

HANDBOOK

INDIAN TESTUDINES



B. K. TIKADER
R. C. SHARMA





DR. BENOY KRISHNA TIKADER, born in Joydihi, a small village in the District of Khulna, now in Bangladesh, was educated at the University of Calcutta. Dr. Tikader was awarded the Ph.D. and D.Sc. Degrees of the Calcutta University for his outstanding and meritorious contributions on spiders. His areas of interest however did not remain confined to only Arachnida

but extended over ecology and natural history of both vertebrates and invertebrates in terrestrial and aquatic ecosystem. His recent publications include *Threatened Animals of India*, *Birds of Andaman & Nicobar Islands* and his other publications in the offing include a variety of titles, viz. *Handbook of Indian Spiders*, *Sea Shore Animals of Andaman and Nicobar Islands*, *Glimpses of Animal life in Andaman and Nicobar Islands* and *Endemic Birds of India*. Dr. Tikader has a hobby of wildlife and nature photography and majority of the photographs which will be used in the above mentioned books are by him. Dr. Tikader is at present the Director of the Zoological Survey of India and is a member of the Indian Board for Wildlife.

DR. RAMESH CHANDRA SHARMA, co-author of this book, has been engaged in the study of Indian reptiles since 1964 and has published several papers on their taxonomy, ecology and morphology. He has collected reptiles in most of the parts of India and was recorded detailed observations on their taxonomy and ecology. Dr. Sharma was awarded the Ph.D. degree



by the University of Rajasthan, Jaipur, in the year 1973 for his work on the "Taxonomic Studies on the Reptiles of Peninsular India". He is now actively engaged in writing a Handbook on Indian Lizards under the guidance of Dr. B. K. Tikader, Director, Zoological Survey of India.

HANDBOOK
INDIAN TESTUDINES

HANDBOOK

INDIAN TESTUDINES

B. K. TIKADER
Zoological Survey of India, Calcutta

R. C. SHARMA
*Desert Regional Station,
Zoological Survey of India, Jodhpur*



Edited by the Director
ZOOLOGICAL SURVEY OF INDIA, CALCUTTA

© Government of India, 1985

Published : November, 1985

Price :

Indian : Rs. 150/00

Foreign : £ 20/00

\$ 30/00

Printed at The Radiant Process Private Limited, Calcutta, India and
Published by the Director, Zoological Survey of India, Calcutta

FOREWORD

One of the objectives of Zoological Survey of India is to provide comprehensive systematic accounts on various groups of the Indian fauna. To achieve this objective, the Zoological Survey of India undertakes faunistic survey programmes and publishes the results in the form of research papers and reports and under the series "Fauna of India", "The Handbooks" and "Technical Monographs". The present contribution on the Turtles and Tortoises is the sixth in the series of "Handbooks". This is a very primitive group of animals which have a role in the conservation of Nature and are an important protein source. While studies on this group of animals began at the turn of this century, intensive studies were taken up only recently. The present "Handbook" gives a comprehensive taxonomic account of all the marine, freshwater and land turtles and tortoises of India, along with their phylogeny, distribution and keys for easy identification. It includes other information, wherever known, about their biology, ecology, conservation and captive breeding. A total of 32 species and subspecies distributed over sixteen genera and five families are dealt with here.

I congratulate the authors for undertaking this work which I am sure will prove useful to students and researchers in the field of Herpetology both in India and abroad. I would also like to put on record the appreciation for Dr. B. K. Tikader, Director, Zoological Survey of India who has initiated a number of programmes on the fauna of India as also in building up public awareness about wildlife conservation.

Department of Environment
Government of India
New Delhi

T. N. KHOSHOO
Secretary

EDITOR'S PREFACE

Since the publication of Malcolm Smith's work on Indian Testudines (The Fauna of British India Vol. I—Loricata, Testudines) in 1933, the knowledge in this field has increased considerably. This Handbook on Indian Testudines gives complete information on 32 species and subspecies inhabiting the different ecosystems of India. Besides the systematic studies, the authors have given an illustrated account of the structure of the carapace, plastron, skull and other body parts. Detailed accounts of their taxonomic importance, geographical distribution, phylogeny, history, habits, habitats, food and feeding habits, breeding biology and present status and conservation measure have also been suitably incorporated. Moreover, the colour photographs of dorsal and ventral sides of each species have been given for easy identification.

This Handbook is the sixth volume in this series and two more are in press. Assignments have been made to other specialists to write further volumes on groups so far not covered or which require upto-date information and these are expected to be published within a couple of years.

Dr. Ramesh Chandra Sharma, co-author of this book has been engaged in the study of Indian reptiles since 1964 and has published several papers on their taxonomy, ecology and morphology. He has collected reptiles in most of the parts of India and has recorded detailed observations on their taxonomy and ecology. During the course of his career in the Zoological Survey of India he has served as an Assistant Zoologist, Zoologist, and Superintending Zoologist in the Herpetology Division from 1964 to 1983. Dr. Sharma is now actively engaged in writing a Handbook on Indian Lizards under my guidance and suggestion.

It is my privilege that I am able to write the preface to this popular series of publications of 'Handbook' by virtue of my position as Editor and to this particular one for which I happen to be the senior author also. It is hoped that this illustrated book will serve as an important and handy tool to specialists, research students and naturalists in India and abroad interested in the fascinating study of colourful Indian Turtles, Tortoises and Terrapins.

Zoological Survey of India
Calcutta

B. K. TIKADER
Director

CONTENTS

	Page
FOREWORD	v
PREFACE	vii
ACKNOWLEDGEMENTS	xii
INTRODUCTION	1
PHYLOGENY	4
GEOGRAPHICAL DISTRIBUTION	7
HISTORICAL REVIEW	10
SYSTEMATIC ACCOUNT	11
ORDER TESTUDINES	14
SUBORDER CRYPTODIRA	14
KEY TO THE FAMILIES OF THE ORDER TESTUDINES	14
FAMILY I. CHELONIIDAE	14
KEY TO GENERA OF THE FAMILY CHELONIIDAE	15
Loggerhead Sea Turtle	16
Green Sea Turtle	24
Hawksbill Sea Turtle	30
Olive Ridley Turtle	36
FAMILY II. DERMOCHELYIDAE	41
Leatherback Sea Turtle	42
FAMILY III. EMYDIDAE	47
KEY TO GENERA OF THE FAMILY EMYDIDAE	48
Batagur/River Terrapin	50
Brahminy River Turtle	54
KEY TO SPECIES OF THE GENUS <i>KACHUGA</i>	58
Dhongoka Turtle	59
Bengal Roofed Turtle	62
Brown River Turtle	65
Assam Saw-back Turtle	68
North Indian Roofed Turtle	71
South Indian Roofed Turtle	74
North Indian Freshwater Tortoise	78
Garo & Khasi Hill Tortoise	81
Assam Freshwater Tortoise	84

Kavalai Forest Turtle	17.	<i>Heosemys silvatica</i> (Henderson)	86
Three Keeled Tortoise	18.	<i>Melanochelys tricarinata</i> (Blyth)	90
Indian Snail-eating Turtle	19.	<i>M. trijuga trijuga</i> (Schw.)	92
Indian Snail-eating Turtle	20.	<i>M. t. coronata</i> (Anderson)	95
Indian Snail-eating Turtle	21.	<i>M. t. indopeninsularis</i> (Annandale)	97
Indian Snail-eating Turtle	22.	<i>M. t. thermalis</i> (Lesson)	98
FAMILY IV TESTUDINIDAE			101
KEY TO SPECIES OF THE GENUS <i>GEOCHELONE</i>			102
Indian Starred Tortoise	23.	<i>Geochelone elegans</i> (Schoepff)	102
Yellow Tortoise	24.	<i>G. elongata</i> (Blyth)	106
Travancore Tortoise	25.	<i>G. travancorica</i> (Boulenger)	109
Assam Land Tortoise	26.	<i>G. emys</i> (Sch. & Muell.)	112
FAMILY V. TRIONYCHIDAE			116
KEY TO GENERA OF THE FAMILY TRIONYCHIDAE			116
North Indian Flap-shelled Turtle	27.	<i>Lissemys punctata punctata</i> (Lacepede)	118
Southern Flap-shelled Turtle	28.	<i>L. punctata granosa</i> (Schoepff)	121
Narrow-headed Soft-shelled Turtle	29.	<i>Chitra indica</i> (Gray)	123
KEY TO SPECIES OF THE GENUS <i>TRIONYX</i>			126
Ganga Soft-shelled Turtle	30.	<i>Trionyx gangeticus</i> Cuvier	127
Peninsular Soft-shelled Turtle	31.	<i>T. leithi</i> Gray	
Peacock-marked Soft-shelled Turtle	32.	<i>T. hurum</i> Gray	130
BIBLIOGRAPHY			137
GLOSSARY			149
ALPHABETICAL INDEX			152

ACKNOWLEDGEMENTS

We are deeply indebted to the Late Hon'ble Prime Minister, Smt. Indira Gandhi, Chairperson, Indian Board for Wild Life, who had suggested to one of us (BKT) to write illustrated popular books on the different groups of fauna and the Wildlife of India, to develop an awareness among our people about the importance of conservation of wildlife.

We express our deep sense of gratitude to Dr. T. N. Khoshoo, Secretary, Department of Environment, Government of India, for writing the foreword and for his personal interest and inspiration, which we have received all the time and it is only due to his constant support that one of us (BKT) has been able to write quite a number of books including this one.

Thanks are due to Dr. R. K. Varshney, Deputy Director, and Dr. N. S. Rathore, Zoologist, Desert Regional Station, Zoological Survey of India, Jodhpur, and to Shri D. P. Sanyal, Reptilia Section, Z.S.I., Calcutta for assisting us in various ways during the preparation of this book. The majority of colour pictures which we have used in this book were taken by Shri Abdul Basit, Photographer, Desert Regional Station; black and white illustrations were prepared by Shri Sitaram Mondal, Senior Artist, Z.S.I., Calcutta; typing of the manuscript was done by Shri V. Murlidharan, Stenographer, Desert Regional Station, Shri Anil Bhattacharjee, Senior Stenographer and Shri Kumar Chatterjee, U. D. Clerk, Z.S.I., Calcutta and Shri Mrinal Kanti Sen, Photographer, provided photographs of head of some species of tortoises; our thanks are also due to them. We are thankful to Dr. J. G. Frazier, National Zoological Park, Smithsonian Institution, Washington, U.S.A., the well known herpetologist and Shri K. S. Sankhala, I.F.S., the well known naturalist, who were kind enough to lend some photographs which we have used in this book.

We must thank the Directors of The Radiant Process Pvt. Ltd., namely, Shri Nirad Baran Mukherjee and Shri Sudhir Chandra Mukherjee and their working staff who were engaged in printing of this book. We are also thankful to Shri G. Sivagurunathan, Publication Production Officer and his staff, Zoological Survey of India, for constant supervision during the printing of this book.

Last but not the least we are thankful to Dr. M. L. Roonwal, former Director, Zoological Survey of India, Dr. K. C. Jayaramakrishnan, Joint Director and Dr. O. B. Chhotani, Deputy Director, Zoological Survey of India, Calcutta, for kindly going through the manuscript and offering valuable suggestions for improvement. Shri Shyamal Tikader gave significant assistance in the selection of suitable photographs which is warmly appreciated.

