifices and internal haemorrhage occur. Death from cardiac or respiratory failure or septicemia may occur in 1 to 14 days or even later. The Haffkine Institute's Polyvalent Serum is an effective antidote to the poison.

Saw Scaled Viper *Echis carinata* (Schneider) (Plate-3)

Local Names: Pushtu Phissi', Sindhi Kuppur, Janndi', Hindi Afai, Marathi Phoorsa', Kannada Kallu have', Tamil Viriyan pamboo, Surutai vireyan', Malayalam Churuta-, Gujarati Tarachha, Zeripadkoo udaneyn.

Size: Usually less than 457 mm in length, rarely attains 610 mm. Longest recorded 788 mm.

Identification: Distinguished from other Indian snakes by the absence of shields on the head, the broad ventrals covering the whole belly and the undivided subcaudal shields. Body cylindrical, short and stout, rough from the serrated flank scales, tapering towards both neck and vent; neck distinctly constricted. Head subovate with short rounded snout. Eyes large, iris golden yellow, pupil vertical. Tail short.

Coloration: Color and pattern varies considerably. Pale brown, buffer tawny, with dark brown or even blackish markings in the form of dark edged spots in a vertebral series,

connected to a light colored, inverted U- or V-shaped flank mark enclosing a dark area connected to each other and forming a wavy flank line. A cruciform or trident shaped mark on crown. Whitish below, uniform or spotted with brown.

Habitat, Distribution, and Status: Mainly inhabits arid country. Pakistan, India, south and west of the Ganga. Not recorded in the Cochin and Travancore areas of Kerala, or in Sri Lanka. Common.

Habitat: Though essentially a desert snake, it occurs in semi-desert and broken scrub country. In some parts of the Deccan it has been recorded as extremely abundant, over 2,25,000 being collected on an average per year for bounty over a period of six years in the Ratnagiri dist. in the early years of the 20th century. When the bounty payment was increased from six pies to two annas, 1,15,921 were brought for collection in eight days! Often seen basking in the full force of the sun or may retire below or into clefts of rocks too hot to touch from the sun's heat. In such conditions, relies on moisture of the animals it eats, but drinks when water is available. An alert little snake, it is largely diurnal and is capable of quick movement when necessary. In sandy areas it side winds. Hibernates in the winter in its northern range, but may emerge to bask in the heat of the sun. Often climbs on to shrubs and other low vegetation. The readiness with which it bites on the smallest provocation and the extremely fast strike makes it a very dangerous reptile. The striking posture is characteristic, a double coil in the form of a figure of 8, with its head in the centre. The coils keep moving against each other and the serrated keels on the flank scales produce a hissing noise by friction, amplified by the inflated body acting as a resonator. There is a report of a pot full of these snakes hissing with excitement sounding like a boiling kettle.

Food: Feeds largely on centipedes, scorpions, larger insects, mice, skinks, geckos and frogs.

Breeding: The Saw Scaled Viper is viviparous, producing 3 to 15 young at a time. Mating is believed to take place in the cold weather in north India, and young are born from April to August and occasionally in other months of the year. The young at birth measure 115 to 152 mm.

Poison: The fangs of this snake are remarkably long for its size, specimens 380 mm in length having 5 mm long fangs. The almond shaped poison glands are placed behind the eye. The average yield by weight of dry venom is about 18 mg, with a recorded maximum 72 mg. About 12 mg are injected at a bite, roughly twice the lethal dose for an adult. The venom is said to be five times as toxic as Cobra venom, sixteen times as toxic as Russell's Viper venom and is very rapidly absorbed. The lethal dose for man is believed to be 5 mg. The yield from snakes varies considerably and about 20% of the bites may prove fatal. The poison acts mainly as an anti-coagulant, a destroyer of blood cells and lining of blood vessels, a cardiac depressor and generally as a depressor to nerve cells. The local symptoms are similar to those of the Russell's Viper. The heart is strongly affected through the vasomotor centre in the brain, resulting in a weak pulse and low blood pressure. The venom acts directly on the cardiac muscle also. The blood cells are destroyed and haemorrhage almost inevitably occurs from damaged blood vessels. Death results from heart failure and may occur within 24 hrs or less, or when caused by exhaustion from repeated haemorrhage may occur after a week or two. The Haffkine Institute's Polyvalent Serum is an effective antidote to the poison. It is essential to keep

the victim under medical observation, as delayed effects of the poison prove fatal even many days after the bite. The kidneys are often damaged beyond repair.

Green or Bamboo Pit Viper *Trimeresurus gramineus* (Shaw):

Local Names: Hindi Sakra', Marathi Hara ghonas', Tamil Pachai viriyan.

Size: Average size 600 to 760 mm. Longest measured 1,117 mm.

Identification: The loreal pit separates the pit vipers from all other groups of snakes. From other green pit vipers, it is distinguished in having 21:21:15 rows of smooth or feebly keeled costals. The head is flattened and appears unduly broad, owing to the constricted neck. Body stout. Tail short and tapering. Prehensile. Females usually have shorter tail. Head scalation of *Trimeresurus gramineus* key character: Loreal pit (Lp).

Coloration: Grass green above, glossy white, yellow or greenish below and on upper lip, chin and throat. A well-defined white, bluish or yellow flank line usually present. Tail yellowish or reddish, mottled darker. Iris golden black or blackish markings occasionally on head and back. Markings on back may be in the form of crossbars. Occasionally, yellowish or olivaceous rather than green.

Habitat, Distribution, and Status: A snake of hill forests, it is said to be confined to the Indian peninsula south of Lat. 22. Not uncommon.

Habitat: A hill species not normally seen below 450 m. In the Western Ghats, it is usually seen during the rains, though rarely after October. Frequents low vegetation, showing a marked preference for bamboo in localities where it occurs. Usually sluggish during the day as it reclines on branches four to eight feet from the ground, its colour merging with its surroundings. When provoked to strike, anchors itself firmly by its tail and hind body to a branch, and with the rest of the body in a broad 'S', strikes with open

mouth as far as it can straighten itself. The venom's action is feeble but painful, consisting of pain and swelling of the bitten part, nausea, vomiting and fever. The symptoms disappear in about 48 hrs.

Food: Preferred food is small mammals, but takes other small vertebrates also. Known to take small rats, mice, shrews, small birds, and lizards. A snake is also reported to have been taken. The tail tip is vibrated when about to strike at prey. Breeding: Viviparous, producing 7 to 15 young at a time. Most births occur in June- July. Tip of tail of young reddish in colour.

Table:1. Details of major four venomous snakes of Gujarat.

Name of Snake	Length at adult age	Total quantity of venom in their glands	Lethal dose for human	Death in hour due to snakebite
Common Cobra	120 to 150 cm.	115 mg	11 mg	1 to 6
Common Krait	60 to 120 cm	30 mg	2.5 mg	6 to 24
Russels' Viper	60 to 150 cm	172 mg	42 mg	4 to 24
Saw Scaled Viper	240 to 450 cm	12 mg	5 mg	6 to 24

Snake of Gujarat

In Gujarat out of this eight snake families 10 type sea snakes and 8 type land snakes are poisonous. This is not the final list, more research is going on in this area.

1. **Family - typhlopidae**

    1) Common blind snake or Brahminy Snake *Ramphotyphops braminus*
    2) Beaked blind Snake *Typhlops acutus*
    3) Slender worm Snake are slender blind snake *Typlops Porrecutus*.

2. Family - uropeltidae

    4) Elliot's shields tail snake *Uropeltz ellioti*
    5) Bombay shield tail snake *Uropeltis macrolepis*.

3. Family - boidae

6) Russell's Earth boa or common sand boa - *Eryx conicus*
7) John's earth or Red Sand boa or Blunt tailed sand boa or stump tailed sand boa - *Eryx johnii*
8) Indian Python - *Python molurus*.

4. Family - acrochridiae

9) File Snake - *Acrochordus granulatus*

5. Family - colubridae

10) Common wolf snake - *Lycoden aulicus*
11) Yellow Spotted Coolf snake - *Lycoden flavomaculatus.*
12) Barred wolf snake - *Lycoden striatts*.
13) Common Kukri snake - *Oligodon arnensis*.
14) Streaked kukri snake - *Oligodon taenliolatus*.
15) Dumeril's black headed snake - *Sibynophis subpunctatus*.
16) Buffstriped keel back - *Amphiesma stolate*.
17) Green keel back - *Macropisthodon plumbicolor*
18) Checkered keel back or common water snake - *Xenochrophis piscator*
19) Trinket Snake - *Elaphi helena*
20) Rat snake or Dhaman - *Ptyas mucosus*
21) Gray's rat snake or glossy belliedracer - *Argyrogence ventromaculatus*
22) Fascilolatus rat snake or banded racer - *Argyrogena fascilolatus*
23) Royal snake or Diadem snake - *Spalerosophis diadema*
24) Bronteback tree snake or common tree snake - *Dendrelaphis tristis*
25) Golden tree snake or flying snake - *Chrysopelea ornate*
26) Sand snake or stont sand snake - *Psamnophis longifrons*
27) Indian ribbon snake or Leith's sand snake - *Psammophis leithii*
28) Common Vine snake or Common green whip snake - Ahaethlla nasutus
29) Brown vine snake or brawn whip snake - *Ahaethlla pulverulentus*
30) Common cat snake or Indian gamma - *Boiga trigonatus*
31) Forsten's cat snake - *Boiga foresteni*
32) Dog faced water snake - *Cerberus rhynchops*
33) Glossy marsh snake - *Greadia prostianus*

6. Family - elapidae

34)	Common Krait	-	*Bungarus caeruleus*
35)	Sindh Krait	-	*Bungarus sindanus*
36)	Slender coral snake	-	*Calliophis melanursus*
37)	Common Cobra or spectacle Cobra or biocellate Cobra	-	*Naja naja*
38)	Black Cobra, or oxus Cobra	-	*Naja oxiana*

7. viperidae

39)	Saw Scaled Viper	-	*Echis carinatus*
40)	Russell's Viper or Chain Viper	-	*Viper russellii*
41)	Bamboo Pit Viper	-	*Trimeresurus gramineus*.

8. Family - hydrophidae

42)	Beaked sea snake or hook raised sea snake	-	*Enhydrina schistose*
43)	Yellow sea snake	-	*Leiocephalus spiralis*
44)	Annulated sea snake	-	*Leioselasma oyanocinota*
45)	Pearsian gulf or black headed sea snake	-	*Hydrophis lapemoides*
46)	Bombay sea snake	-	*Hydrophis mamilaris*
47)	Malacca sea snake	-	*Hydrophis caerulescens*
48)	Malabar sea snake	-	*Lapemis curtus*
49)	Common narrow headed sea snake	-	*Microcephalophis grqcilis*
50)	Cantor's narrow headed sea snake	-	*Microcephalophis cantoris*
51)	Black and yellow sea snake	-	*Pelamis plathrus*

The non venomous snakes of Gujarat (Plate-4 to 12).

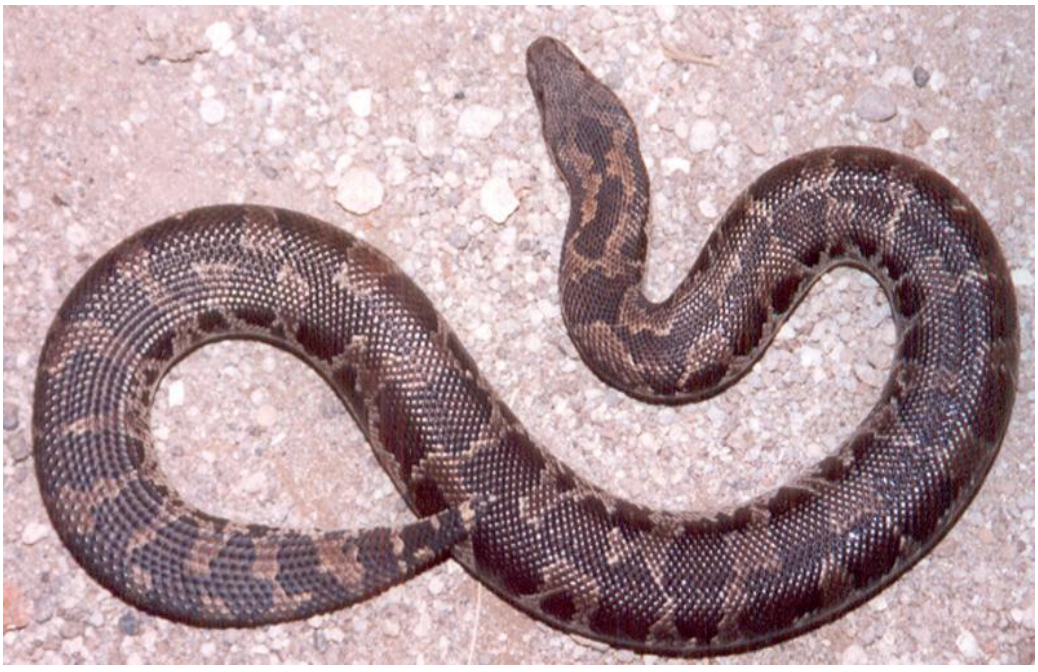
Plate-4. Non-venomous snakes of India and Gujarat (Indian Python and Trinket snake)

Indian rock Python (*Python molurus*)

Trinket snake (*Elaphi helena*)

Plate-5. Non-venomous snakes of India and Gujarat (Red sand boa & Russel's Earth Boa)

Red Sand Boa (*Eryx johnii*)



Russell's Earth Boa (*Eryx conicus*)

Plate-6. Non-venomous snakes of India and Gujarat (Banded Racer & Cat snake)

.Banded Racer (*Algyrogena fascilotatus*)

Cat snake (*Boiga trigonata*)

Plate-7. Non-venomous snakes of India and Gujarat (Common vine snake & Bronze back tree snake)

Common vine snake (*Ahaetulla nasuta*)

Bronze back tree snake (*Dendrelaphis tristis*)

Plate-8. Non-venomous snakes of India and Gujarat (Common wolf snake & Barred wolf snake)

Common wolf snake (*Lycodon aulicus*)

Barred wolf snake (*Lycodon striatus*)

Plate-9. Non-venomous snakes of India and Gujarat (Indian ribbon snake & Buff stripes keelback).