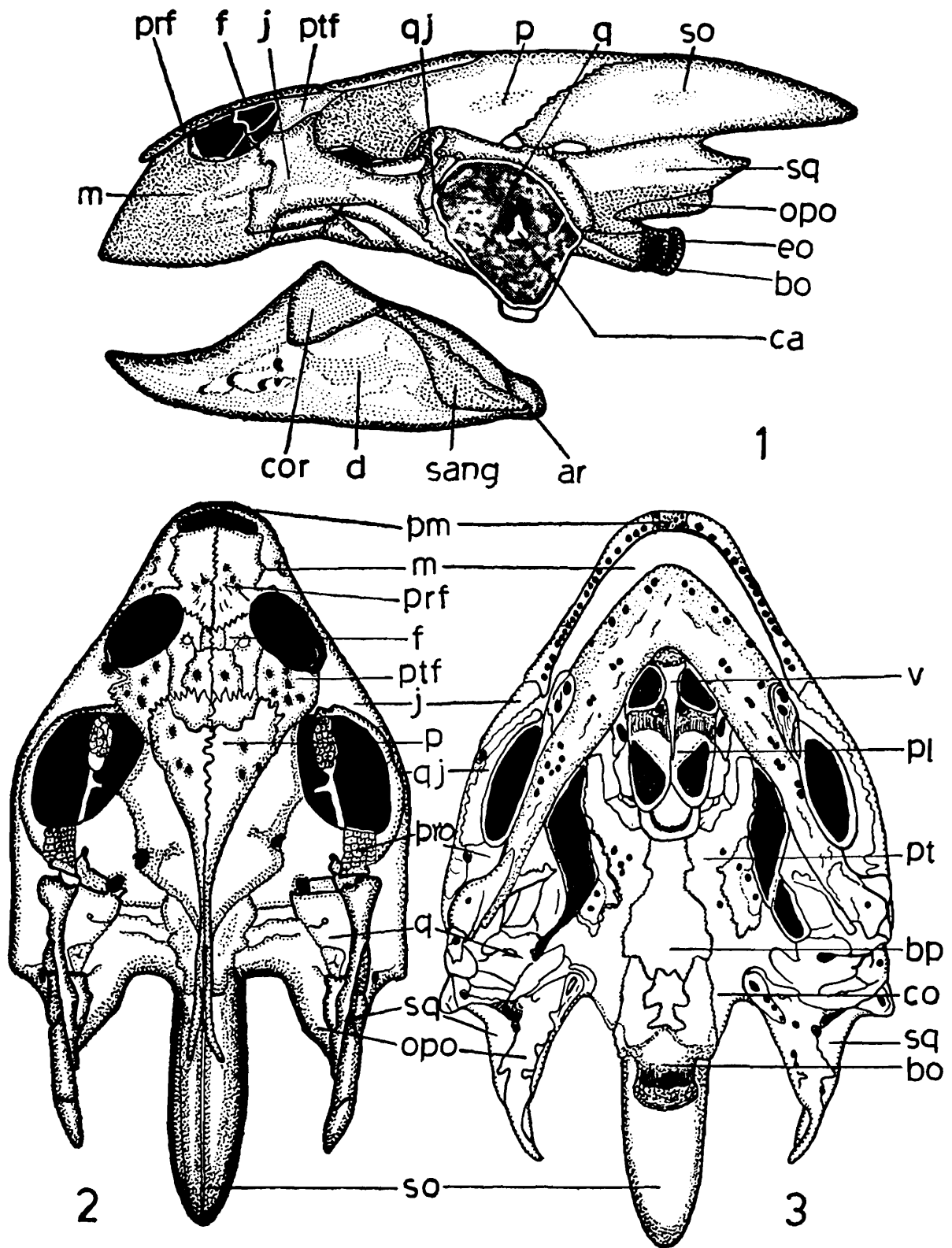
ABBREVIATIONS

AB.	-	Abdominal	J.	-	Jugal
AN.	-	Anal	m.	-	Maxillary
ar.	-	Articular	MA.	-	Marginal
AX.	-	Axillary	NU.	-	Nuchal
bo.	-	Basioccipital	opo.	-	Opisthotic
bp.	-	Basisphenoid	p.	-	Parietal
ca.	-	Columella auris	PE.	-	Pectoral
cor.	-	Coronoid	PF.	-	Prefrontals
CL.	-	Claw, claws	pm.	-	Premaxillary
d.	-	Dentary	PN.	-	Prenuchal
EN.	-	Entoplastron	Prf.	-	Prefrontal
eo.	-	Exoccipital	pro.	-	Prootic
EP.	-	Epiplastron	pt.	-	Pterygoid
f.	-	Frontal	ptf.	-	Postorbital
FE.	-	Femoral	q.	-	Quadrates
GU.	-	Gular	qj	-	Quadrato-jugal
HH.	-	Hyo-hyoplastron	s.ang.	-	Supra-angular
HO.	-	Hyoplastron	so.	-	Supraoccipital
HU.	-	Humeral	sq.	-	Squamosal
HY.	-	Hypoplastron	SU.	-	Supracaudal
IF.	-	Inframarginals	v.	-	Vomer
IG.	-	Intergular	VE.	-	Vertebral
IN.	-	Inguinal	XI.	-	Xiphoplastron

INTRODUCTION

Testudians or chelonians are most primitive, typically clumsy and poikilothermous animals. They are mainly amphibious creatures and have adapted to various ways of life. Some live in freshwater some in muddy habitats while some have become terrestrial and some have adapted themselves to marine way of life, leading a semi-pelagic life. Common turtles and tortoises are small to medium size reptiles ranging from 100 grams to a few kilograms in body weight but the giant sea turtles might attain a weight of many hundred kilograms. The largest and the most pelagic species among the living turtles these days is the Huge Leather-back turtle (*Dermochelys coriacea*) which reaches a body weight of over 750 kg. These reptiles have a very long life span and the available records indicate that a giant tortoise *Geochelone gigantea* survived for 152 years in Seychelles Islands in the Indian Ocean, from 1766 to 1918.

Their body is well protected as it is enclosed in a box-like bony or leathery shell. The upper portion of the shell is the carapace and the lower one is the plastron. The carapace and plastron are generally composed partly of a modified inner layer of bony dermal plates and partly of a covering of modified outer layer of horny scales, scutes or shields. The carapace is composed of a median series of plates comprising the anterior most large nuchal and eight neurals, a right and a left lateral series of eight costal plates and a series of marginals bordering the complete carapace. The nuchal shield is not united to the first dorsal vertebra but the eight neurals are intimately fused with the eight dorsal vertebrae immediately below them and one to three supracaudal shields. The coastals are firmly united with the ribs below them, and by their inner and outer extremities with the neural and marginal plates, respectively. The marginal plates are usually eleven on each side. The plastron is made up of nine bones, namely a pair of epiplastral, hyoplastral, hypoplastral, xiphiplastral plates and a median entoplastral shield. The epidermal shields of the turtle plastron are comprising pairs of gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. The carapace and plastron are connected by a hinge at the sides. In the turtle species of families Dermochelyidae and Trionychidae the shell is covered by a leathery soft skin. All the species of Testudines are devoid of sternum or sternal ribs. The clavicles and interclavicles have been merged into the plastron. A major portion of the



1-3. Typical anapsid skull of Testudines.
 1. Lateral view 2. Dorsal view. 3. Ventral view

vertebral column and most of the ribs with capitular portion have fused with the carapace. Dorsal ribs have fused laterally with the pleurals and only two sacral ribs remain free. Single headed ribs are present on the trunk and sacral vertebrae. The ribs of the trunk except the first are fused to the carapace. The vertebrae are procoelous, amphicoelous or opisthocelous. There is a remarkable and drastic reduction of the axial skeleton in the Testudines. Out of the ten trunk vertebrae nine have bony attachment with the neural bones of the carapace. The cervical vertebrae form a complex articulation and the trunk vertebrae, except the first are immovably fixed by fusion of the neural arch with the carapace. The skull (Figs. 1-3) is most primitive like earliest cotylosaurian reptiles, typically anapsid and is devoid of true temporal fossae and arches but the temporal region is usually emarginated. The chelonian skull is devoid of ectopterygoids, lachrymals, nasals and interparietals. The vomer is unpaired, the quadrate is fixed and absolutely immovable. A continuous hard palate forms the bony roofing of the mouth, thus separating the buccal and nasal cavities. The skull is thus having only a single nasal opening and is devoid of penial or parietal foramen in its mid-dorsal region. Jacobson's organ is not separated from the general nasal cavity. Teeth are not available in the living species except in the embryonic stage of the species of genus *Trionyx* (family Trionychidae). In most of the fossil forms from the Triassic period distinct teeth were present. Now--a-days in all the living species the teeth have been replaced by a strong, horny, bill-shaped structure bounding the margins of the jaws which are provided with a tough bony sheath. On account of the fusion of the ribs and most of the trunk vertebrae to the shell, the pectoral and pelvic girdles stay within the rib cage and the limbs emerge sideways from the anterior and posterior apertures of the shell. Openings for the head and tail are also left at the front and behind of the shell. The limbs are placed at the sides of the body with a short stride in walking. Limbs are typically pentadactyle and complete; the phalangeal formula is generally 2, 3, 3, 3, 3 and 2,2,2,2,2. Elephantine hind limbs are a characteristic feature of the terrestrial species; webbed limbs are present in the freshwater species and these are modified as flippers in the marine turtles. Eyelids are present and the pupil is round. Tympanum and columella auris are present. The neck is long, flexible and retractile. In all the Indian species the bending of the neck is vertical and enables the head and neck to be withdrawn for protection within the shell. The infra-ventral surface of the eight neck vertebrae are modified in such a way that they allow the neck to bend in two places in a vertical S-shape manner at the time of withdrawal. The cloacal opening is longitudinal and circular. The copulatory organ is a well developed unpaired structure which is retracted into the ventral sheath of the cloaca anterior to cloacal aperture. The lungs and other soft parts have been modified drastically in all the species of modern turtles and are dorsally situated, lying immediately beneath the carapace and are ventilated mainly by changes in pressure in the viscera. In all species special respiratory muscles are available in

view of the enclosure of the body by the shell. In land tortoises breathing takes place by movements of the head, limbs, and abdominal muscles and the hyoid apparatus. Inspiration is brought about by the contraction of the oblique abdominal muscles at the hind leg pockets which expand the spongy lung cavities. Expiration is effected by the ventral abdominal muscles which push the viscera against the lungs and deflate them. In certain aquatic species the accessory respiration takes place by water circulating through the pharynx and the cloacal sacs. On account of these natural arrangements only, the turtles can live submerged for many days without suffocation. Vision is well developed in all the species of chelonians and it is a matter of interest that some aquatic species are remarkably receptive to infra-red radiation. Organs of sense are quite specialized and are absolutely capable to judge any physical or chemical stimulation. The sense of smell is acute as the olfactory parts of the brain are considerably large. The sense of hearing is moderate and the ears are most effective within a narrow range of sound. In some species the ear drum is covered by ordinary skin. Males generally have longer nails on fore feet, longer preanal region and long, thick tails in comparison to the females. While copulating the male mounts the female back and coincides its cloacal region with that of the female. In aquatic species courtship and copulation occurs in water only. There is no viviparity and all the species are oviparous and lay cleidoic eggs. Eggs are round or oval, soft or hard-shelled, laid in a nest excavated in the soil or sand. The number of eggs laid at a time varies from one to over 200 and some turtles lay several times in a year. Clutch size varies from 10 in some terrestrial species to hundreds in marine turtles. Parental care is not exhibited by any species at any stage in life. Hatchlings are provided with a horny curuncle on upper jaw for slitting the egg shell. Most of the species become sexually mature within ten years. The species found in India represent carnivorous, herbivorous and omnivorous forms. Five families, 16 genera and 32 species and subspecies are available within the limits of India today.