Indian ribbon snake (*Psammophis leithii*)

Buff stripes keelback (*Amphiesma stolata*)

Plate-10. Non-venomous snakes of India and Gujarat (Green Keelback & Chequered Keelback).

Green Keelback (*Macropisthodon plumbicolor*)

Chequered Keelback (*Xenochrophis piscator*)

Plate- 11. Non-venomous snakes of Gujarat (Common kukri and Dumeril's black headed snake)

Common kukri (*Oligodon arnensis*)

Dumeril's black headed snake (*Sibynophis subpunctatus*)

Plate-12. Non-venomous snakes of India and Gujarat (Common rat snake & Royal snake).

Common rat snake (*Ptyas mucosus*)

Royal snake (*Spalerosophis diadema*)

Snake Venom

Many species of animals have the capacity to produce venom. The venom has a passive defensive function in frogs, toads and salamanders, in which the venom glands are distributed in the skin. The venom apparatus reaches the highest development in snakes and is a weapon for capturing prey, for defense and also a digestive aid. The venom glands are actually specialized salivary organs and inoculation of the venom is through the canalized or grooved teeth. The salivary secretion of the harmless snakes is equally effective against their prey species. The venom not only immobilizes the prey but aids the subsequent digestion of animal tissues. Snake venom is a mixture, chiefly of proteins, varying in composition from species to species. Studies so far undertaken indicate that the biological significance of snake venoms is primarily in their digestive role. Snakes cannot chew and mix the products of their salivary glands with the tissues of their prey. Instead, they use a highly developed injection apparatus to apply digestive aids to their food. These powerful and concentrated enzymes are extremely poisonous. For instance, the lethal dose of Russell's Viper venom for a rabbit is 0.05 mg when injected intravenously. To enable the poisons to spread rapidly in the body, compounds in the poison break down the connective tissues and destroy blood vessels, causing the spread of erythrocytes and serum into the tissues. Necrosis at the site of a bite is due to the digestive properties of snake venom. A non-toxic component of the venom, not always present, liberates proteolytic enzymes into the victim's body and hastens putrefaction.

Characteristics of Snake Venom

The venom produced by snakes is considered to be one of the most highly developed and complex of all toxins produced by plants or animals. The effect of snake venom of a particular species varies from animal to animal. It can also vary from place lo place (sea level to high altitude), the age of the snake, the time of the year, and other unknown causes. The lethal dose appears different for mice, rabbits and humans. The higher the altitude and lower the temperature the less toxic the venom. Due to reasons not clear, bites in November, December and January showed increased mortality and morbidity. The older the snake the more lethal the venom appears to be. There are other unexplained factors also that cause varying effects on the victims of snakebite.

Venom has at least three main functions. Basically it helps the reptile to immobilize its prey. It also helps in the digestion of the prey, even though snakes without venom can digest food. The third function is in the defense against aggressions and predators. The venomous snakes are the most highly developed of all reptiles. The venom is a superior modification to speed, size or strength or better concealment and even visual acuity as well as other characteristics, which many of the non-poisonous snakes have developed. The common chemistry of snake venom is a complex mixture of proteins. It was seen later that this protein is in the form of enzymes, peptides and polypeptides. Metallic elements such as zinc and magnesium have been separated from the venom. The components are so many in each of the venom that the collective effect of the venom on

the victim may not be the effect of its component. It is also known that in vitro effect may not be seen in vivo.

The venom of snakes may have up to 26 enzymes with at least 10 of them in each of venom of a snake species. There are several proteolytic enzymes which include arrine-hydrolase, collagenase which cause digestion of collagen, haileuronidase which is known as to spread factor helping venom to penetrate in to the tissues, phosphorailise which causes haemolysis, acctylchol intesterase seen in Cobra which may be a factor in the neuroparalylic symptoms, etc. Polypeptides which are of low molecular weight and do not have enzymatic ability. The neurotoxic factor of Cobra venom acts on the motor-end-plate of muscles producing paralysis identical to deturbocurarine. The toxin however, is more potent and binds more strongly with the receptor. These small molecules enter the blood stream directly in contrast to viperoid toxins, which enter the lymphatic and thereby have a slower onset of action. The cardiotoxin, originally isolated from the Indian Cobra, damages the cardiac muscle. Haemolysin studied .extensively in-vitro is not a major factor to produce haemolysis in human envenomation. Hemorrhaging is the major factor that produces spontaneous bleeding seen in many viperid poisonings. The defibrination syndrome, an accepted effect of viperine toxicity, seldom produces active bleeding in the absence of hemoglobin.

Neurotoxicity - Neurotoxicity is the most prominent feature in the bites of Elapids such as Cobra, Krait and sea snakes. Depending on the degree of envenomation, the symptoms can develop in a few minutes up to 4-6 hours later. The effects of neurotoxins on humans and animals are strictly at the peripheral level on the neuromuscular junction

and some times (as in the case of sea snakes) on the muscle itself. Earliest signs are drooping of eyelids, drowsiness and an extreme desire to lie down. The muscles supplied by the cranial nerves are always affected first resulting in drooping of head, paralysis of deglutition, dysphonia, respiratory muscle paralysis, cyanosis, convulsion, coma and death. Cytotoxicity the tissue oedema, blillae, necrosis, and ulceration caused by viper and some Cobra bites are due to cytotoxic components of the venom. It appears there are various cytolysins such as (1) Haemolysin, which causes red cell lysis (2) Leukolysin, which causes white cell destruction (3) Haemorrhagin, which causes vascular endothelial damage (4) Cytolysin, which causes destruction internal organs such as liver, kidney, myocardial tissue, etc. (5) Rhabdomyolysis in sea snakes venom poisoning causing extensive necrosis of striated muscles and myogloburia which can lead to renal failure. The proteases and hyaluronidase cause the local reaction, inflammation, necrosis, etc. Cardiac rhythm abnormalities, nonspecific ECG changes, hypotension, cardiac arrests are all attributed to the cardiotoxin venom components. It appears these are seen in poisoning by Pit Viper. In certain Cobra bites cardiac arrest can precede respiratory failure.

It is suggested that the bleeding tendency so commonly seen in viper envenomation is due to endothelial damage caused by the haemorrhagin fraction, of the venom. Anaemia which occurs very frequently following envenomation from snakes of viperidae families has been attributed to both hemorrhage and haemolysis. Moreover, microangiopathic anaemia can occur directly due to the entrapment of red cells in the fibrin in disseminated coagulation. This is an additional cause for anaemia. Haemolytic effect on red cells by snake venom has been thought to be due to phospholysin, which converts red blood cells

or plasma, lecithin to a haemolytic substance lysolecithin. Evidence of a complement mediated mechanism of haemolysis has been described in Cobra venom. Most snake venoms are concentrated and excreted through their kidneys. There appears to be direct damage to the kidney by some factor - probably the cytotoxic factor, in viper venom. The very rapid development of oliguria seen in some patients supports the idea of massive occlusion of the renal microvasculature with fibrin. The loin pain and renal tenderness could be manifestation of ichaemia. Direct nephrotoxic effects such as vasculitis of glomerular capillaries, interstitial glomerulonephritis and tubular damage are not unknown. Release of endogenous vasodilators by venoms is thought to play a part in causing early and often transient hypotension. The delayed allergic reaction such as serum sickness can be due to antivenom or venom protein but it is felt that it is .due to the former.

Some enzymes found in snake venoms:

	Biological action	**Source examples**
Proteinases	Aids digestion and breaks down proteins. Largely causes clotting in snakebite cases, also local gangrene.	Most pit vipers, puff adder.
L-amino Acid	Gives yellow color to venom cotton-Oxidase and aids digestion. Also activates mouth.	Blunt-nosed Viper.
Hyaluronidase	Dissolves tissue and enhances aspic rapid absorption of venom,	Most snake venoms, Viper, eastern diamond-back rattlesnake.
Cholinesterase	Probably a nerve depressant But true function uncertain,	All elapid venoms, banded Krait, forest Cobra, brown snake.
Ribonuclease	Function in venom uncertain.	Most snake venoms, Asiatic Cobra, russels

		Viper.
PhospholipaseA	Promotes histamine Production on tissue.	Black mamba.taipan, cotton-mouth.
Pliospliompnesterase	function in venom uncertain.	Most elapid venoms, and Some Viper, Egyptian Cobra, Waglers viper.

Snakebite and its effects:

It is not correct to assume that bites from harmful snakes are invariably fatal. Hospital case histories with definite identification of the biting snake show that in about half the cases there is little or no effect of the poison. This is understandable, considering the fact that snakebite on man is a purely defensive reaction.

The local symptoms of poisoning are distinctive and consist of pain, immediate swelling and later blisters and necrosis (Plate-13). These symptoms vary according to the species. Severe pain is felt after a Cobra or viper bite, starting within a few minutes of the bite in the case of the vipers and reaching a maximum in about 12 hours. In the case of the Cobra, swelling starts about 1 to 3 hours after the bite and reaches a maximum in 24 to 48 hours. Swelling of the whole limb occurs in viper and Cobra bites and the swelling is tender in both cases. Poisoning by Common Krait may not cause local swelling. Discolouration of the skin around the bite occurs both in Cobra and viper bites (Plate-14). Blisters appear around the bite and extend up the body in the case of a viper bite if a large amount of venom is injected. Local necrosis is invariable in Cobra poisoning and may be extensive even if more serious effects of the poison do not develop. The toxic effects of the poison in the case of Cobra and Common Krait poisoning are drowsiness, commencing in 15 minutes to 5 hours in Cobra which may be delayed up to 8 hours in

Common Krait poisoning; difficulty in opening the eyes and mouth, moving the lips and swallowing (Plate-15). Severe abdominal pain occurs in the case of Krait poisoning. Limb weakness develops last. The

Plate : 13. Signs of Russell's Viper bite (Hematuria,swelling and necrosis).

Russell's Viper bite and haematuria.

Swelling and necrosis at Russell's viper bite site.

Plate:14. Russell's viper drooping sign and treatment.

Russell's viper drooping signs.

Russell'sviper bite and treatment of haemotoxicity

Plate:15. Sign of Indian cobra bite (drooping eyelids, infection at bite site).

Cobra bite site and infection

Drooping eyelids due to Cobra bite

victim is unable to sit up or hold the head up. The lower jaw falls and drools saliva, breathing becomes increasingly difficult. The most significant symptom of viper poisoning is bleeding from the bite site, any sores on the body and internal haemorrhage (plate-16). Heart sounds become faint. Death occurs quickly in Cobra and Common Krait poisoning and is delayed in viper bites. If by chance the strike of the snake ruptures a vein, death may occur within 15 minutes in any case.

The treatment recommended is to reassure the person by a placebo injection if necessary. The site of the bite should be gently wiped and covered with a clean handkerchief. No incision should be made as it often introduces infection. Apply a firm but not tight ligature above the bite with a cloth or handkerchief. The patient should be taken to the nearest doctor or hospital for treatment. The polyvalent serum now available against the bites of Cobra, Common Krait, Russell's Viper and Saw Scaled Viper makes death from snakebite exceptional.

Plate:16. Signs of Saw Scaled viper bite (bite site, swelling, bleeding and necrosis).