PHYLOGENY

The modern chelonians have maintained numerous characters of their ancestors which flourished in the Permian epoch. This ancient group of reptiles has no close relationship to other orders of recent or extinct reptiles and as such there is a deep mystery regarding their origin and relationship. From Triassic period to this date turtles have hardly undergone any changes. Their maximum development took place from late Mesozoic to early Tertiary period. The main divisions of chelonians which occurred in those early days are still existing to-day. But there has been a considerable reduction

in the number of their families and genera. For many years a small fossil reptile, *Eunotosaurus africanus*, from the Middle Permian of South Africa was regarded as the connecting link between the cotylosaurs and the turtles on the basis of its broadened body and eight pairs of expanded ribs. But the fossil remains of *Eunotosaurus* did not reveal the presence of plastron, abdominal ribs, hard dermal covering and other such features suggesting relationship with the turtles and their allies. Moreover, certain most important parts like skull roof, neck and the limbs have not been discovered so far in the fossil remains of *Eunotosaurus*. The expanded ribs of *Eunotosaurus* are leaf-shaped and are not the homologous to the pleural bones of true turtles. The earliest fossil Testudines of family Proganochelyidae, are from the Triassic of Germany. The closely allied *Triassocheilus dux* and *Proganochelys quenstedti* contained primitive features like teeth in both the jaws and palate, numerous marginals and supramarginals, four pairs of costal scutes and five vertebral shields. The exact mode of evolution of Proganochelyidae from the primitive stem reptiles is still unknown as fossils of the connective missing links have not been discovered so far. There are enough evidences that the ancient Proganochelyd turtles were marsh-dwellers and the modern turtles have evolved independently in the early Permian. Turtles neither evolved from any group which has already developed a lateral or dorsal temporal fossa in the skull nor can they be evolved from any form in which the palate was fused with the other bones of the cranium. Many factors indicate that recent turtles have not evolved even from the primitive reptiles like Didactomorph cotylosaurians which were at the peak of development and vigorously flourished from the Carboniferous to the Triassic period. These reptiles exhibit a marked resemblance to turtles by having a perfect and complete roofing of the skull and a well-defined otic notch. On the other hand, the Didactomorphs had the palate firmly fused to the braincase. This indicates that the chelonians had already assumed an independent evolutionary channel and become separate by the time this marked change crept in the anapsid skull of the cotylosaurs. The exact ancestry of the modern terrestrial and aquatic testudines goes back to the Upper Cretaceous period. The fossil *Zangerlia testudinimorpha*, a large amphibious turtle from the lower Nemegt beds of Mongolia had a deep shell, very strong dorsal sulci, thick sculptured scutes, shortened phalanges and the extensive fusion of the carpal elements. All these characters present in *Z. testudinimorpha* are also available in most of the tortoises of the present times. The freshwater adaptations exhibited by this ancestral turtle are the presence of features like a straight humerus, slightly reduced plastron and the elaborate superficial sculpturing of the shell. It is evident that the fully aquatic preference of most of the present turtles is most probably a secondary adaptation. The shielded or scaled body covering, shelled eggs and habits of egg laying on the land indicate the change in their original tendencies of mud and water dwelling. They preferred a change and became gradually adapted to lead a life without fully depending on aquatic or marshy habitat. On the other hand, the broad, shell-encased heavy body makes

many species helpless on land against strong predators, thus compelling them to move back to the freshwater medium. It was rather a forced protective adaptation during the early difficult times. This is the main reason why the majority of both recent and extinct turtles have or had a freshwater habitat. There are enough evidences that the terrestrial tortoises have evolved a long back from the primitive emydid turtles. Fossil records of the primitive tortoises which are ancestral to the modern land tortoises are available from the Mid-Eocene deposits. Possibly they were present in the Paleocene and flourished in the Pliocene period. Evolutionary history of the modern marine turtles can be traced back to the early Triassic period. Fossil records of the marine turtles are available from the Lower Cretaceous, Upper Jurassic, and Upper Cretaceous. The exact phylogeny of the modern marine turtles of the families Cheloniidae and Dermochelyidae is yet to be established. It is quite interesting that certain modern emydid species show a strong preference for the estuarine life.

It can be concluded without any doubt that modern Testudines emerged from the early cotylosaurs, although their ancestral fossil records have not been found in rocks before the Triassic period. It has been indicated that the Triassic turtles differ from their modern counterparts in minor respects only.

GEOGRAPHICAL DISTRIBUTION

MARINE TURTLES (FAMILIES DERMOCHELYIDAE AND CHELONIIDAE)

Five species of sea turtles are available in the Indian waters: the Leatherback (*Dermochelys coriacea*), the Green Sea turtle (*Chelonia mydas*), the Hawksbill (*Eretmochelys imbricata*), the Loggerhead (*Caretta caretta*) and the Olive Ridley (*Lepidochelys olivacea*). The Leatherback is widely distributed in tropical seas and often visits temperate water zones also. The exact distribution in Indian waters is not known and as the turtle is scarce everywhere the exact areas of origin are still unknown. The maximum concentration of the Leatherback in Indian Ocean has been recorded at the Gulf of Kutch, Okha coast, Goa coast, Tangasseri reef near Calicut, the Gulf of Mannar, the Palk Bay and in the coastal areas of Sri Lanka. The Green Sea Turtle is a circumtropical species which is widely distributed in tropical and subtropical seas and comes ashore on particular beaches and nests in a colonial fashion. It is widely distributed in Indian waters and the maximum concentration of its population has been recorded at the Sandspit and Hawks Bay, in Pakistan; Gulf of Kutch, Okha coast in Gujarat; coasts of Salm district in Maharashtra; along the entire Kerala coast extending south from Quilon; complete eastern coast of Tamil Nadu (Kanyakumari, Rameswaram, Tuticorin and adjoining islands, Point Calimere, Nallatanni Island); and in all coral reef areas in the Gulf of Mannar and Palk Bay. The Hawksbill turtle also has almost a similar range of distribution as the Green Sea Turtle in tropical and subtropical seas but it is nowhere in abundance and prefers to lead an independent life, prepares scattered nests individually in localities far apart, does not form breeding colonies and prefers to migrate short distances only. The maximum concentration of the Hawksbill is at the coastal parts of southern Tamil Nadu, Kerala, Andaman and Nicobar Islands, islands in the Gulf of Kutch, all coral reef areas in the Gulf of Mannar, Palk Bay and Lakshadweep Islands. The Loggerhead Sea Turtle is the most widely distributed species in all the temperate and subtropical waters of the world. Most of the nesting zones of this turtle are either north of the Tropic of Cancer or south of the Tropic of Capricorn. Loggerhead turtles are in the habit of migrating long distances and their nesting takes place in a colonial fashion, and the largest population of nesting females up to 30,000 per year has been reported from Masirah Island near Oman. The exact nesting areas of the Loggerhead in India are not known but the maximum concentration of this turtle has been reported from southern Tamil Nadu coast and coral reef areas in the Gulf of Mannar and the Palk Bay. The Olive Ridley Turtle has a wider tropical range in Indian, East Pacific and Eastern Atlantic oceans. This turtle is most widely distributed in the Indian ocean and the maximum concentration has been recorded from the coastal areas of Maharashtra, Goa, Kerala, south Tamil Nadu, Andhra Pradesh, Orissa, Andaman Islands, Gulf of Mannar, southern

coast of Sri Lanka, Lakshadweep Islands, Hawks Bay and Sandpit in Pakistan, Diamond Islands in Burma and southern Kelantan to Pahang in Malaysia.

FRESHWATER TORTOISES-TERRAPINS (FAMILY EMYDIDAE)

These are the hard-shelled, amphibious, herbivorous, or carnivorous and omnivorous chelonians, relatively of small size, inhabiting the various freshwater bodies of Northern Hemisphere. They are devoid of mesoplastron infralabials and gular shields. They are closely related to the land tortoises, but can be differentiated by not having elephantine hind feet and are more adapted to freshwater life than to a terrestrial one. The family Emydidae is well represented in India by seven genera, namely: *Cyclemys*, *Melanochelys*, *Heosemys*, *Geoclemys*, *Hardella*, *Kachuga* and *Batagur*. The genus *Cyclemys* is widespread from Assam to the Philippines Islands through south-east Asia and is represented by three species, *Cyclemys mouhoti*, *C. dentata* and *C. annamensis*. *Cyclemys* is so close to *Heosemys* and *Melanochelys* that sometimes the validity of their generic distinction is doubted. *Melanochelys* includes two species of three-keeled, semi-aquatic forms, *M. tricarinata* and *M. trijuga*. The latter has four distinct subspecies in India, namely *M. trijuga trijuga*, *M. trijuga indopeninsularis*, *M. trijuga coronata* and *M. trijuga thermalis*. The fossil species of *Melanochelys* are from the Siwalik Hills. *Heosemys* is represented by a single species, *H. silvatica*, which is quite a small, secretive and terrestrial turtle endemic to India, inhabiting the dense rain forests of Kudamurutti, Idukki, Kavalai, Masanguddi and Chalakudi near Cochin in the Kerala State. *Geoclemys* is a monotypic genus inhabiting the Ganga and Sind river systems of India and Pakistan. The species *G. hamiltoni* is a moderately large, yellow and black, elegant species with a thick and strong tricarinate shell and large yellow spotted head with powerful crushing jaws. Fossil records of this species are reported from the Siwalik Hills. *Hardella* is also a monotypic genus and the species *H. thurgi* is a perfectly herbivorous, docile, large aquatic tortoise with a projecting, conical snout. It frequents the slow flowing and stagnant waters of the Ganga and Brahmaputra river systems and makes nests on the suitable spots on the sandy river banks. Genus *Kachuga* comprises seven perfectly aquatic and generally herbivorous species out of which six, namely *K. smithi*, *K. tentoria*, *K. tecta*, *K. sylhetensis*, *K. dhongoka* and *K. kachuga*, are restricted to the Ganga, Brahmaputra, Mahanadi, Godavari and Krishna river systems of India; the Sind river system of Pakistan and are also available in Nepal. *K. trivittata* frequents the waters of Irrawaddy and Salween river systems in Burma. Fossils of *Kachuga* have been obtained from the pleistocene deposits of Siwalik Hills and Narbada valley. Genus *Batagur* is represented by a single omnivorous, entirely aquatic and extremely shy

species *Batagur baska* which has a wide range of distribution from India (Bengal) to Sumatra through Burma, Malaysia and Vietnam. This species frequents the estuaries, deep slow running rivers away from tidal influence, freshwater lakes and canals.

THE LAND TORTOISES (FAMILY TESTUDINIDAE)

These are the heavy-shelled, terrestrial and herbivorous forms with head and neck completely retractile within the shell; the temporal region is not roofed; the plastron is large without inframarginal plates in the plastral bridge and is completely devoid of any hinge. The carapace is strongly domed, rigid, covered with dermal shields showing the growth rings. The carapace and plastron are united by a broad bridge. These tortoises are having strong, unwebbed feet with comparatively short digits. The hind feet are club-shaped and elephantine. The skin of the anterior side of the forelimbs is covered with strong horny scales. The family Testudinidae is represented in India by the only tortoise genus *Geochelone* which is widespread in tropical south-east Asia also. *G. elegans* has got a wide range of distribution from Pakistan (Sind) to Sri Lanka through central and south India. *G. emys* is the largest of the Asiatic species of the genus *Geochelone*, inhabiting hilly areas of eastern India (Assam), Burma, Kampuchea, Laos, Malaysia, Thailand, Vietnam and Indonesia (Sumatra and Borneo). *G. elongata* is quite abundant in the hilly areas throughout its range which extends from North-eastern India to Vietnam through Burma, Kampuchea, Laos, Malaysia and Thailand. *G. travancorica* which is closely allied to *G. elongata* is an endemic species inhabiting the hilly areas of Travancore-Cochin, Mercara (Coorg) and western Ghats. There is every possibility that *G. elongata* and *G. travancorica* might have evolved from the same ancestral stock of tortoises which once flourished on the vast areas of India and Indochina in the Pliocene period. Leaving aside the differences in certain characters like nuchal shields and plastral sutures, both the species have a remarkable similarity in coloration, size and habits. Plenty of fossil records of Indian land tortoises have been obtained from the Siwalik Hills.

FRESHWATER AND MUD TURTLES (FAMILY TRIONYCHIDAE)

The group comprising the modern, flattened, soft-shelled, carnivorous, aquatic turtles and showing typical divergence are quite distinct from other cryptodirans. Head and neck are completely retracted within the shell; the temporal region of the skull is not roofed; carapace covered with

a leathery skin, scutes are replaced by a continuous layer of soft skin and peripheral bones are missing except in the genus *Lissemys* where they are replaced by the rudimentary bony structures; edges of carapace are generally composed of flexible cartilage and become ossified only in very large turtles; the shell is dorso-ventrally flattened, round or oval; the carapace has raised sculptures; the plastron is generally reduced and not joined to the carapace by a bridge; lateral and hinder portions of the dorsal disc are most flexible and the free rib ends are just embeded in the marginal cartilaginous mass of the shell; head is narrow, tympanum is hidden, snout elongated, tubular and is like a proboscis, neck is quite long, jaws are markedly sharp and are hidden below the soft lips; limbs are modified into swimming paddles, clawed and webbed.

Trionychid turtles are represented in India by three well established genera, namely *Lissemys*, *Chitra* and *Trionyx* inhabiting freshwater habitats like marshes, pools, lakes and rivers. Genus *Trionyx* is widely distributed in Asia, Africa and North America and is represented in India by three species, namely *Trionyx gangeticus*, *Trionyx hurum* and *Trionyx leithi*. *T gangeticus* is available in Nepal foothills, Pakistan and India and considerable populations of the species are present in the Sind, Ganga and Mahanadi river systems. *T leithi* is available in the Ganga, Mahanadi, Godavari and Krishna river systems. *T hurum* frequents the lower reaches of the Ganga and Brahmaputra river systems. *Lissemys* is a monotypic genus inhabiting India and Burma. The species *L. punctata* includes three quite distinct subspecies. *Lissemys punctata punctata* ranges in the Sind and Ganga river systems. *Lissemys punctata granosa* inhabits the rivers of Peninsular India and Sri Lanka. *Lissemys punctata scutata* frequents the Irrawaddy and Salween river systems of Burma. Genus *Chitra* is represented by a single species *Chitra indica* inhabiting the river systems of North India, Thailand, Malaysia, Pakistan and Nepal. Trionychid fossils of *Trionyx*, *Chitra* and *Lissemys* have been recorded from the Pliocene and Pleistocene deposits of the Siwalik Hills in India.

HISTORICAL REVIEW OF WORKS ON INDIAN TESTUDINES

The beginning of studies of Testudines in India dates back as early as the middle of the nineteenth century and the first consolidated work was published by A. Gunther in the year 1864 in his book, "The Reptiles of British India." The various Indian Herpetologists, who made outstanding contributions to the study of testudines are Theobald 1876 (Descriptive catalogue of the reptiles of British India); Boulenger 1882-1920 (The Fauna of British India Reptilia and Batrachia); Hardwicke 1756-1835 (Drawings of reptiles including Testudines); Hamilton Francis 1762-1829 (Sketches of

Chelonians); J. Anderson, 1872-1879 (Notes on various Indian Testudines). H. Ferguson, 1907. (A new tortoise from Travancore); N. Annandale, 1906-1921 (numerous papers on Indian testudines); Thomas Bell, 1825-1842 (Monograph of the Testudinata, etc.); J. E. Gray, 1825-1872 (Catalogue of the Shield Reptiles and numerous papers on Indian Testudines); R. Lydekker, 1876-1889 (many papers on living and fossil testudines of India), and M. A. Smith, 1931 (The Fauna of British India Loricata, Testudines—the latest and most consolidated account of all the Indian species and subspecies).

SYSTEMATIC ACCOUNT

Order TESTUDINES

Suborder CRYPTODIRA (Modern Testudines)

Family I. CHELONIIDAE. Gray 1825 (Marine Turtles)

- Genus 1. **Caretta** Rafinesque 1814
1. *Caretta caretta* (Linnaeus 1758)
Loggerhead Sea Turtle
- Genus 2. **Chelonia** Brongniart 1800
2. *Chelonia mydas* (Linnaeus 1758)
Green Sea Turtle
- Genus 3. **Eretmochelys** Fitzinger 1843
3. *Eretmochelys imbricata* (Linnaeus 1757)
Hawksbill Sea Turtle
- Genus 4. **Lepidochelys** Fitzinger 1843
4. *Lepidochelys olivacea* (Eschscholtz 1829)
Olive Ridley Sea Turtle

Family II. DERMOCHELYIDAE Siebenrock 1909 (Marine Turtles)

- Genus 5. **Dermochelys** Blainville 1816
5. *Dermochelys coriacea* (Linnaeus 1766)
Leatherback Sea Turtle

Family III. EMYDIDAE GRAY 1825 (The Freshwater Tortoises—Terrapins)

- Genus 6. **Batagur** Gray 1855
6. *Batagur baska* (Gray 1831)
Batagur. River Terrapin

- Genus 7. **Hardella** Gray 1870
7. *Hardella thurgi* (Gray 1831)
Brahminy River Turtle
- Genus 8. **Kachuga** Gray 1869
8. *Kachuga dhongoka* (Gray 1834)
Dhongoka Turtle
9. *Kachuga kachuga* (Gray 1831)
Bengal Roofed Turtle
10. *Kachuga smithi* (Gray 1863)
Brown River Turtle
11. *Kachuga sylhetensis* (Jerdon 1870)
Assam Saw-back Turtle
12. *Kachuga tecta* (Gray 1831)
North Indian Roofed Turtle
13. *Kachuga tentoria* (Gray 1834)
South Indian Roofed Turtle
- Genus 9. **Geoclemys** Gray 1855
14. *Geoclemys hamiltoni* (Gray 1831)
North Indian Freshwater Tortoise
- Genus 10. **Cyclemys** Bell 1834
15. *Cyclemys dentata* (Gray 1831)
Garo and Khasi Hills Tortoise
16. *Cyclemys mouhoti* Gray 1862
Assam Freshwater Tortoise
- Genus 11. **Heosemys** Stejneger 1902
17. *Heosemys silvatica* (Henderson 1912)
Kavalai Forest Turtle
- Genus 12. **Melanochelys** Gray 1869
18. *Melanochelys tricarinata* (Blyth 1856)
Three Keeled Tortoise
19. *Melanochelys trijuga trijuga* (Schweigger 1812)
Indian Snail-eating Turtle
20. *Melanochelys trijuga coronata* (Anderson 1878)
21. *Melanochelys trijuga indopeninsularis* (Annandale 1913)
22. *Melanochelys trijuga thermalis* (Lesson 1830)

Family IV. TESTUDINIDAE Gray 1825
(The Land Tortoises)

- Genus 13. **Geochelone** Fitzinger 1835
23. *Geochelone elegans* (Schoepff 1795)
Star Tortoise, Indian Starred Tortoise
24. *Geochelone elongata* (Blyth 1853)
Yellow Tortoise
25. *Geochelone travancorica* (Boulenger 1907)
Travancore Tortoise
26. *Geochelone emys* (Schlegel & Muller 1844)
Yellow and Black Giant Tortoise

Family V. TRIONYCHIDAE Bell 1828
(Soft-shelled Turtles)

- Genus 14. **Lissemys** Smith 1931
27. *Lissemys punctata punctata* (Lacepede 1788)
North Indian Flap-shelled Turtle
28. *Lissemys punctata granosa* (Schoepff 1801)
Southern Flap-shelled Turtle
- Genus 15. **Chitra** Gray 1844
29. *Chitra indica* (Gray 1831)
Narrow-headed Soft-shelled Turtle
- Genus 16. **Trionyx** Geoffroy 1809
30. *Trionyx gangeticus* Cuvier 1825
Indian or Ganga Soft-shelled Turtle
31. *Trionyx leithi* Gray 1872
Peninsular Soft-shelled Turtle
32. *Trionyx hurum* Gray 1831
Peacock-marked Soft-shelled Turtle

Order TESTUDINES

Suborder CRYPTODIRA

Indian Testudines belong to five families exhibiting the external characters as indicated in the following key:-

Order Testudines
Suborder Cryptodira

Key to the families of the order Testudines

1. Digits elongated, flattened, and bound together;
limbs paddle-shaped. 2
 Digits not elongated, flattened, and bound together..... 3
2. Limbs paddle-shaped, clawless, feet scaleless; carapace covered with smooth skin, no epidermal shields and with seven prominent longitudinal keels.....DERMOCHELYIDAE
 Limbs paddle-shaped, with one or two claws, feet covered with scales; carapace covered with epidermal horny shieldsCHELONIIDAE
3. Forelimbs semi-paddle-shaped with 3 claws; carapace covered with smooth skin; edge of carapace flexibleTRIONYCHIDAE
 Forelimbs paddle-shaped with more than 3 claws; carapace covered with horny shields 4
4. Limbs paddle-shaped but more or less flattened: digits webbed; top of head covered with smooth skin or with the posterior part of it divided into shields; claws 4-5; carapace covered with horny shields or its skin bears many projections giving it a roughened appearanceEMYDIDAE
 Limbs more or less cylindrical, the hind limbs clubshaped or elephantine, digits not webbed; upper portion of the head shielded; plastron with 12 shields, pectoral shield forming front part of bridge.....TESTUDINIDAE

Family I. CHELONIIDAE Gray 1825

This family comprises marine turtles whose carapace and plastron are covered with horny epidermal shields. The neck in these turtles is incompletely retractile and bends in a sigmoid curve almost in a vertical plane; cervical vertebrae much reduced in length; outer margin of tympanic

cavity is notched; pterygoids articulate medially; squamosal forms a suture with the parietal. Pelvic girdle not ankylosed to the shield. Legs are modified to form swimming paddles; feet are covered with scales, the digits of the fore-limb are much elongated and phalanges noncondylar. Claws are one or two. Skull roof (Plate 1) and bony shell is incomplete. Nuchal shield is devoid of costiform process. Plastron is composed of nine bones and its elements are remarkably reduced in size, a median vacuity is always present between the two lateral halves. All the parts of plastron are connected ligamentously to the carapace. The other characteristic features of the family are the complete and perfect roofing of the temporal region; downward prolongation of the parietals; incomplete costal plates at the periphery; presence of frontanelles between the costal plates and the marginal bones. The Indian species of family Cheloniidae are included in four monotypic, cosmopolitan genera with a wide distribution in tropical and subtropical seas, and casually visit to the coasts of certain temperate zones of the world. The Sea Turtles lead a perfect aquatic life and visit the sandy coastal areas of the land only during the breeding season.

Key to the Genera of the family CHELONIIDAE

1. Costal shields four on each side; one pair of pre-frontals between the eye; horny scutes juxtaposed not overlapping (imbricated); horny edge of lower jaw strongly dentate; bony alveolar surface of upper jaw having low but regularly raised ridge; jaws not hooked; single claw is present on each flipper; carapace greenish with violet markings; skin of neck yellow or creamish **Chelonia**

Costal shields 4-9 on each side; 2 pairs of pre-frontals between the eye; horny edge of lower jaw smooth or feebly dentate; bony alveolar surface of upper jaw smooth or with a sharp crested ridge..... 2

2. Costal shields 4 on each side; horny scutes imbricated; two pairs of pre-frontal scutes; nuchal not in contact with the first costal on each side; snout elongate, narrow; premaxilla deeply excavated and not toothed terminally; alveolar surface of upper jaw with a single sharp-crested ridge; jaws are hooked; 2 claws are present on each flipper; carapace is brown with deep brown markings; neck is light orange **Eretmochelys**

Costal shields 5 or more on each side, not imbricate; nuchal in contact with first costal on each side; snout comparatively short and broad; pre-maxilla toothed; bony alveolar surface of upper jaw smooth or with a rounded ridge 3

3. Costal shields 5-9 (generally 6 or 7) on each side; plastron with 4 pairs of inframarginals on bridge; each inframarginal is provided with pores on the hinder margin; maxillae separated by vomer, single claw is present on each flipper. Dorsal colour grey to olive-green (generally carapace is grey and plastron yellow) **Lepidochelys**

Costal shields 5 on each side; plastron with 3 pairs of inframarginals on bridge, pores are not present on the hinder margin of inframarginals; dorsal shields are juxtaposed; maxillae in contact with each other; 2 claws are present on each flipper; colour brown or reddish brown, carapace brownish-red with light spots and plastron is yellow with orange spots **Caretta**