Necrosis and bleeding due to Saw Scaled Viper bite in finger

Saw Scale Viper bite and sweling in hand

CHAPTER: 4
METHODOLOGY

4.1. Data collection

To fulfill the objectives of the study, information on a total of 2087 snakebite incidences were collected from 2002 to 2005 from seven districts. The data were collected from the Government hospitals at district and taluka levels and at Public Health Centers (PHCs) from rural areas. Information was also collected from newspapers, which has better coverage specially in reporting death records from hospitals. Information on each of the incidences of snakebites, which was collected through newspaper, was further crosschecked with the concerned hospital records to avoid any ambiguity. For each snakebite incidences, information on the name of the person (victim), age, sex, occupation of victim, and their education level were collected as per the availability of record. Data on whether victim believes on any orthodox method of curing snakebite such as treatment by witchcrafts (bhuva and tantric) etc. also collected to assess the prevalence of myth or blind beliefs. The data collected from various sources from different districts are given in Table:2.

During the present study all coastal districts (Porbandar, Bhavnagar, Junagadh and Jamnagar) were visited in order to collect information on sea snakebite cases. During this local hospitals on the coastal areas were visited. Fishermen on the coastal region were interacted to get information on the sea snakebite. It is understood from the interactions made with fishermen and hospital personals on the coastal areas that there are negligible or no cases recorded of sea snakebites in this region. Therefore there are no data on sea snakebites for the present study.

Table:2. Sources of data collected from seven districts in study area from 2002-2005.

Districts	District civil hospital	Private hospital	Taluka hospital	PHCs	News paper
Amreli	√		√		√
Bhavnagar	√	√	√	√	√
Jamnagar	√		√	√	√
Junagadh	√	√	√		√
Porbandar	√		√		√
Rajkot	√				√
Surendranagar	√	√	√	√	√

4.2. Analysis:

4.2.1 Epidemiology/ magnitude

It is important to estimate the number of snakebite incidences that take place in the region per year. The magnitude of the problem needs to be quantified in order to sensitize the community, health department, policy makers and politicians etc. to do needful to reduce it. The present study has tried to assess the magnitude at two different levels i.e. 1) Saurashtra level and 2) district levels. The magnitude was also studied in different ways i.e. 1) the average number of snakebite cases, 2) Percentage of people affected by snakebite from the total population of the district and also from the rural population 3) Percentage of snakebite incidence per area of Saurashtra and each of the districts.

4.2. 1.1. Average number of snakebite cases per annum

The information on total number of snakebite incidences collected for four years from 2002 and 2005 was classified year wise and the average number of annual incidences was calculated at Saurashtra level and for each of the seven district levels. The above - mentioned average annual snakebite incidences derived from the data was used to

calculate one snakebite incidence occurring per number persons from the total population of Saurashtra and for each of the seven districts.

4.2.1.2. Percentage of people affected by snakebite from the total population and rural population

To get further insight in to the problem, it was also calculated to know if the problem is more severe in rural areas. The average number of snakebite incidences derived from the data was used to divide the total rural population of Saurashtra region and also for each of the seven districts. The data on the total population and rural population were acquired from the published report of Census of India, 2001 (Annexeure-1-7).

4.2.1.3. Snakebite incidence per areas of Saurashtra and each of the districts

To know the intensity of snakebite cases per area in the Saurashtra region as well as in different districts, the derived annual average of snakebite incidences in Saurashtra region was used to divide the total area of Saurashtra region and also the areas of each districts.

4.2.2. Identifying the regions with high magnitude of snakebite incidences in Saurashtra

Different districts of Saurashtra were tabulated and ranked based on the intensity of snakebite cases found in above mentioned various analysis. The districts were ranked based on 1) area per Snakebite cases, 2) Incidence per number of people of total population and 3) Incidence per number of people from rural population. The districts were ranked from 1-7 i.e. 1 representing higher intensity and 7 representing lowest. Finally the sum of the ranking in all the three analyses were calculated and lowest sum

represented the higher magnitude and highest sum represented lowest magnitude in the region.

4.2.3. Occurrence of venomous snake species in different districts of Saurashtra

The occurrence of total number of venomous snakes were calculated in order to get better insight into the reasons of differential magnitude of snakebite in different districts. Based on secondary literature i.e. papers, articles and personal discussions with various individuals involved in snake rescue and or handling the occurrence of venomous snake species were tabulated. The total numbers of venomous snakes found in each of the districts were calculated.

4.2.4. Age wise distribution of snakebite victims in Saurashtra region

The age of snakebite victims throws light on the vulnerable section of the population. In order to know the age classes that are more susceptible to snakebite, data available on the victim's age were classified into a total 11 different classes. The classes were of 5 years of interval till the age of 50 years and the last class was of age 50 years and above. The classes were logically formed. The initial age class i.e. up to 5 years of age is childhood, between 5-10 years of age is when child may move independent of its parents. From 10-15 years is adolescence and 15 to 40 years is youth. The age class of 50 years and above is considered to be one. These classes provide better resolution to cover and throw more light on the different stages of human life.

4.2.5. Sex-wise distribution of snakebite incidences in Saurashtra region

The gender of the snakebite victims also explains the vulnerable section of the society to snakebite. In order to know if there is any differential ratio of the snakebite victims in different genders i.e. male and female or not, all the data on the gender were classified. The data were also classified in to above mentioned age classes.

4.2.6. Seasonality in snakebite cases in Saurashtra region

In order to know if there is any seasonality in the snakebite incidences, the data were classified in to four different seasons i.e. 1) monsoon (June-September), 2) post monsoon (October-November), 3) winter (December- February) 4) summer (March-May). The data were also classified month wise as number of snakebite incidences were and plotted graphically in order to know the pattern of snakebite with monthly resolution.

4.2.7. Occupation of snakebite victims in Saurashtra region

A total of 218 snakebite victims were interviewed from 7 districts from 2002 and 2005 to get the information obtained by the in case of death their relatives or sometimes the hospital staff where they were admitted were interviewed. The data were classified into five major occupation classes in which the majority of the data fell. The classes were 1) farmers, 2) agriculture laborers, 3) other laborers, 4) hose wives and 5) others. The farmers and agriculture laborers can broadly be considered into the occupation of agriculture. However, the other laborers include mason, industrial workers, gardeners, sweepers etc. The data were classified in to different occupation classes at Saurashtra level and also district levels.

4.2.8. Crop pattern and snakebite incidences

The average annual snakebite incidences were correlated with the area under various types of major crop (groundnut, cotton, millet and fodder), in order to know if the snakebite incidences are more in a particular type of crop in the study region. The data on crop pattern i.e. area under different crop cultivation in different districts were obtained from agriculture department, Government of Gujarat. Since the seasonality of snakebite incidence suggested that the magnitude of snakebite is higher in monsoon and post monsoon period, therefore the data on rainfed (Kharif) agriculture only were used in the analysis. The data acquired from agriculture department suggests that the above - mentioned crops are the major crop in the study region.

4.2.9. Evaluation of myths and awareness level among the snakebite victims

A total of 218 snakebite victims/ their relatives were interviewed to estimate the prevalence of myths or blind beliefs in different districts of Saurashtra. A total of 35 victims from Amreli districts, 27 from Bhavnagar, 29 from Jamnagar, 40 from Junagadh, 19 from Porbandar, 35 from Rajkot and 33 from Surendrangar were interviewed. In majority of incidences victim's relatives were interviewed to know if the victim was taken directly to hospital or taken to witchcraft for initial treatments. These questions were used to assess the level of awareness since educated or aware people are likely to take the victims directly to hospital where as illiterate or people who believe in myths are likely to take victims to witchcrafts initially.

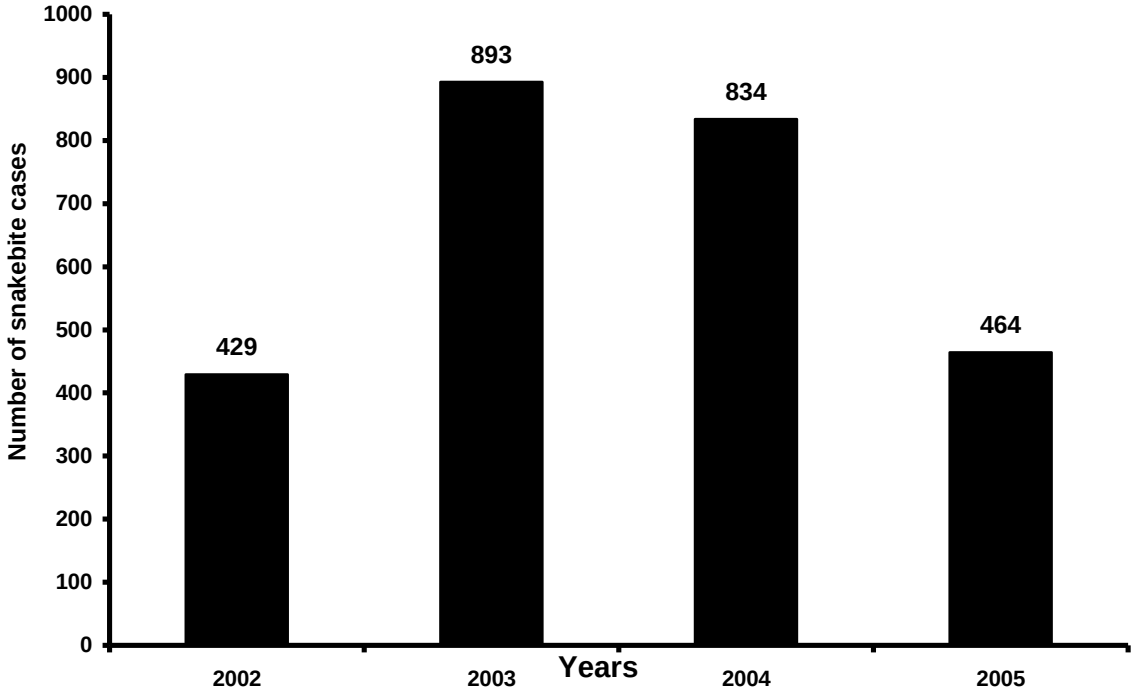
CHAPTER: 5
RESULTS

5.1 Epidemiology/ magnitude:

5.1.1 Saurashtra level:

The average annual snakebite incidences in Saurashtra region (seven districts) were found to be 695.6 ±118 SE (n=2087) from 2002 to 2005 which ranged from minimum of 429 incidences in 2002 to maximum of 893 incidences in 2003 (Fig.1). The data suggests that annually one person is subjected to snakebite out of every 19381 people of the total population of Saurashtra. However, in rural areas of Saurashtra region annually one person is subjected to snakebite per every 12007 persons. The data also suggested that every 96.0 km^2 one person is subjected to snakebite annually in Saurashtra region.

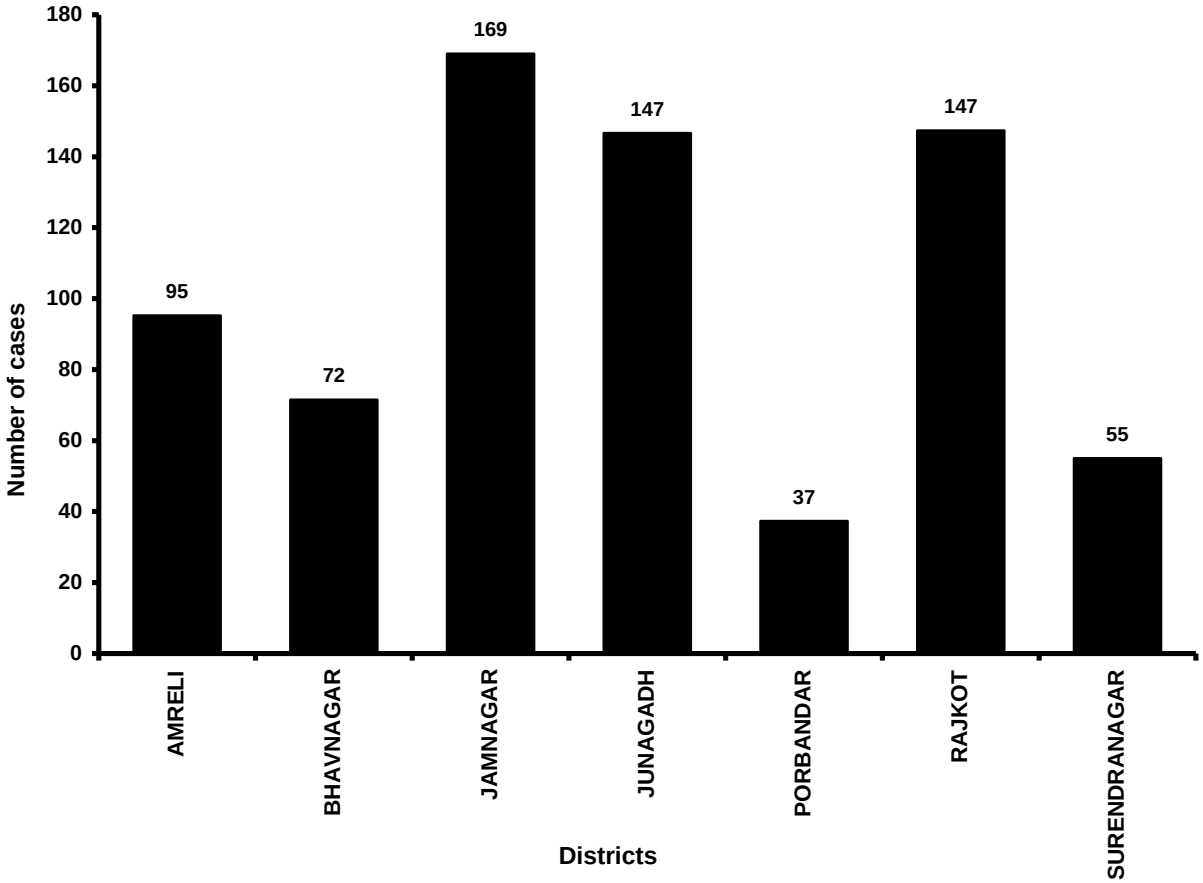
Figure:1. Year wise snakebite incidences in Saurashtra region from 2002-2005.