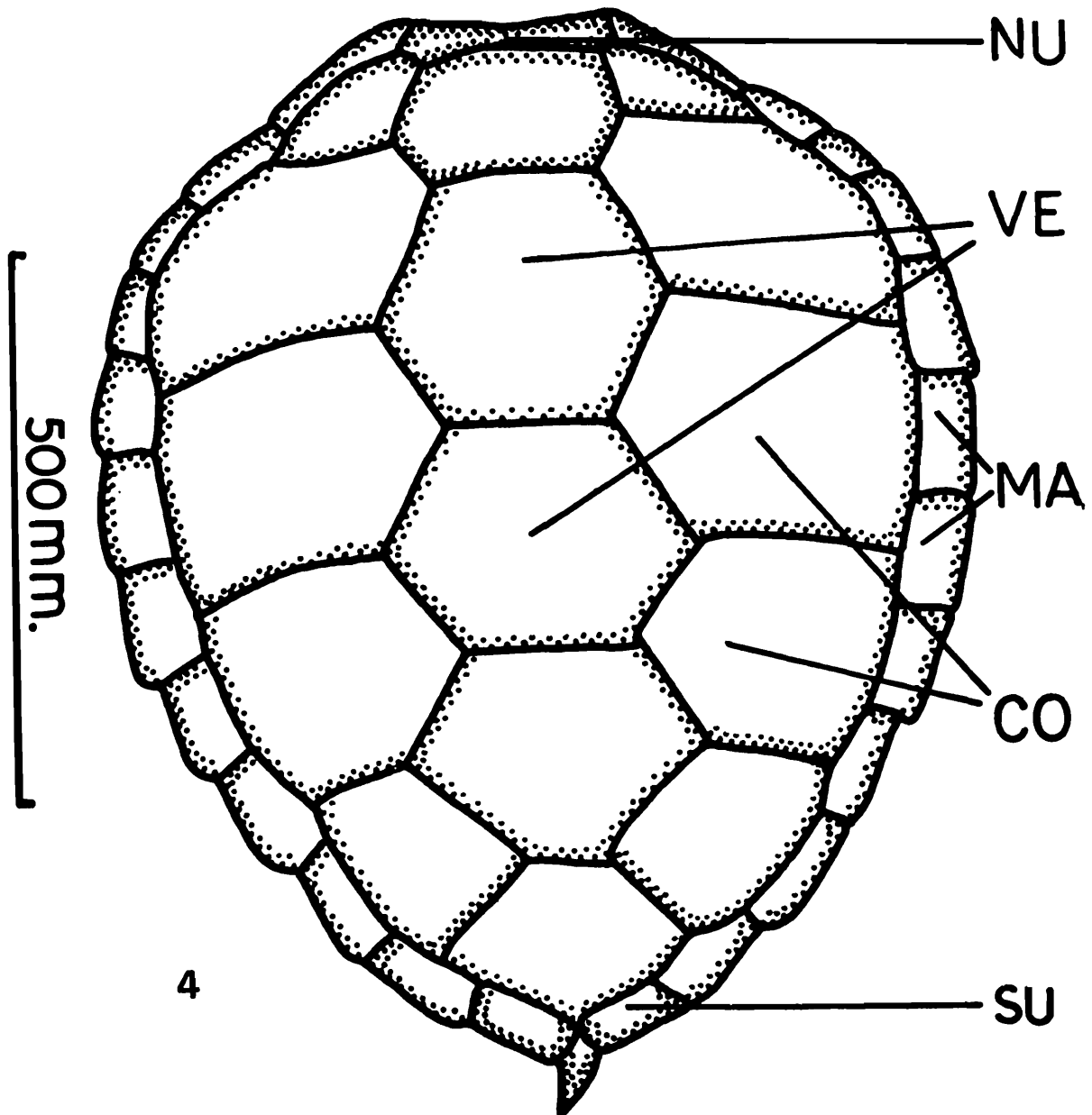
Genus 1. *Caretta* Rafinesque 1814

LOGGERHEAD SEA TURTLE

1. *Caretta caretta* (Linnaeus 1758)

(Plate 2; figs. 4, 5, 14, 18, 23)

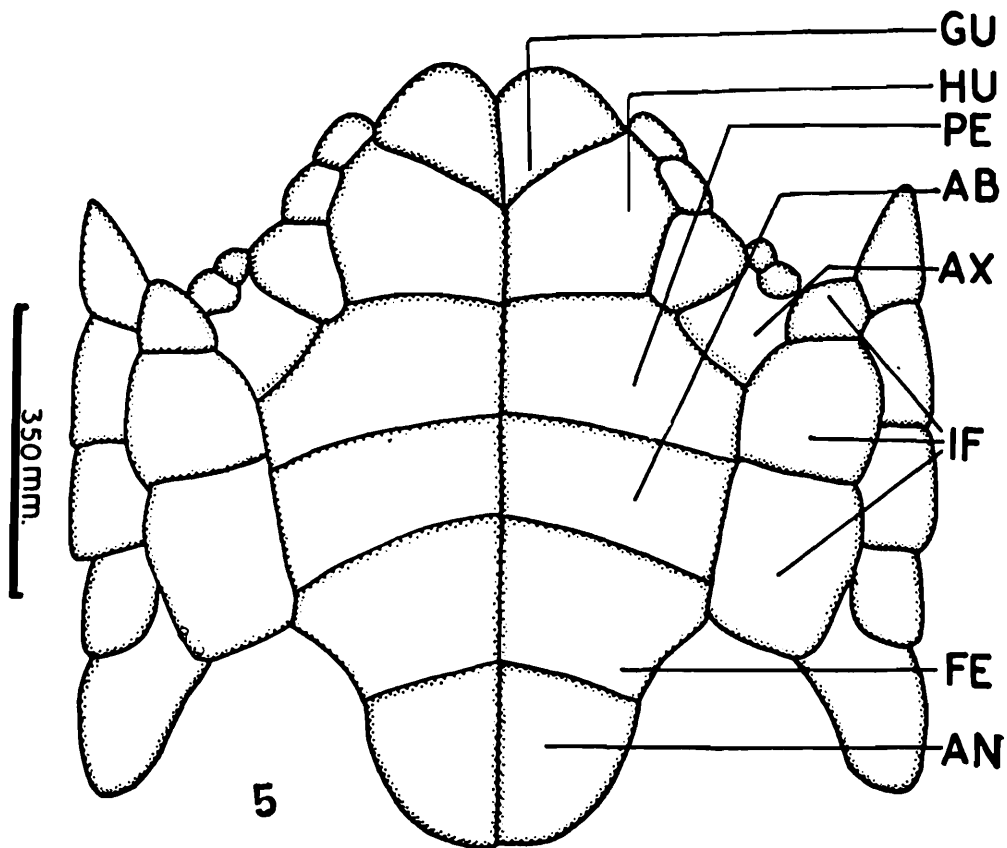
The Loggerhead Sea Turtle is a large, cosmopolitan species with somewhat elongate carapace. The species gets its name from its big head, which in an old adult turtle reaches up to 30 centimeters in length and is one of the largest amongst all other sea turtles. The large head suitably accommodates massive jaw-closing muscles. It has been recorded that a large, fully adult Loggerhead may attain a length of 2.7 metres and weight 385 kilograms. According to the IUCN Red Data Book the maximum recorded length of the carapace is 114 centimeters, and the weight of a mature specimen ranges between 91-152 kilograms. The turtle has a pronounced beak and large brown eyes. The carapace (Fig. 4) is more or less serrated posteriorly; costal scutes are generally 5 on each side; neural or central scutes are 5 or more; marginal shields are 27 (including 1 precentral or nuchal and a pair of postcentral or supracaudal scutes) and the mid-marginals are comparatively wide. The number of costal and neural shields of carapace is variable. The plastron (Fig. 5) consists of paired gular, humeral, pectoral, abdominal, femoral and anal shields; intergular which may be single, double or even absent, and inframarginals are in 3 pairs, enlarged and devoid of pores on the hinder margin. The dorsal shields are juxtaposed. Maxillae are in contact with each other. Head is covered with symmetrical shields and two pairs of prefrontals are present. A dorsal keel is present in small young individuals which becomes inconspicuous in large, aged adults.



4. Carapace of *Caretta caretta* (Linnaeus)

Two claws are present on each flipper. Tail is extremely short in comparison to the body. General colouration is brown or red-brown; carapace is brownish-red with light spots; eyes are brown and the flippers are grey-brown.

Distribution: Loggerhead Sea Turtle is found in all the temperate and subtropical oceans of the world. Generally the nesting zones are either north of the Tropic of Cancer or south of the Tropic of Capricorn. Numerous individuals choose nesting areas on the sandy beaches of Oman (Masirah Island), U.S.A. (Florida), and Australia. Low to moderate populations of these turtles have been recorded on the coastal and offshore areas of Angola, Azores Islands, Bahamas, Belize, Burma, Canary Islands, Colombia, Cape Verde Islands, Cuba, Cyprus, France, Greece, Guatemala,