5.1.2 District wise average annual Snakebite incidences in Saurashtra region from 2002-2005:

The annual average snakebite incidences were higher in the districts of Jamnagar (169), Junagadh (147), Rajkot (147) followed by Amreli (95). However, average annual snakebite incidences were lower in Bhavnagar (72), Surendranagar (55) and followed by Porbandar (37) (Figure:2).

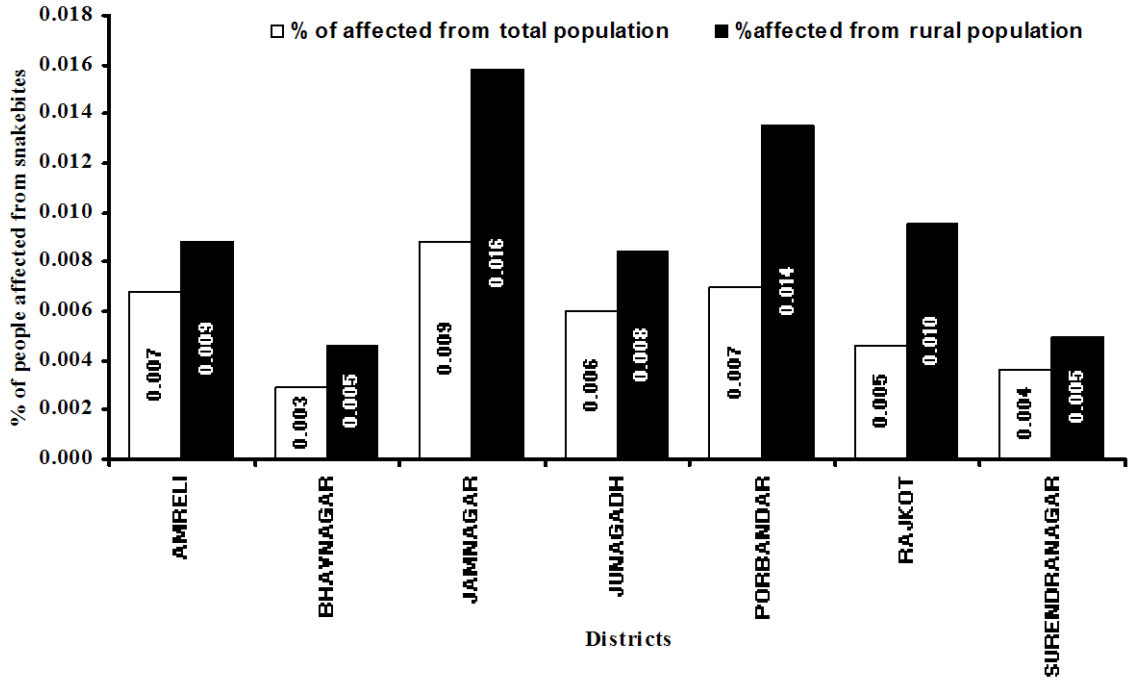
Figure: 2. District wise average annual Snakebite incidences in Saurashtra region from 2002-2005.



5.1.3 Percentage of people affected by snakebite from the total population and rural populations.

Of the various districts of Saurashtra, people from Jamnagar district was highly affected by snakebite incidences annually as it showed that 0.009% of total population and 0.016% of rural population. This was followed by Porbandar district as 0.007% of the total and 0.014% of the rural population is subjected to snakebite annually. However, in Bhavnagar district, it was found that only 0.003% of total and 0.005% of rural population was subjected to snakebite at annually (Figure:3).

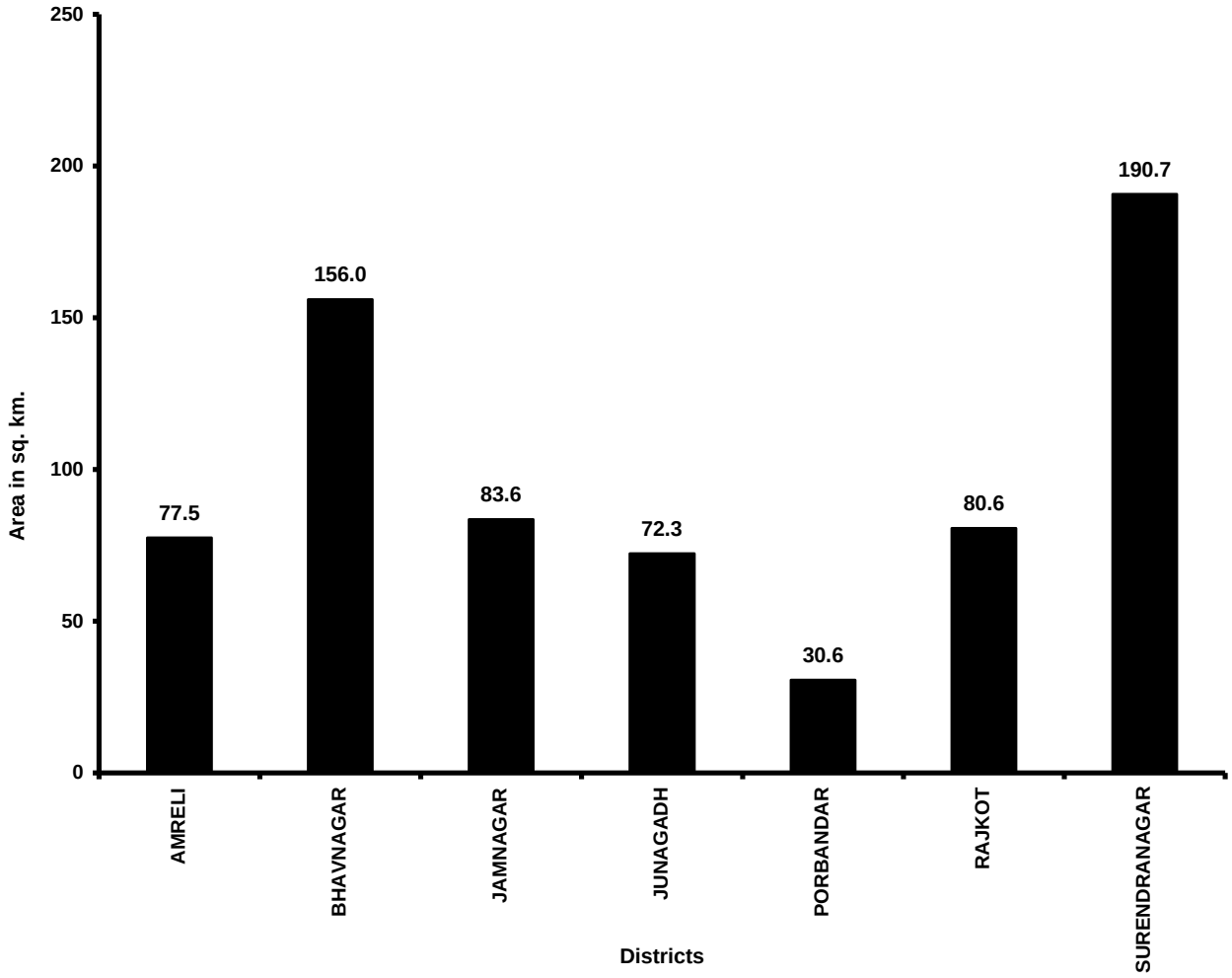
Figure:3. District wise one snakebite incidence per number of people from general and rural populations.



5.1.4. Intensity of snakebite cases in terms of area per snakebite incidence in different districts of Saurashtra region from 2002-2005.

The intensity of snakebite cases in terms of area per snakebite incidence was higher in Porbandar district where every 30.6 km^2 one snakebite incidence was recorded which was followed by Junagadh (72.3 km^2), Amreli (77.5 km^2), Rajkot (80.6 km^2), Jamnagar (83.6 km^2), Bhavnagar (156 km^2) and Surendranagar (190.7 km^2) (Figure:4).

Figure:4 The area per snakebite incidences in different districts of Saurashtra region from 2002-2005.



5.1.5. Identifying the regions with high magnitude of snakebite incidences in Saurashtra.

The ranking of each districts based on the occurrence of snakebite cases found in various analysis showed that Porbandar district has higher magnitude of snakebite incidences in compared to other districts of Saurashtra. This was followed by Jamnagar, Amreli, Junagadh, Rajkot, Surendranagar and Bhavnagar (Table:3).

Table:3. Relative ranking of magnitude of snakebite incidences as revealed through different analysis in the present study.

Districts	Magnitude categories			Total Rank	Final Rank
	Density of Snakebite cases in Saurashtra region	Incidence per number of people of total population	Percentage of people affected annually		
Porbandar	1	2	2	5	**1**
Jamnagar	5	1	1	2	**2**
Amreli	3	3	4	10	**3**
Junagadh	2	4	5	11	**4**
Rajkot	4	5	3	12	**5**
Surendranagar	7	6	6	19	**6**
Bhavnagar	6	7	7	20	**7**

5.1. 6. Occurrence of venomous snake species in different districts of Saurashtra.

Based on subjective information available on the distribution of venomous snakes suggests that all coastal districts except Bhavnagar i.e. Porbandar, Jamnagar, Amreli, Junagadh have all the four venomous snakes species present (Table:4). However Surendranagar, Bhavnagar and Rajkot districts do not have prominent presence of Russell's Viper.

Table:4. Presence and absence of venomous snake species in different districts of Saurashtra.

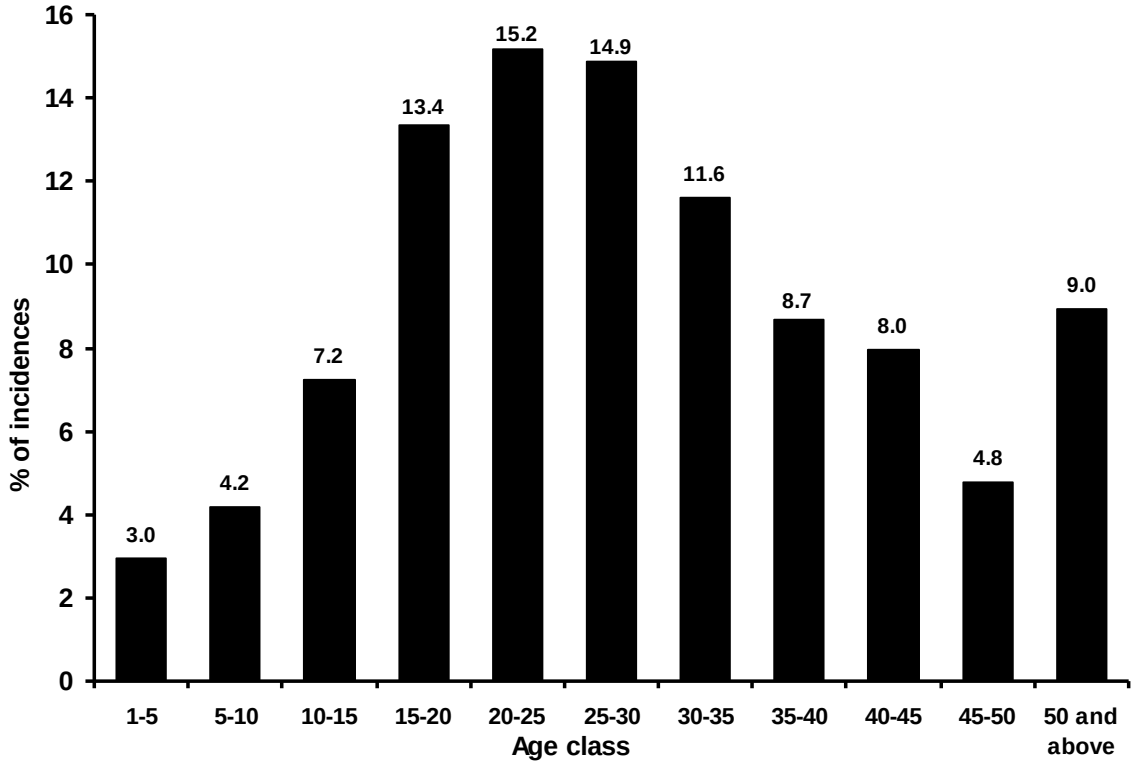
Districts	Venomous Snakes				Total Species	Reference
	Common Krait *(Bungarus caeruleus)*	**Cobra** (*Naja naja*)	**Russell's Viper** (*Vipera russellii*)	**Saw scaled Viper** (*Echis carinatus*)		
Amreli	√	√	√	√	**4**	Dharmendra Trivedi
Bhavnagar	√	√	**x**	√	**3**	Dr. Indra Gandhi
Jamnagar	√	√	√	√	**4**	Arprit Devmurari Sanjay Kalaiya
Junagadh	√	√	√	√	**4**	Punil Gajjar Sakkarbaug Zoo
Porbandar	√	√	√	√	**4**	Sanjay Kalaiya
Rajkot	√	√	**x**	√	**3**	Bhavesh Trivedi
Surendranagar	√	√	**x**	√	**3**	Chiku Vora Yogendra Shah