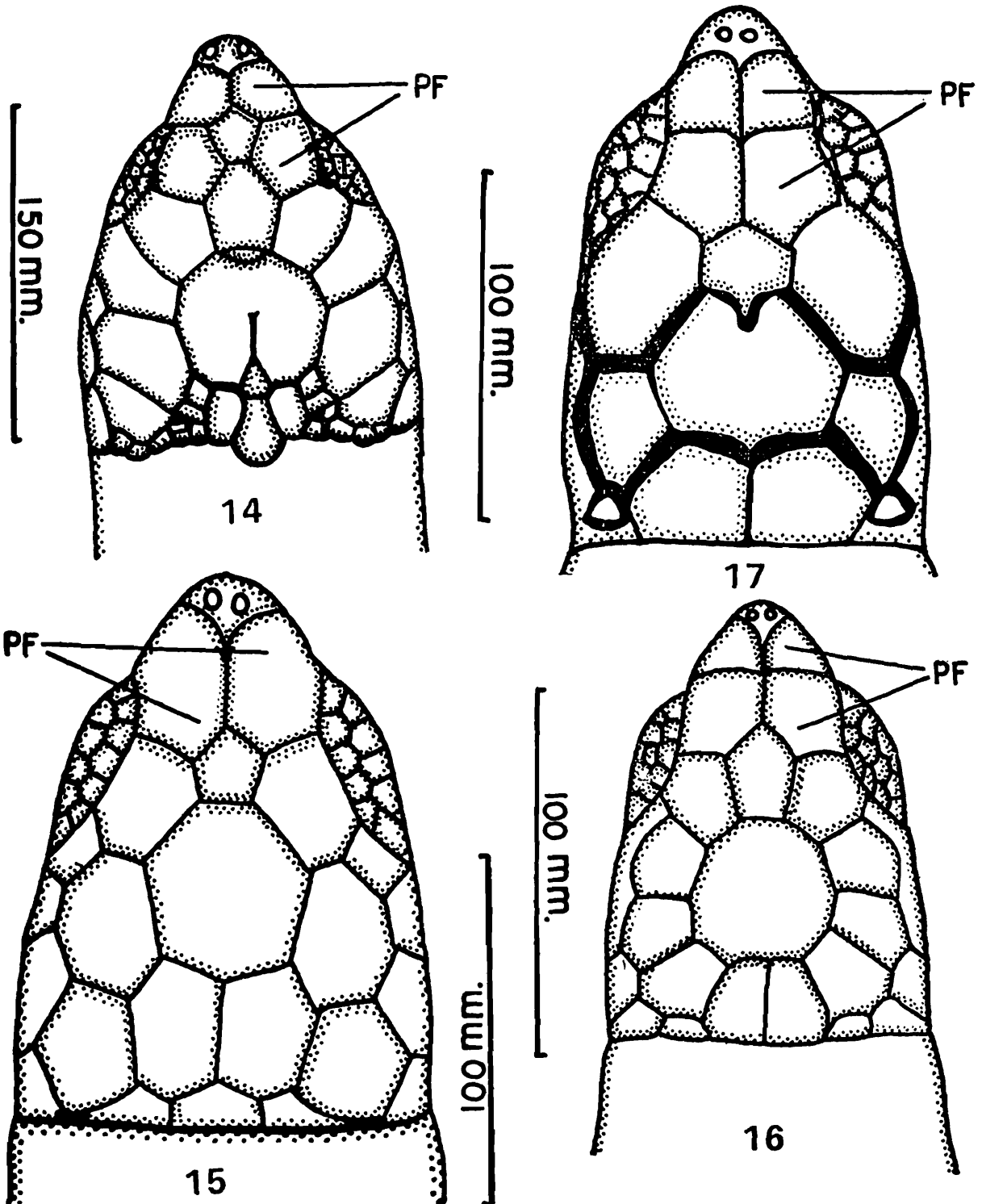


5. Plastron of *Caretta caretta* (Linnaeus)

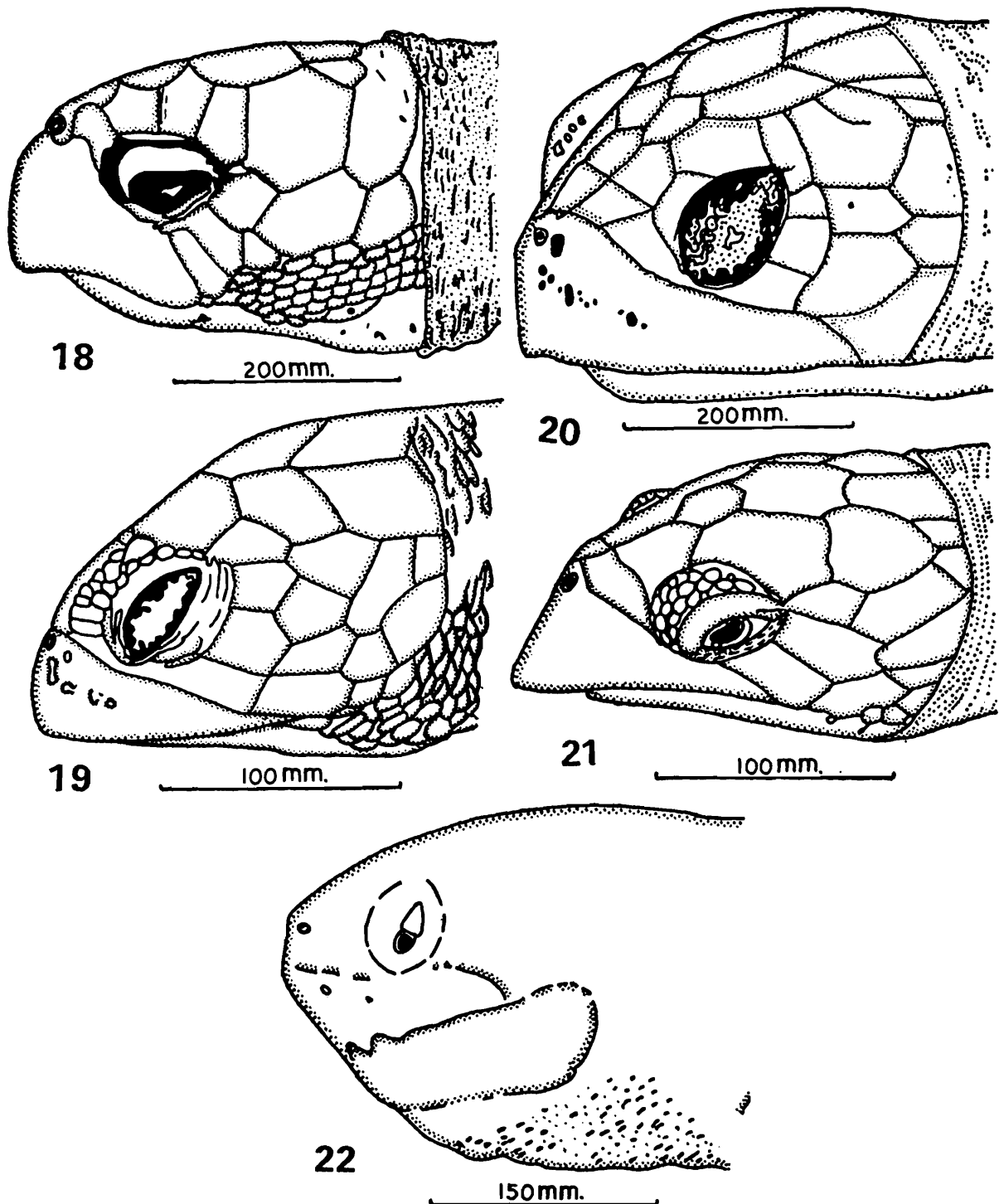
Honduras, Israel, Italy, Jamaica, Japan, Madagascar, Madeira, Mexico, Mozambique, Nicaragua, Panama and Senegal. Loggerheads are fairly common throughout the Mediterranean Sea, with large-scale nesting along the coast of Turkey to Israel. In the Indian Ocean the main nesting locations are in Paradise Island, Mozambique, Tongaland Coast of South Africa. The largest nesting population has been recorded so far on Masirah Island (Oman), where an estimated 30,000 female Loggerheads visit every year for nesting. These turtles have been recorded from the waters of India. Sri Lanka, Pakistan, Maldives, west coast of Sumatra, coasts of Southern China and Taiwan.

Habits and habitat: Nesting is seasonal and generally the nests are constructed during the night. The nesting season of this circumglobal species ranges from May-January. At Kwa-Zula area on the Tongaland Coast of South Africa the nesting of Loggerheads takes place between

November to January while at Florida and South Carolina, U.S.A., nests are made from May-August. When coming ashore to nest, female Loggerheads move magnificently in slow strides by using their flippers in a typical



14-17. Dorsal view of head in Marine turtles showing the Prefrontal (PF) and other shields. 14. *Caretta caretta* (Linnaeus) 15. *Chelonia mydas* (Linnaeus) 16. *Lepidochelys olivacea* (Eschscholtz) 17. *Eretmochelys imbricata* (Linnaeus)



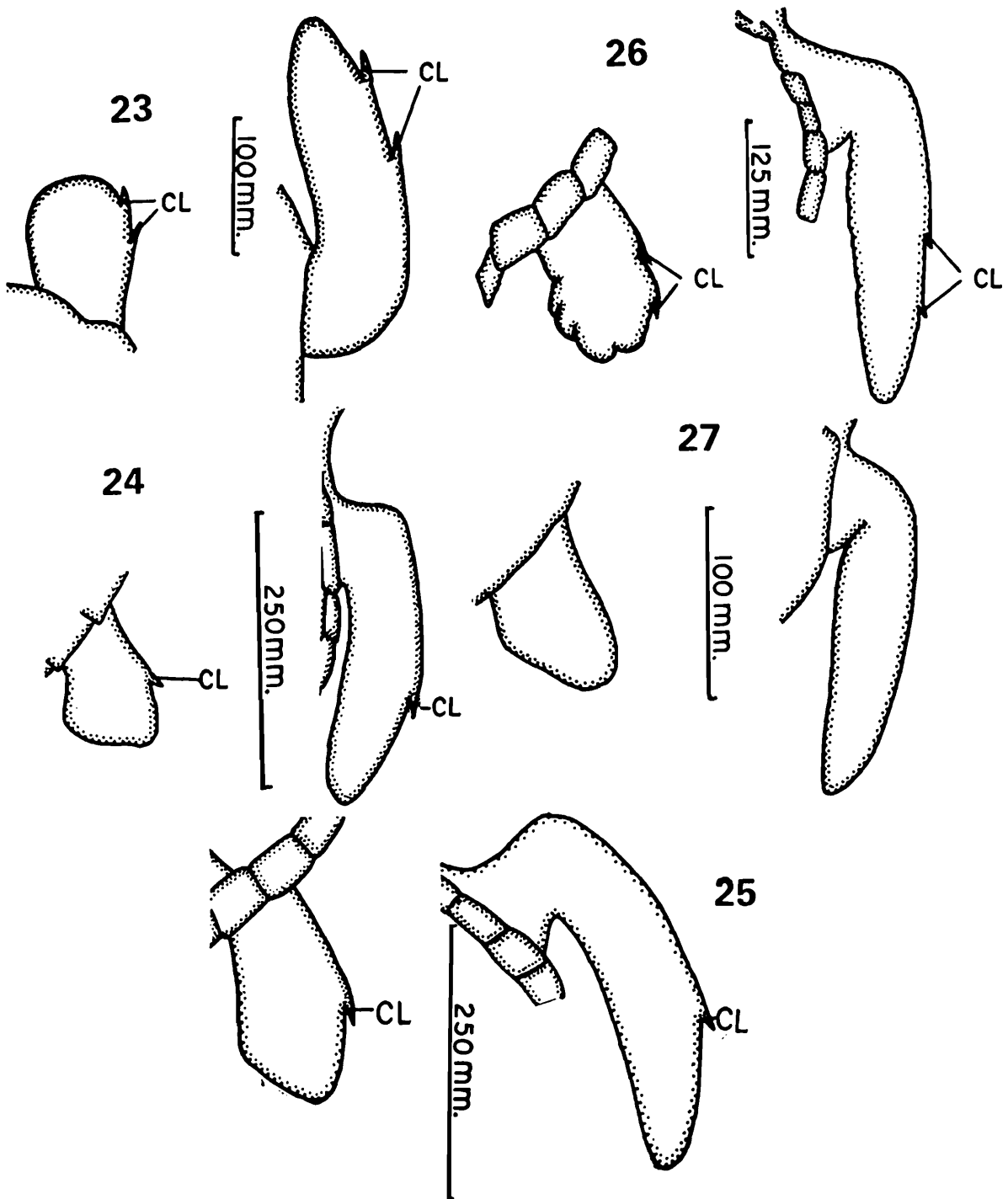
18-22. Lateral view of head in Marine turtles. 18. *Caretta caretta* (Linnaeus)—showing the hooked jaws and head shields. 19. *Chelonia mydas* (Linnaeus)—showing the short snout and head shields. 20. *Lepidochelys olivacea* (Eschscholtz)—showing the narrow and small snout and head shields. 21. *Eretmochelys imbricata* (Linnaeus)—showing the compressed Hawk's like snout and head shields. 22. *Dermochelys coriacea* (Linnaeus)—showing the blunt snout.

four-legged manner. With the help of hind flippers she digs a shallow nest pit and the round eggs, slightly smaller than a ping pong ball with a diameter between 40-42 mm. are deposited, 12 to 56 cm. deep in the sand. Clutch size varies from 60-200. After the egg laying, the female covers the nest with sand and roughs up the surface of the beach over a wide area in order to hide the exact spot of the nesting. The incubation takes 55 to 66 days. Females may nest 4-5 times in one season but a single female can make a maximum of 7 nests. It has been recorded that the hatchling output per season per female is not more than 200. Loggerheads mature in 10-15 years. Female Loggerheads can re-migrate at 2-3 year intervals, most females tagged on the nesting beach are never seen nesting in another season. The hatchlings spend the first few months of life while hiding under the layers of certain weeds and feed mainly on small prawns, fish and crustaceans. The adult Loggerheads are fully carnivorous, feeding mainly on benthic invertebrates like molluscs, crustaceans, sponges, jelly-fish, crabs, fish, seaurchins and starfish.

Status: The Loggerhead Turtle has become extremely vulnerable and is hunted in many countries for eggs, flesh and tourist curios. The main threats to survival are incidental capture in trawls, loss of nesting habitat due to the urbanisation of the coastal areas, tourist pressure and local exploitation. Artificial lights are said to be responsible in causing disorientation of nesting females and hatchlings. Electric and other such lights attract them towards the inland roads and many females and hatchlings are killed by traffic accidents and dessication. Exploitation for meat, eggs and for making local curios is carried out in Mexico, Azores, Madeira, Canary Islands, Cuba, Mozambique, Dominican Republic, India, China, Japan and Columbia. At various industrially developed places of the world the numerous hatchlings of this species are killed by the chocking of jaws and throat by tar, mineral oil and by the various chemicals which accumulate in sea water as industrial waste or by any other method. Racoons are the strong predators on Loggerhead eggs in North America.

All over the world the status of the Loggerhead has been estimated mainly on the basis of nesting female population on the beaches. So far the routes of migration of the species, the exact habitats of hatchlings and their mortality rate, exact feeding grounds, methods for the estimation of the male population (males never leave water) are not known. Loggerhead populations are under enormous pressure and their number has alarmingly declined in Honduras, Mexico and Colombia.