√ = Present, X = Absent

5.2. Age wise distribution of snakebite victims in Saurashtra region from 2002-2005.

Maximum snakebite victims contributing 15.2% of total snakebite incidences were of age between 20-25 years. However, almost one third of the total victims i.e. 30.1% of snakebite incidences were of between 20-30 years of age. It was also noteworthy that, more than half of the victims contributing 55.1% of the total snakebite incidences were of age between 15 –35 years. It was observed that snakebite incidences increases with the increase in the age class up to the age of 20-30 and again showed decreasing trend afterward till the age class of 45-50. However, 9% of the total snakebite victims were above 50 years of age (Figure:5).

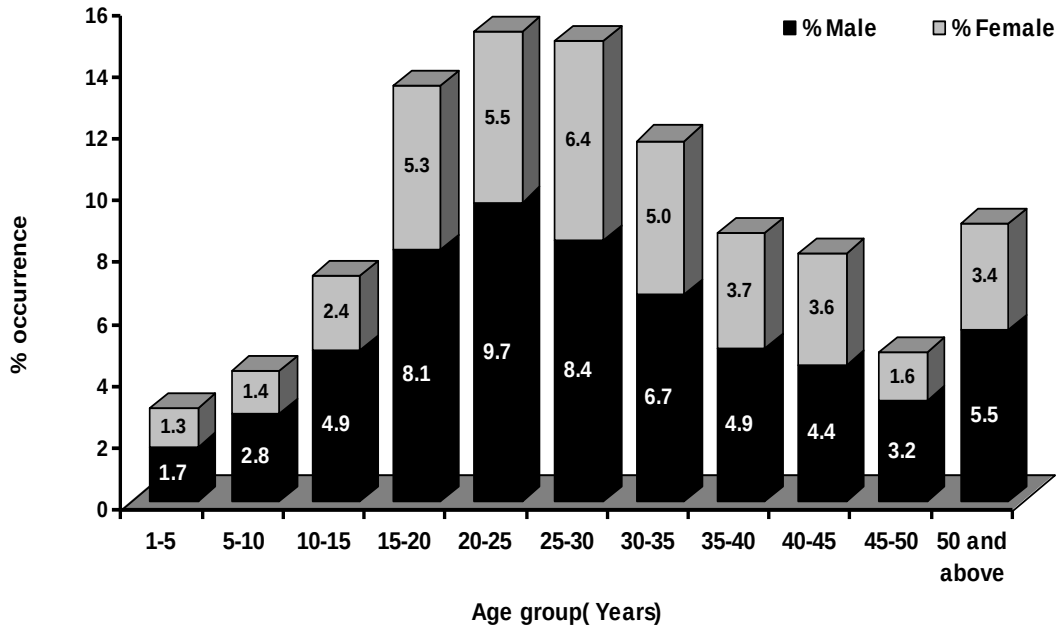
Figure:5. Age wise distribution of snakebite incidences in Saurashtra region from 2002-2005



5.3. Sex-wise distribution of snakebite incidences in Saurashtra region from 2002-2005.

It was observed that 60.3% (n=2206) of the total victims were males and 39.7 % were females. The male snakebite victims were higher in almost all the age classes than the female victims (Figure:6).

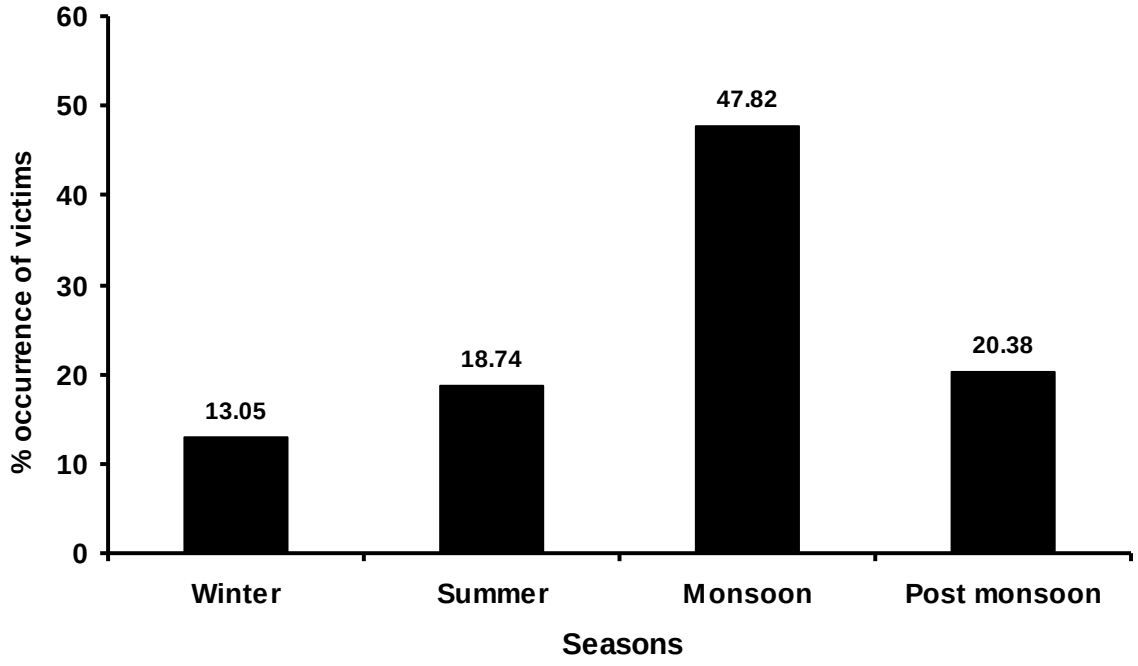
Figure:6. Sex and age wises distribution of snakebite victims in Saurashtra region from 2002-2005.



5.4.1 Seasonality in snakebite cases in Saurashtra region from 2002-2005:

Maximum snakebite incidences were observed to occur during monsoon (June-September) i.e. 47.82 %, followed by20.38 % during post monsoon (October-November), 18.7% during hot summer (March-May) and 10.05% during cold winter (December-February) (Figure:7).

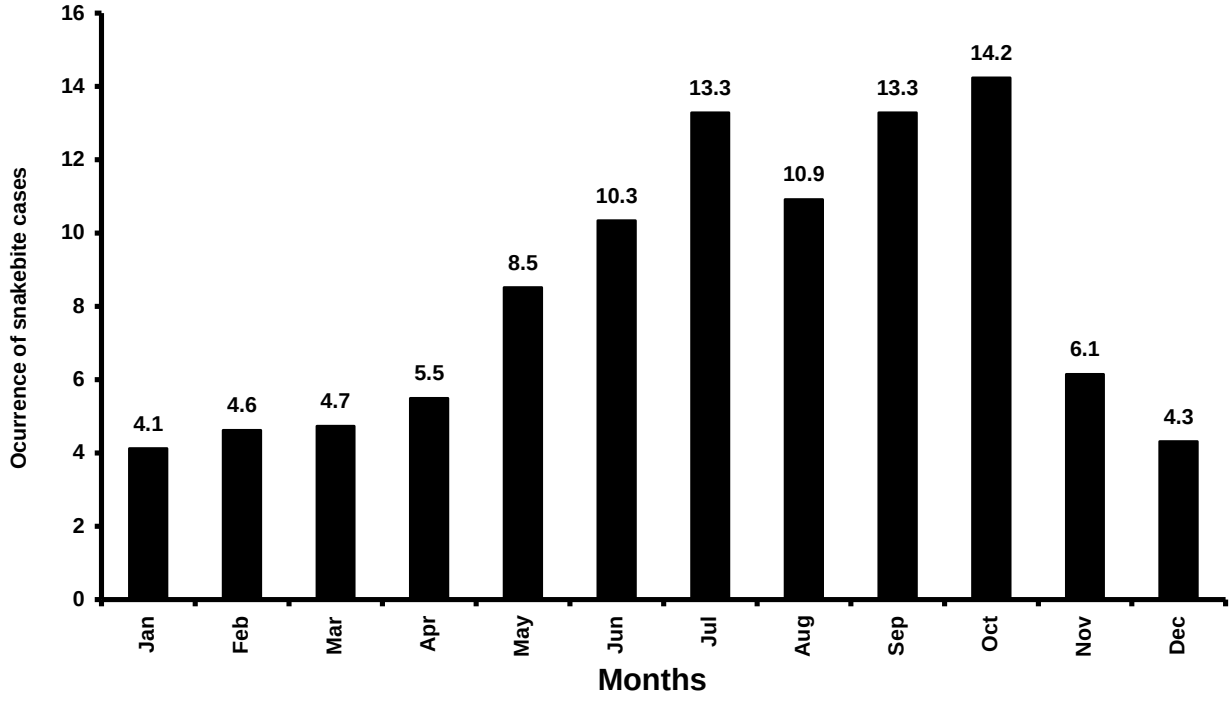
Figure:7. Seasonality in snakebite cases in Saurashtra region from 2002-2005.



5.4.2. Month wise snakebite cases in Saurashtra region from 2002- 2005.

Maximum incidences of snakebite were observed to occur in the month of October contributing 14.2% of the total incidences annually. During the months of July and September the snakebite cases were 13.3% each of the total snakebite cases occurred annually followed by 10.9% in August, 10.3% in June and 8.5% in the month of May. However, snakebite cases were observed to occur low in other months i.e. January to April and November, December, which contributed less than 6.5 % of the annual snakebite incidences (Figure:8).

Figure:8. Month wise snakebite cases in Saurashtra region from 2002- 2005.



5.6. Occupation of snakebite victims in Saurashtra region:

Majority of the snakebite victims (n=218) interviewed during 2005 from seven districts were farmers (32.9± 2.5 %), agriculture laborers (31.3±3.6 %), other laborers (15.4±2.4 %), hose wives (6.8±1.0 %) and others were (13.6± 2.5%). The victims involved in agriculture related occupation i.e. farmers and agriculture laborers contributed to the major percentage (64.2%) of the total snakebite incidences in the region (Figure:9).

Figure:9. Occupation of snakebite victims interviewed in Saurashtra region.

5.7 District wise occupation of interviewed snakebite victims:

The district wise analysis of occupations of snakebite incidences showed that in all the districts the farmers and agriculture laborers were the prime victims however, in the districts of Bhavnagar, Rajkot, and Surendranagar the contribution by the people involved in agriculture related occupation was relatively lower (Table:5).

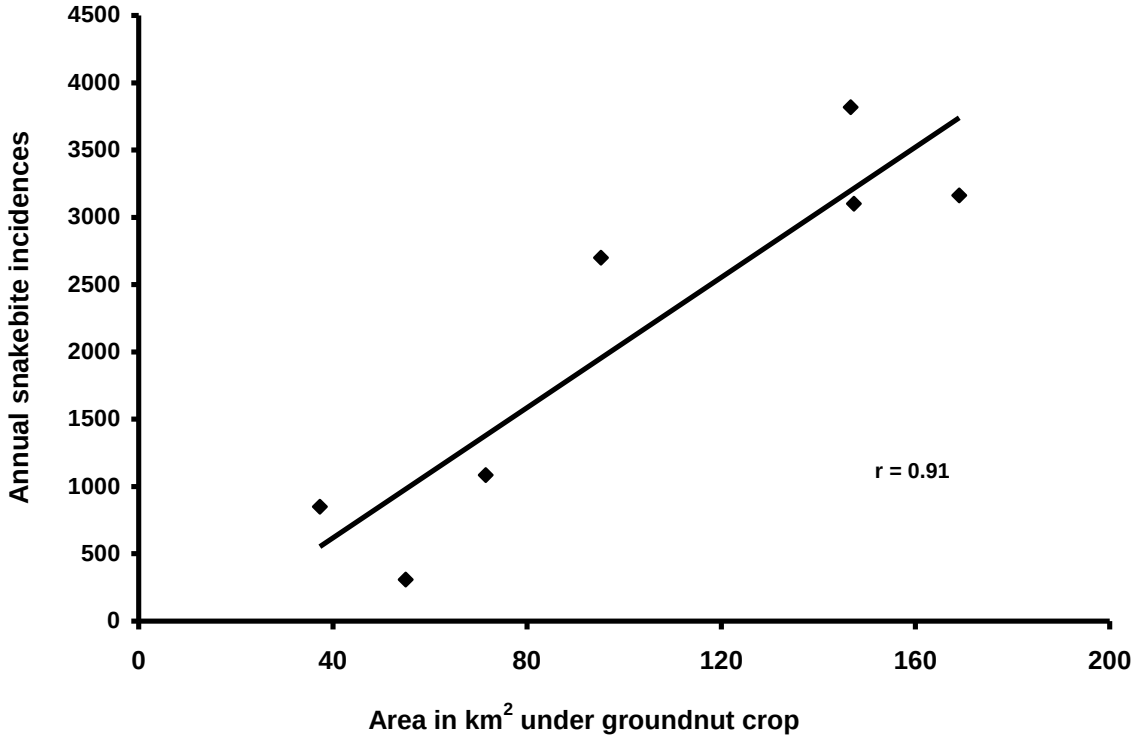
Table:5. District wise occupation of interviewed snakebite victims:

DISTRICTS	Total number of victims interviewed	Farmer	Agriculture laborers	Other laborers	House wives	Others
Amreli	35	42.9	34.3	5.7	5.7	11.4
Bhavnagar	27	25.9	29.6	22.2	7.4	14.8
Jamnagar	29	34.5	44.8	10.3	3.4	6.9
Junagadh	40	37.5	27.5	17.5	5.0	12.5
Porbandar	19	36.8	42.1	10.5	5.3	5.3
Rajkot	35	25.7	22.9	20.0	11.4	20.0
Surendranagar	33	27.3	18.2	21.2	9.1	24.2

5.5. Crop pattern and snakebite incidences:

The study showed that there is a strong positive correlation (r =0.91) between the area (in hectors) under groundnut crop and the annual snakebite incidences in Saurashtra region. (Figure:10). Junagadh, Jamnagar and Rajkot districts are found to be the major groundnut producing areas accounting for 67% of the total area under groundnut crop of Saurashtra region, these districts have also showed 64.1% of the total annual snakebite incidences of the Saurashtra region. However, there was no correlation between average annual snakebite incidences and area under cotton (r = 0.005), and there was negative correlation between area under millet crop (r = -0.33) and area under fodder cultivation (r = -0.33).

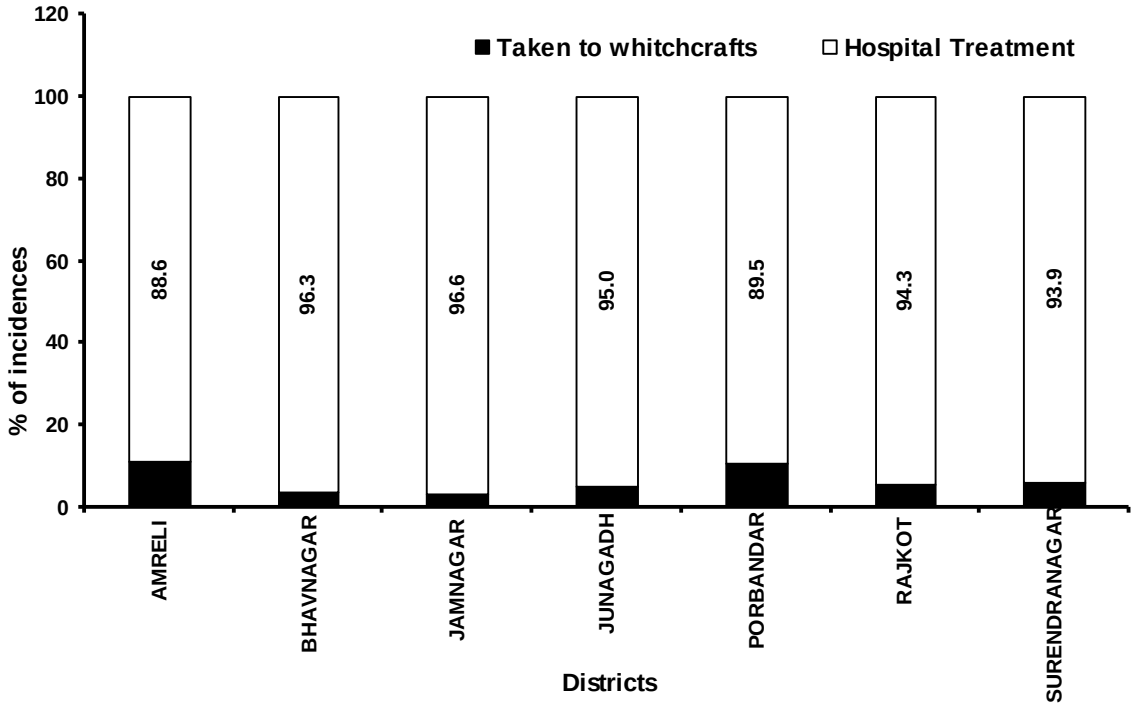
Figure:10. Relationship between crop pattern and snakebite incidences in Saurashtra region from 2002-2005.



5.8. Evaluation of myths and awareness level among the snakebite victims:

On the average 93.4 ± 1.2 % (n=218 victims from 7 districts) of the interviewed snakebite victims were taken directly to hospital for proper medical treatment and 6.6 ± 1.2 % (SE) were taken to witchcrafts for initial treatment suggesting their belief in myth that witchcraft could treat the snakebite case. The prevalence of such misbelieve was higher in Amreli district as 11.4 % of the total annual victims were taken to witchcraft for treatment after snakebite incidences. However, it was followed by Porbandar with 10.5 % and Surendranagar 6.1% of the sampled victims believed that snakebite could be treated by witchcrafts. On the contrary majority of the snakebite victims from Bhavnagar (96.3%), Rajkot (94.3 %), Junagadh (95.0) and Jamnagar (96.6 %) districts were taken to hospital immediately for proper medical treatment (Figure-11).

Figure-11, Evaluation of myths and awareness level among the snakebite victims :



CHAPTER: 6
DISCUSSION

Epidemiology:

It is important to estimate the number of snakebites incidences that take place in the region per year. The magnitude of the problem needs to be quantified in order to sensitize the community, health department, policy makers and politicians etc. to do needful to reduce it. The present study is one of the efforts to study the epidemiology of snakebite cases in the Saurashtra region of Gujarat, western India. There has not been any study conducted so far on the issue in the region, therefore the study is first of its kind in the region and the discussion on the issue would be corresponding to the studies conducted in India and abroad.

Several studies done by World Health Organization (Swaroop and Grabb 1954) in the 1950s, estimated the number of bites at 200,000 in India alone with a mortality of 15,000 annually. In the late 20th century, the number was estimated 1.2–2.4 deaths per 100,000, which would equate to a mortality level of 25,000 per annum. WHO (1987) estimated over 20,000 cases and 1000 deaths from ophitoxaemia in Nepal. In Sri Lanka, the overall annual mortality from a single venomous species ranges from 5.6 per 100,000 to as high as 18 per 100,000 in some areas (Sawai 1984). It has been estimated that 150 to 200 ophitoxaemia related deaths occur annually in Nepalese hospitals (Joshi *et al.* 1997). Myanmar seems to have the highest mortality in Asia and 70% snakebites are by Russell's Viper (Aung-Khin 1980 and Naing 1985). However, this may only reflect a better reporting system prevalent in that country.

Swaroop and Grabb (1954) reported about 200,000 bites and 15,000 deaths in India due to snakebite. More recent estimates by World Health Organization (Warrell 1999) stated that the annual mortality due to snakebite is approximately 50,000 in India. The present study observed that annual snakebite incidences in Saurashtra region (seven districts) were found to be around 695.6 ±118 SE (n=2087). However, the global disparity in the epidemiological data reflects variations in health reporting accuracy as well as the diversity of economic and ecological conditions (Chippaux, 1988). Though snakebite remains a public health problem in many countries even though it is difficult to be precise about the actual number of cases. In the present study also the information gathered is basically from the hospitals, news papers reporting, therefore the present study do suggest that the actual number could not have been estimated. To complicate matters further, accurate records to determine the exact epidemiology or even mortality in snakebite cases are also generally unavailable (Philip 1994). Hospital records fall far short of the actual number owing to dependence on traditional healers and practitioners of witchcraft etc. The present study also observed that there is a poor record keeping in case of snakebite incidences which could not make it possible to calculate the total death ratio from the number of incidences.

The present study observed that annually one person is subjected to snakebite per 19381 people of the total population of Saurashtra. However, in rural areas of Saurashtra region annually one person is subjected to snakebite per every 12007. The data also suggested that every 96.0 km^2 one person is subjected to snakebite annually in Saurashtra region. The higher rate of snakebite incidences among rural population could be attributed to

several factors such as the probability of higher rate of encounter of snakes as such, higher rate of encounter of snakes due to proportionally higher number of people involved in the agricultural practices in rural areas and the lower rate of literacy.

In Asia, the highest recorded mortality was 162 snakebite deaths per 100,000 people per year, in the Eastern Terai of Nepal (Sharma *et al.* 2004). In Africa, for instance, the responsible for a large number of cases worldwide, constitute a serious problem in specific regions. In Africa, for instance, the incidence of snakebites in the Benue Valley of northeastern Nigeria was 497 per 100,000 people per year, with a mortality of 12.2% (Warrell and Arnett, 1976). In Maharashtra, one of the states of India with the highest incidence reported 70 bites per 100,000 population and mortality of 2.4 per 100,000 per year (Gaitonde and Bhattacharya 1980). The other states with a large number of snakebite cases include West Bengal, Tamil Nadu, Uttar Pradesh and Kerala (Philip 1994). Based on an epidemiological survey of 26 villages with a total population of nearly 19,000 individuals in Burdwan district of West Bengal state in India. Hati *et al*. (1992) worked out an annual incidence of 0.16% and mortality rate of 0.016% per year.

The present study observed that annual average snakebite was reported to be higher in Porbandar district followed by Jamnagar, Amreli, Junagadh, Rajkot, Surendranagar and Bhavnagar (Table:3 and Figure:2). The higher snakebite incidences in the some of the districts are also likely due to the prevalence and number of deadly venomous snake species in the district. The best approach in relating to the venomous species of snakes is based firmly in a better understanding of the behaviors, the critical environmental factors,

and the general characteristics of each dangerous snake possibly to be encountered in a geographic area. Avoiding bites seems to be a natural outgrowth and simple result of this increased knowledge level (Bayou 1997). It is evident from the subjective information on the distribution of the venomous snakes that all the four venomous species are present in Porbandar Jamnagar, Amreli and Junagadh districts (Table:4). However, the numbers of venomous snakes are restricted to three in other districts such as Bhavnagar, Surendranagar, and major parts of Rajkot where Russell's Viper is absent or its occurrence is very low (Table:4). Though, Russell's Viper is not restricted to any particular habitat, but does not tend to avoid dense forests and is mostly found in grassy or bushy areas, second growth forests (scrub jungles), on forested plantations and farmland. They are most common in coastal areas, forested lands and hills of suitable habitat (Mallow *et al*. 2003). The above-mentioned districts i.e. Porbandar, Jamnagar, Amreli and Junagadh have combination of coastal environment, intensive agriculture zone and forested ecosystems therefore providing ideal habitats for Russell's Viper. Porbandar district has coast and has Barda Wildlife Sanctuary a forested area. However, Junagadh and Amreli have coast and has Gir and Girnar hill forest areas. However, Jamnagar has long coast. Moreover, all the districts have irrigated agriculture where farming is intensive and carried out almost in all the seasons. Relatively higher snakebite incidences are recorded among the rural population than that of urban population (Figure-3). This is likely due to the more people involved in agriculture practice in rural areas. Jamnagar and Porbandr districts have proportionally higher population in rural areas than that of other districts. However, the intensity of agriculture crop that supports snake

population indirectly in rural areas also plays critical role in observed higher incidences of snakebites.