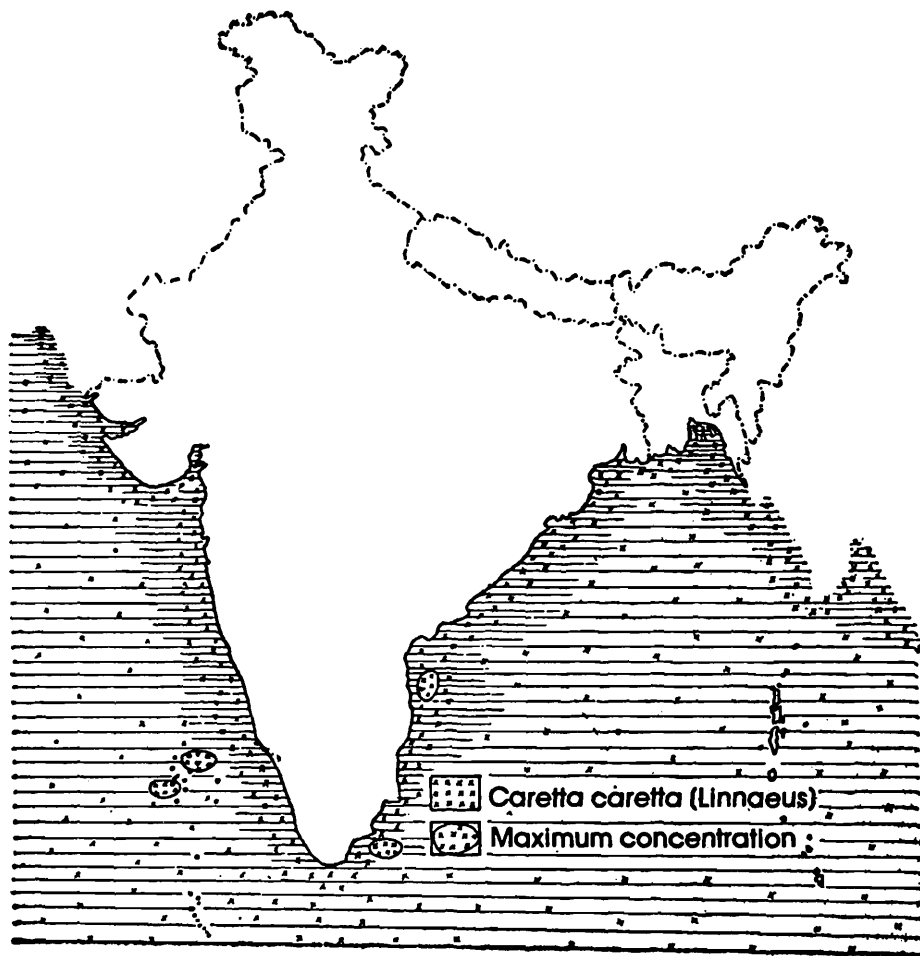
Conservation: All over its range, the species is nominally protected by legislation. Any type of commercial exploitation of turtles, hunting and egg collection is absolutely banned or allowed only in a limited way. Many countries like U.S.A. have established restricted fishery zones in order to avoid the incidental catch of Loggerheads. Various beaches throughout



23-27. Fore (Large) and hind (Small) flippers or swimming paddles of Marine turtles showing the general shape and claws. 23. *Caretta caretta* (Linnaeus). 24. *Chelonia mydas* (Linnaeus). 25. *Lepidochelys olivacea* (Eschschltiz). 26. *Eretmochelys imbricata* (Linnaeus). 27. *Dermochelys coriacea* (Linnaeus).

the world have been declared protected to conserve the nesting or breeding turtles. The Loggerhead Turtle is listed on Appendix I of the Convention on International Trade in Endangered species of Wild Fauna and Flora

(CITES) according to which any international trade concerning the species and its products and any sort of commercial exploitation is strictly prohibited. It has been proposed all over the world that the existing legislation should be enforced more strictly for the protection of these turtles at major nesting zones such as at Masirah Island, Oman. Places like Madagascar should be provided, all the possible help to re-establish their turtle reserves. The nesting beaches and other such areas should be made restricted fishing zones all over the world. There should be international co-ordinated programmes for the conservation of nesting, feeding and migratory areas of Loggerheads.



Map showing the Indian range and maximum concentration of *Caretta caretta* (Linnaeus)

Captive Breeding: It is carried out at Seafloor Aquarium at Nassau, where a full breeding cycle has occurred.

Genus 2. *Chelonia* Brongniart 1800

GREEN SEA TURTLE

2. *Chelonia mydas* (Linnaeus 1758)

(Plate 3 & 40; figs. 6, 7, 15, 19, 24)

The Green Sea Turtle is the largest of the hard-shelled species of marine turtles, having marked variations in size, weight and carapace shape between its different populations all over the world. The name comes from the colour of its green fatty tissues. Its body is smooth, flat, streamlined and heart-shaped. A fully grown adult attains a carapace length up to 155 cm. (average length varies between 100-155 cm.) and normally attains a weight of 135-175 kg.; the heaviest recorded is of 425 kg. The head is round and small in comparison to the body, the snout is short and jaws are

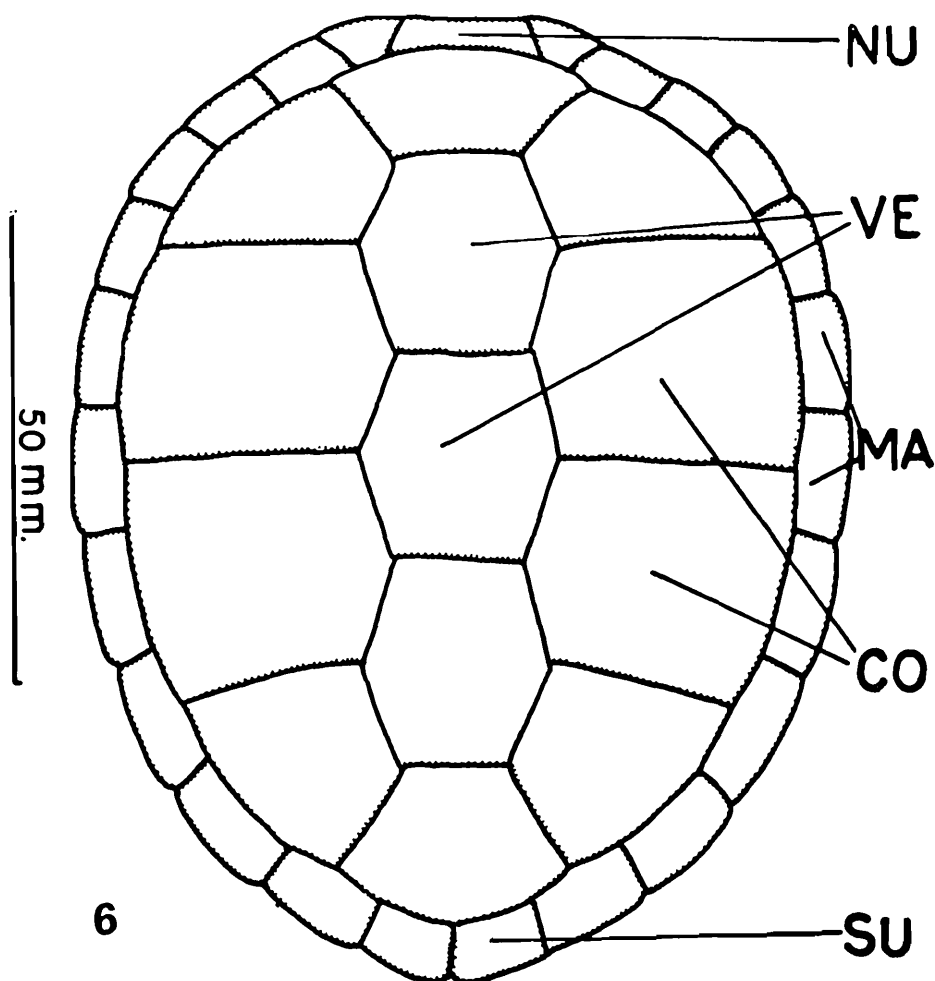
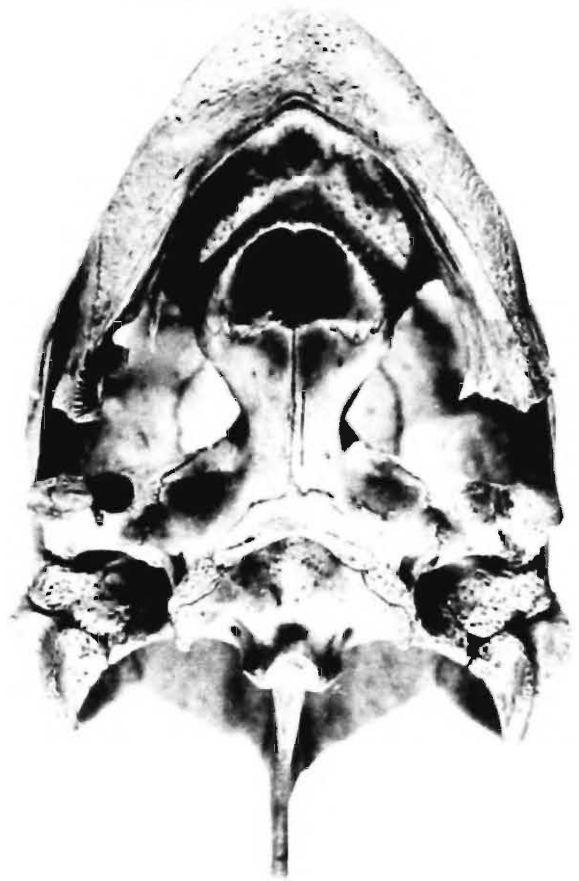
6. Carapace of *Chelonia mydas* (Linnaeus)

PLATE 1



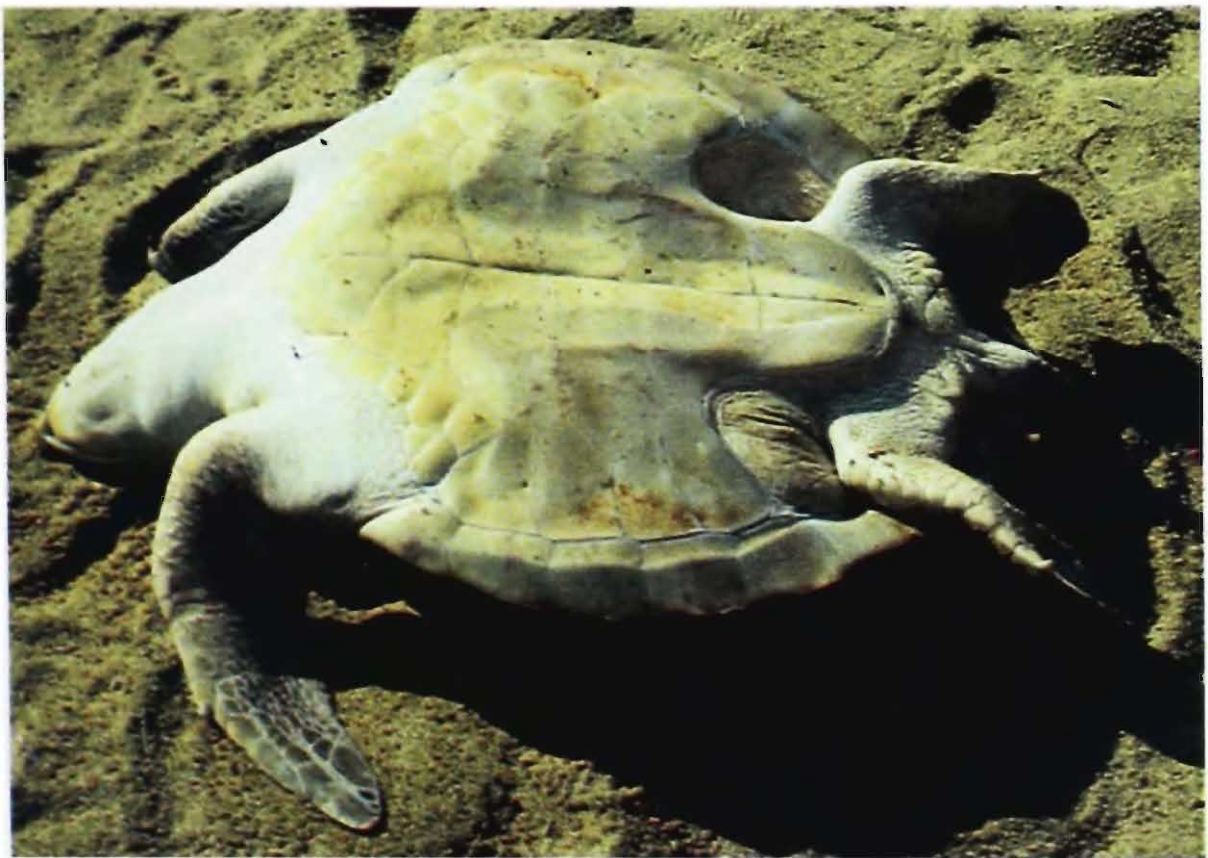
Skull—Family Cheloniidae— Lateral view, Dorsal view, Ventral view.