Age class of snakebite victims:

The age class distribution of snakebite victims throws light on the vulnerable section of the population. The snakebite cases in different age groups have different reasons. The children of age up to 5-7 years are usually unaware of snakes are left unattended in the field by laborers. Such children are at higher risk of snakebite. However, youth class is more likely to become victim to snakebite due to their occupation such as farmer, agriculture laborers or any other laborer, which involves handling stones etc. and bare feet movement. The snakebite cases in old age are often due to their slow reflexes, loss of vision and hearing abilities and slow movements. The present study observed snakebite victims in all the age groups, however, maximum snakebite victims contributing 15.2% of total snakebite incidences were of age between 20-25 years. However, almost one third of the total victims i.e. 30.1% of snakebite incidences were of between 20-30 years of age. The present study reported that 9.0% of the total victims were of age above 5 year. A study by Hansdak *et al*. (1998), reported 37% incidence in the second decade of life in Nepal. However, the present study revealed that more than half of the victims contributing 55.1% of the total snakebite incidences were of age between 15 –35 years. This pattern of snakebite victims suggests that the youth or the working members of the society are more at risk or susceptible to snakebite. Majority of the victims in above mentioned age classes belong to farmer of agricultural labor communities who spend relatively more time in field where the possibility of snake encounter is high. In majority

of the incidences the victimized youth is the only or one of the earning members of the family, therefore any impairment due to snakebite may cause serious economical consequences to the entire family. Moreover, the treatment of snakebite is also expensive which causes additional economic loss to the family.

Gender wise snakebite incidences:

The present study also observed that 60.3% (n=2206) of the total victims were males and 39.7 % were females. The male snakebite victims were higher in almost all the age classes than the female victims (Figure-6). Gera (2000) reported snakebite in all age groups however, the large majority (90%) are in males aged 11-50 years. Paul (1993) also observed uniform sex ratio all over with males being affected twice or thrice as commonly as females. The predominance of male victims suggests a special risk of outdoor activities (Hansdak *et al*., 1998). The society is male dominant in the study region though females do tend to work in the field as agriculture labors. The present study observed that males of age between 15 to 45 years contribute 42.2 % of the total snakebites incidences. This information suggests that the working youth males are at a higher risk of being bitten by snakes in the region.

Seasonality of snakebite:

Present study observed that maximum snakebite incidences occurred during monsoon (June-September) i.e. 47.82 %, followed by20.38 % during post monsoon (October-November), 18.7% during hot summer (March-May) and 10.05% during cold winter (December- February) (Figure-7). Punde (2005) also reported that majority of snakebites (68.9%) occurred between May and November. The observed pattern is obvious since the

monsoon and post-monsoon are the season of highest activities by snakes that also include their breeding season (Smith 1943, Daniel 2002). Hansdak *et al*. (1998) observed that the snakebite incidences shows a distinct seasonal pattern closely related to rainfall and temperature which compels the reptiles to come out of their shelter. In the study region summer is hot where temperature even reaches as high as 48°C and the winter is cold lowering the temperature up to 7-8°C, which restricts the activities and movement of snakes. The month wise information on snakebite showed that maximum incidences of snakebite were observed to occur in the month of October contributing 14.2% of the total incidences annually. During the months of July and September the snakebite cases were 13.3% each of the total snakebite cases occurred annually followed by 10.9% in August, 10.3% in June and 8.5% in the month of May. However, snakebite cases were observed to occur low in other months i.e. January to April and November, December, which contributed less than 6.5 % of the annual snakebite incidences (Figure-8). Though the snakebite cases are distributed throughout the year, it is difficult to relate species-specific incidences since there is not much seasonal difference in their annual cycle. The peak activity period of snakes coincides with the intensive agriculture phase of the year, which increases the probability of encounter of venomous snakes with farmer and agriculture labors. Gera (2000), observed that the most frequent site of bite is the lower extremity suggests that in most cases the snake is inadvertently trodden upon. There is significant seasonal variation in snakebite incidence that is attributable to climate, especially to rain fall and temperature, which determine annual cycles of agricultural activity (Gutiérrez *et al*. 2006)

Occupation of snakebite victims:

Occupation of snakebite victims combined with their age, sex provides much detailed information on the section of population vulnerable to snakebite. The present study observed that majority of the snakebite victims were farmers (32.9± 2.5 %), agriculture laborers (31.3±3.6 %) followed by other laborers (15.4±2.4 %), hose wives (6.8±1.0 %) and others were (13.6± 2.5%). Young agricultural workers, especially males, are the most highly affected group, making snake bite envenoming a truly occupational disease a fact that is frequently overlooked by the national authorities. Children are also common victims of snakebites (Gutiérrez *et al*. 2006). Among the host factors, people involved in occupations and/or lifestyles requiring movement in dense undergrowth or undeveloped land, are the worst affected. These include farmers, herders and hunters and workers on development sites (Warrel 1987). The victims involved in agriculture related occupation i.e. farmers and agriculture laborers contributed to the major percentage (64.2%) of the total snakebite incidences in the region (Figure-10). A study by Punde (2005) in Maharashtra also showed higher vulnerability of farmers (36%). Movement of people involved in agriculture in the field particularly during the monsoon and posts-monsoon season when the snakes are more active increases the probability of encounter with snakes. The housewives are usually involved in cleaning house and backyards, fire wood collection for cooking and animal husbandry etc. These activities are normally carried in out bare feet and sometime even in darkness, which makes them more vulnerable to snakebite. The others involve victims from various occupations such as mason who require lifting of stones and mud, gardeners involve cleaning and cutting small bushes and trees,

industrial workers often found to sleep on the open ground and darkness, and sweepers also involved cleaning activities which makes them more susceptible to snakebite.

Crop pattern:

The present study also showed that there is a strong positive correlation (r= 0.91) between the area (in hectors) under groundnut crop and the annual snakebite incidences in Saurashtra region. Intensive farming increases the chances of encounter of snakes by the farmers. Warrel (1987), reported that among the host factors, people involved in occupations and/or lifestyles requiring movement in dense undergrowth or undeveloped land, are the worst affected. These include farmers, herders and hunters and workers on development sites. A large number of bites occur in fields, most individuals are unable to spot the snake due to tall grass and crops (Gera 2000). Russell's Viper is known to be one of the major species of venomous snakes responsible for contributing higher proportion to total snakebite incidences in Asia. Myanmar seems to have the highest mortality in Asia and 70% snakebites are by Russell's Viper (Aung-Khin 1980 and Naing 1985). Junagadh, Jamnagar and Rajkot districts are found to be the major groundnut producing areas accounting for 67% of the total area under groundnut crop of Saurashtra region, these districts have also showed 64.1% of the total annual snakebite incidences of the Saurashtra region (Figure-9). The groundnut is sown in the monsoon and harvested in post monsoon season i.e. in the month of October. Our observation also suggests that maximum snakebite incidences occur in monsoon (48.7%) and particularly in October (14.2%). Of the annual activity cycle of snakes, during monsoon and post monsoon when breeding of snakes takes place and is their high activity period. The groundnut crop

provides maximum opportunity for rats to feed and habitat to stay. The higher concentration of rat population in turn attract snakes towards their prey as well also provide habitat to hide. The groundnut crop at various stages makes farmers susceptible to snakebites such as at harvesting stage the groundnut involves manual pulling of plants holding it tightly from its base. This process is likely to make farmers more susceptible to snakebite as the farmers/ laborers might actually hold snakes in their hands while pulling the plant from the ground. The other stage when the groundnut plants are piled in small stakes after pulling provides much needed refugia for snakes to hide. Handling and gathering such small stakes to create bigger stakes for final harvesting also makes farmers susceptible to snakebite as snakes are often found to hide inside the smaller stakes. Therefore many farmers uses 'Y' shaped forked stick to handle small stakes while some don't, who are more susceptible to snakebite.

On the other hand the other districts such as Bhavnagar and Surendranagar where majority of the land is saline wasteland with low vegetation cover and the area is dry and hot making it less suitable for survival of Russell's Viper. These areas have less intensive agriculture as majority of the agriculture is rain dependent. Bhavnagar district has long stretch of saline flat land called *'Bhal'* where as Surendranagar district has vast tract of saline flatland called *'Rann'* such habitat conditions are suitable for Saw Scaled Viper, which occur in rocky and saline deserts (Spawls and Branch 1995). Saw Scaled Viper is found in open dry wasteland where agriculture is not intensively practiced which reduces their encounter with human being. However, Cobra and Common Krait are the species of

snakes generally found in majority of the habitat types present and are uniformly distributed in the region.

Evaluation of myths and awareness among the snakebite victims:

It has been reported that in most developing countries, up to 80% of individuals bitten by snakes first consult traditional practitioners before visiting a medical center (Chippaux 1998, and Snow, 1994) therefore hospital records fall far short of the actual number owing to dependence on traditional healers and practitioners of witchcraft etc. Owing to the delay several victims die during transit to the hospital. Contrary to the above study the present study reported that on the average 93.4 ± 1.2 % (SE, n=218 victims from 7 districts) of the interviewed snakebite victims were taken directly to hospital for proper medical treatment and 6.6 ± 1.2 (SE) were taken to witchcrafts for initial treatment in the study region suggesting smaller proportion to believe in myth that witchcraft could treat the snakebite. However, in some of the districts of study region such misbelieve was higher as in Amreli district (11.4 %) and Porbandar (10.5%) of the total annual victims were taken to witchcraft for treatment after snakebite incidences. On the contrary majority of the snakebite victims from Bhavnagar (96.3%), Rajkot (94.3 %), Junagadh (95.0) and Jamnagar (96.6 %) districts were taken to hospital immediately for proper medical treatment (Figure-10). Prevalence of misbelieves about the snakes and snakebites are largely due to illiteracy and lack of awareness. It is also noteworthy that there are number of non-governmental organizations, governmental organizations and individual snake lovers are active in Saurashtra region in creating awareness towards the snake and snakebites. Since last two decades such agencies and individuals are active using various means and media i.e. snake shows in education institutes, public places etc. At the same

time the snake charmers who are responsible for spreading myths and misbelieves about snakes are also legally prohibited under the Wildlife Protection Act 1972 and therefore decreasing in numbers. Apart from above mentioned factor, relatively higher percentage of snakebite victims taken directly to hospital than recorded in past, could also be attributed to the increase in literacy rate, better medical facilities in rural areas, better road networks and connectivity, communication and other infrastructure facilities.

CONCLUSIONS

1. Snakebite is a common life-threatening emergency in the study area as total 695.6 ±118 incidences of snakebite are recorded annually.
2. The ranking of districts based on the occurrence of snakebite cases found in various analyses showed that Porbandar district has higher magnitude of snakebites followed by Jamnagar, Amreli, Junagadh, Rajkot, Surendranagar and Bhavnagar.
3. Districts with combinations of intensive groundnut agriculture, higher number of venomous snake species and having coastal and forested habitats showed higher magnitude of snakebites in the study region.
4. Youth between ages of 15-35 years of age are at maximum risk of snakebite as they contributed total 55.1% of the total snakebite incidences in the study region.
5. Males are at higher risk of snakebite in the study region as 60.3% of the total victims were males suggesting their higher vulnerability to snakebite in the study region.
6. Monsoon (June-September) and post monsoon (October-November) are the major seasons in which a total of 68.2% of the annual snakebite incidences of Saurashtra region occurs.
7. The victims involved in agriculture related occupation i.e. farmers and agriculture laborers contributed to the major percentage (64.2%) of the total snakebite incidences in the region.
8. The males of age between 15-35 years, particularly in intensive groundnut producing districts in monsoon and post-monsoon are at maximum risk of snakebite.
9. Prevalence of misbelieve that non-medical methods could treat snakebite was found to be low in compared to reported earlier since, on the average 93.4 ± 1.2 % of the snakebite victims were taken directly to hospital for proper medical treatment and only 6.6 ± 1.2% were taken to witchcrafts for initial treatment.

RECOMMENDATIONS

1. The magnitude of snakebite incidences needs to be regularly quantified and monitored in order to sensitize the community, health department, policy makers and politicians etc. to do needful to reduce it.
2. There is an urgent need for developing and implementing a comprehensive awareness-rasing package to prevent snakebite in the Saurashtra region.
3. Highly susceptible section of the population i.e. males of age between 15-35 years, particularly in intensive groundnut producing districts in monsoon and post-monsoon needs to be targeted on priority bases to educate and made aware to prevent snakebite.
4. The awareness campaign conducted during monsoon and post monsoon seasons using of various media such as television, radio and newspapers may help in reducing snakebite incidences significantly in the study region.
5. There is a need to conduct district wise monitoring studies on snakebite cases by maintaining proper records and data in the region.
6. The existing insurance scheme offered by the Government on human mortality due to snakebite needs to be informed to the people in rural areas particularly the farmers.
7. The command area of 'Narmada canal' is likely to bring changes in agriculture crop pattern and increase the intensity of agriculture in the region which may in turn increase the snakebite incidences in future, therefore government should

target farmers to educate and sensitize them for preventing snakebite incidences in the command areas in the Saurashtra region.

8. There is a need to build capacity of the Government hospitals to be able to handle snakebite cases efficiently, which may need trained staff, infrastructure and enough stock of antivenom in the region.
9. There is need for proper training and coordination between, PHC staff, doctors, nurses, health inspectors and hospital staff to handle the snakebite victims and maintain the record properly.

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(Annexeure-1)

ANNEXEURE- 1

District :
Amreli

State :
Gujarat

Number of Households
248,677

Household size	6,0
Proportion of Urban population (%)	22,5

	P	M	F
Population - Total	1.939.918	701.593	692.325
Population - Rural	1.080.960	540.316	540.644
Population - Urban	312.958	161.277	151.681
Population	198.657	104.997	93.660

Sex Ratio (Females paer 100 males)	987,0
Sex Ratio	892,0

	P	M	F
Promotion of SC population (%)	8,3	8,4	8,1
Promotion of ST population (%)	0,2	0,2	0,2

Number of Literates	789.978	456.025	333.953	Literacy Rate (%)	66,1	76,4	55,8
Number of illiterates	603.940	245.568	358.372	illiteracy Rate (%)	50,5	41,2	59,9

Total workers	600.819	386.048	214.771	Work Participation Rate (%)	43,1	55,0	31,0
Main workers	470.043	365.688	104.155	Proportion of Main Workers (%)	33,7	52,2	15,0
Marginal workers	130.776	20.160	110.616	Proportion of Marginal Workers(%)	9,4	2,9	16,0
Non workers	793.099	315.545	477.554	Proportion of Non Workers (%)	56,9	45,0	60,0

Cultivators	231.308	130.605	100.703	Proportion of cultivators to total workers (%)	38,0	33,8	46,9
Agricultural labourers	150.471	71.992	78.479	Proportion of agricultural labourers to total workers (%)	25,0	18,6	36,5
Workers in household industries	10.754	6.109	4.645	Proportion of workers in household industries to total workers (%)	1,8	1,6	2,2
other workers	206.286	177.342	30.944	Percentage of Other workers to total workers (%)	24,7	45,9	14,4

ANNEXEURE- 2

District :
Bhabnagar

State :
Gujarat

Number of Households
426.001

Household size	6,0
Proportion of Urban population (%)	37,9

	P	M	F
Population - Total	2.469.630	1.274.920	1.194.710
Population - Rural	1.534.592	782	752.365
Population - Urban	935.038	493	442.345
Population	401.780	214	188.183

Sex Ratio (Females paer 100 males)	937,0
Sex Ratio	881,0

	P	M	F
Promotion of SC population (%)	5,8	5,7	5,8
Promotion of ST population (%)	0,3	0,3	0,3

Number of Literates	1.368.920	828.080	540.840
Number of illiterates	1.100.710	446.840	653.870

Literacy Rate (%)	66,2	78	53,7
illiteracy Rate (%)	53,2	42,1	65

Total workers	944.559	681.124	263.435
Main workers	781.166	647.599	133.567
Marginal workers	163.393	33.525	129.868
Non workers	1.525.071	593.796	931.275

Work Participation Rate (%)	38,2	53,4	22,1
Proportion of Main Workers (%)	31,6	50,8	11,2
Proportion of Marginal Workers(%)	6,6	2,6	10,9
Proportion of Non Workers (%)	61,8	46,6	77,9

Cultivators	212.513	136.398	76.115
Agricultural labourers	210.277	92.051	118.226

Proportion of cultivators to total workers (%)	22,5	20,0	28,9
Proportion of agricultural labourers to total	22,3	13,5	44,9

				workers (%)			
Workers in household industries	42.504	31.075	11.429	Proportion of workers in household industries to total workers (%)	4,5	4,6	4,3
other workers	479.265	421.600	57.665	Percentage of Other workers to total workers (%)	50,7	61,9	21,9

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ANNEXEURE- 3

District :
Jamnagar

State :
Gujarat

Number of Households
350,105

Household size	5,0
Proportion of Urban population (%)	43,9

	P	M	F
Population - Total	1.904.278	981.320	922.958
Population - Rural	1.068.022	545.345	522.677
Population - Urban	836.256	435.975	400.281
Population	274.268	144.494	129.774

Sex Ratio (Females paer 100 males)	941,0
Sex Ratio	898,0

	P	M	F
Promotion of SC population (%)	8,1	8,1	8,1
Promotion of ST population (%)	0,5	0,5	0,5

Number of Literates	1.083.696	638.101	445.595
Number of illiterates	820.582	343.219	477.363

Literacy Rate (%)	66,5	76,3	56,2
illiteracy Rate (%)	50,3	41,0	60,2

Total workers	734.382	536.624	197.758
Main workers	624.057	511.030	113.027
Marginal workers	110.325	25.594	84.731
Non workers	1.169.896	444.696	725.200

Work Participation Rate (%)	38,6	54,7	21,4
Proportion of Main Workers (%)	32,8	52,1	12,2
Proportion of Marginal Workers(%)	5,8	2,6	9,2
Proportion of Non Workers (%)	61,4	45,3	78,6

Cultivators	264.708	164.080	110.628	Proportion of cultivators to total workers (%)	36,0	30,6	50,9
Agricultural labourers	105.479	56.140	49.339	Proportion of agricultural labourers to total workers (%)	36,0	10,5	24,9
Workers in household industries	12.540	7.383	5.157	Proportion of workers in household industries to total workers (%)	1,7	1,4	2,6
other workers	351.655	309.021	42.634	Percentage of Other workers to total workers (%)	47,9	57,6	21,6

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ANNEXEURE- 4

District :
Junagadh

State :
Gujarat

Number of Households
432,884

Household size	6,0
Proportion of Urban population (%)	29,1

	P	M	F
Population - Total	2,44,173	1.252.350	1.195.823
Population - Rural	1.736.645	885.414	851.231
Population - Urban	711.528	366.936	344.592
Population	369.691	194.292	175.399

Sex Ratio (Females paer 100 males)	955,0
Sex Ratio	903,0

	P	M	F
Promotion of SC population (%)	9,6	9,7	9,6
Promotion of ST population (%)	0,8	0,8	0,8

Number of Literates	1.408.878	833.064	575.814
Number of illiterates	1.039.295	419.286	620.009

Literacy Rate (%)	67,8	78,7	56,4
illiteracy Rate (%)	50,0	60,8	60,8

Total workers	1.000.842	683.676	317.166
Main workers	785.530	643.755	141.775
Marginal workers	215.312	39.921	175.391
Non workers	1.447.331	568.674	878.657

Work Participation Rate (%)	40,9	54,6	26,5
Proportion of Main Workers (%)	32,1	11,9	11,1
Proportion of Marginal Workers(%)	8,8	14,7	12,3
Proportion of Non Workers (%)	59,1	73,5	76,6

Cultivators	391.834	240.902	150.932

Proportion of cultivators to total workers (%)	39,2	35,2	47,6

Agricultural labourers	246.405	128.319	118.086	Proportion of agricultural labourers to total workers (%)	24,6	18,8	37,2
Workers in household industries	14.703	10.039	4.664	Proportion of workers in household industries to total workers (%)	1,5	1,5	1,5
other workers	347.900	304.416	43.484	Percentage of Other workers to total workers (%)	34,8	44,5	13,7

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ANNEXEURE- 5

District :
Porbandar

State :
Gujarat

Number of Households
105,893

Household size	5,0
Proportion of Urban population (%)	48,7

	P	M	F
Population - Total	536.835	275.821	261.014
Population - Rural	275.460	141.068	134.392
Population - Urban	261.375	134.753	126.622
Population	76.099	40.102	35.997

Sex Ratio (Females paer 100 males)	946,0
Sex Ratio	898,0

	P	M	F
Promotion of SC population (%)	9,0	9,0	9,0
Promotion of ST population (%)	1,2	1,2	1,2

Number of Literates	316.172	184.717	131.455
Number of illiterates	220.663	91.104	129.559

Literacy Rate (%)	68,6	78,4	58,4
illiteracy Rate (%)	47,9	38,6	57,6

Total workers	215.134	153.995	61.139
Main workers	173.594	144.662	28.972
Marginal workers	41.540	9.373	32.167
Non workers	321.701	121.826	199.875

Work Participation Rate (%)	40,1	55,8	23,4
Proportion of Main Workers (%)	32,3	52,4	11,1
Proportion of Marginal Workers(%)	7,7	3,4	12,3
Proportion of Non Workers (%)	59,9	44,2	76,6

Cultivators	68.737	43.749	24.988

Proportion of cultivators to total workers (%)	32,0	28,4	40,9

Agricultural labourers	40.285	20.766	19.519	Proportion of agricultural labourers to total workers (%)	18,7	13,5	31,9
Workers in household industries	3.610	2.374	1.236	Proportion of workers in household industries to total workers (%)	1,7	1,5	2,0
other workers	102.502	87.106	15.396	Percentage of Other workers to total workers (%)	47,6	56,6	25,2

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ANNEXEURE- 6

District :
Rajkot

State :
Gujarat

Number of Households
597,991

Household size	5,0
Proportion of Urban population (%)	51,3

	P	M	F
Population - Total	3.169.881	1.642.018	1.529.865
Population - Rural	1.544.019	792.848	751.171
Population - Urban	1.625.862	849.170	776.692
Population	427.184	230.402	196.752

Sex Ratio (Females paer 100 males)	930,0
Sex Ratio	854,0

	P	M	F
Promotion of SC population (%)	7,7	7,7	7,7
Promotion of ST population (%)	0,4	0,4	0,4

Number of Literates	2.033.946	1.166.122	867.824
Number of illiterates	1.135.935	475.896	660.039

Literacy Rate (%)	74,2	82,6	65,2
illiteracy Rate (%)	41,4	33,7	49,6

Total workers	1.244.806	918.524	326.282
Main workers	1.076.436	879.732	196.704
Marginal workers	168.370	38.792	129.578
Non workers	1.925.075	723.494	1.201.581

Work Participation Rate (%)	39,3	55,9	21,4
Proportion of Main Workers (%)	34,0	53,6	12,9
Proportion of Marginal Workers(%)	5,3	2,4	8,5
Proportion of Non Workers (%)	60,7	44,1	78,6

Cultivators	368.793	219.365	149.428

Proportion of cultivators to total workers (%)	29,6	23,9	45,8

Agricultural labourers	178.725	90.071	88.654	Proportion of agricultural labourers to total workers (%)	14,4	9,8	27,2
Workers in household industries	24.986	13.734	11.252	Proportion of workers in household industries to total workers (%)	2,0	1,5	3,4
other workers	672.302	595.302	76.948	Percentage of Other workers to total workers (%)	54,0	64,8	23,6

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ANNEXEURE- 7

District : Surendranagar

State : Gujarat

Number of Households
277,667

Household size	6,0
Proportion of Urban population (%)	26,6

	P	M	F
Population - Total	1.515.148	787.650	717.498
Population - Rural	1.112.700	576.655	536.045
Population - Urban	402.448	210.995	191.453
Population	247.294	131.120	116.174

Sex Ratio (Females paer 100 males)	924,0
Sex Ratio	886,0

	P	M	F
Promotion of SC population (%)	11	11	11
Promotion of ST population (%)	0,9	0,9	0,9

Number of Literates	781.155	487.094	294.061
Number of illiterates	733.993	300.556	433.437

Literacy Rate (%)	61,6	74,2	48,1
illiteracy Rate (%)	57,9	45,8	70,9

Total workers	647.609	425.491	222.116
Main workers	512.038	397.439	114.599
Marginal workers	135.571	28.052	107.519
Non workers	867.539	362.159	505.380

Work Participation Rate (%)	42,7	54,0	30,5
Proportion of Main Workers (%)	33,8	50,5	15,8
Proportion of Marginal Workers(%)	8,9	3,6	14,8
Proportion of Non Workers (%)	57,3	46,0	69,5

Cultivators	192.223	126.730	63.493
Agricultural labourers	209.346	98.131	111.215
Workers in household industries	13.588	8.431	5.157
other workers	232.452	190.199	42.253

Proportion of cultivators to total workers (%)	29,7	30,3	28,6
Proportion of agricultural labourers to total workers (%)	32,3	23,1	50,1
Proportion of workers in household industries to total workers (%)	2,1	2,0	2,3
Percentage of Other workers to total workers (%)	35,9	44,7	19,0

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Annexeure-7