PI ATF 2



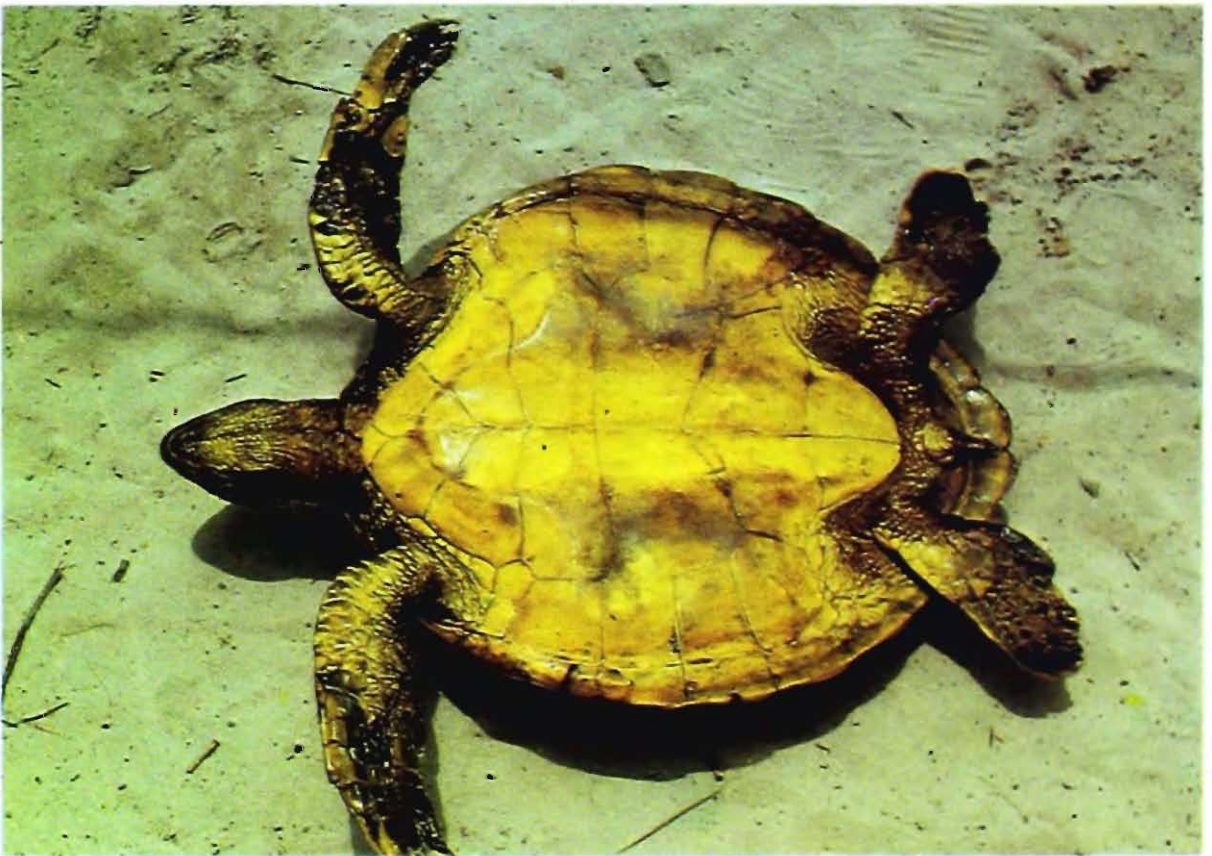
Loggerhead Sea Turtle—*Caretta caretta* (Linnaeus)

PLATE 3



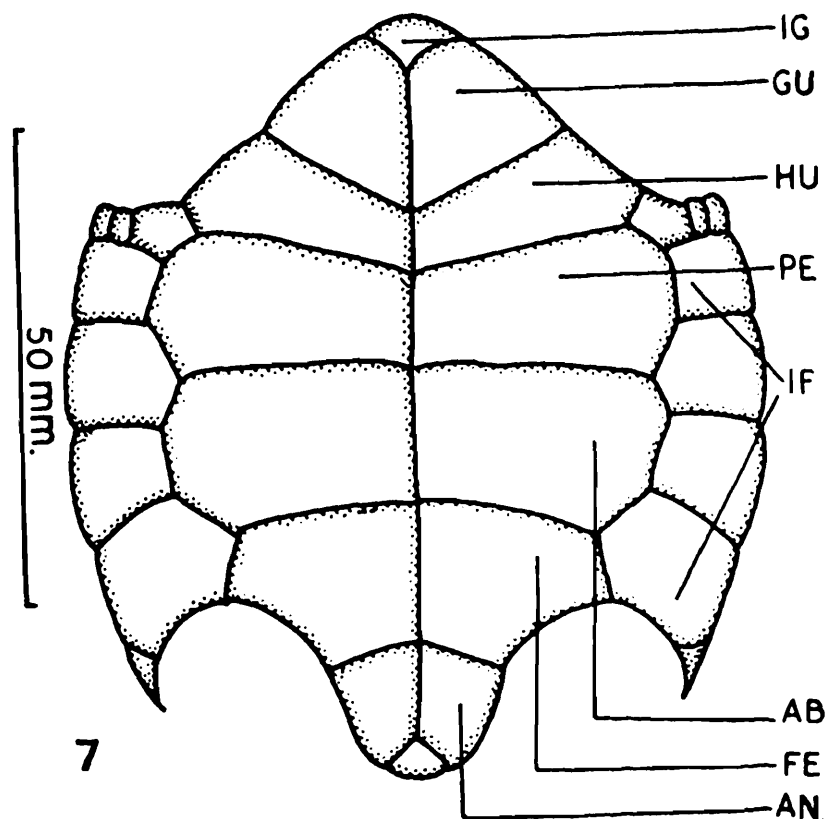
Green Sea Turtle—*Chelonia mydas* (Linnaeus) Dorsal view, Ventral view.

PLATE 4



Hawksbill Sea Turtle—*Eretmochelys imbricata* (Linnaeus) Dorsal view, Ventral view

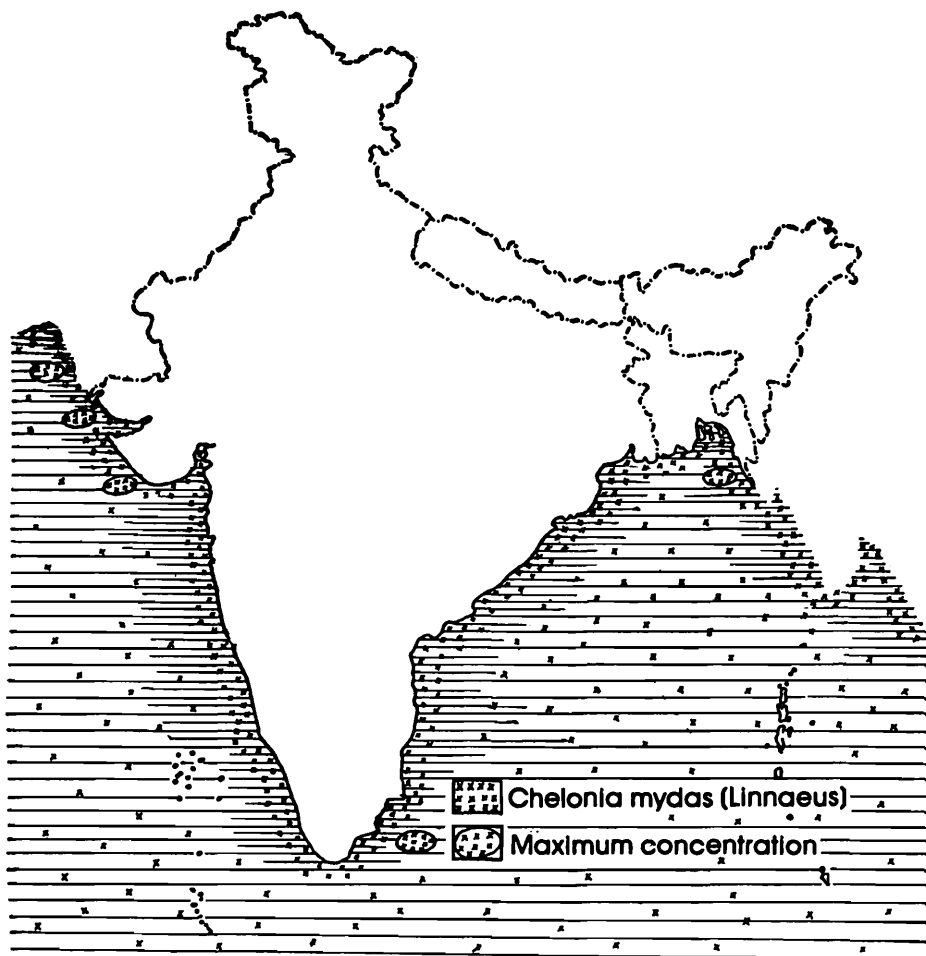
not hooked. The horny sheath of upper jaw is with feeble, and the lower jaw with strong denticulations at the edges; two prominent and strong denticulated ridges are present on the alveolar surface of upper jaw; symphysis of the lower jaw is short and there is one pair of prefrontal shields. Carapace (Fig. 6) is not ossified completely; feebly unicarinate in the young, occasionally with feeble keels on the lateral aspects, arched in fully grown adults and feebly serrated or smooth posteriorly. Dorsal shields are juxtaposed; costal scutes 4 on each side; neural or central scutes 5; marginal shields 25 (including one small precentral or prenuchal and a pair of post-central or supracaudal scutes. The plastron (Fig. 7) consists of paired gular, humeral, pectoral, abdominal, femoral and anal shields; single inter-gular shield and a series of inframarginal shields. Head is covered with symmetrical shields and one pair of prefrontal shields present. Neither the head nor legs can be pulled under the shell. The flippers are long and each is provided with a single claw. Tail is quite short in comparison to the body. The carapace is dark blue-black in the hatchlings, and green, olive, brown, buff or black in adults. Flippers are grey-green; the colour of head and flippers is generally like that of the shell of the individual turtle but the



7. Plastron of *Chelonia mydas* (Linnaeus)

edges of the head scales are pale in most cases. In very old adults the shell becomes brownish. Semiadult turtles are most attractive and are called sunrays because of the beautiful brown and yellow shades on the dorsal shield. Limbs are yellow with a large, dark patch on each hand and foot. Ventrums are yellowish.

Distribution: The Green Sea Turtle is a circumtropical species, nesting mainly in tropical and subtropical zones of the world. According to the IUCN Red Data Book, 150 separate nesting areas are known throughout the world but only 10-15 populations are of significant size where the number of nesting females exceed 2000 individuals per year. These large populations have been reported on Ascension Island, Australia, Costa Rica, Europa and Tromelin Islands (in Mozambique channel), Mexico, Oman, Pakistan, Philippines, Sabah, Sarawak and Surinam. Low to moderate populations of these turtles have been recorded on the coastal areas of American Samoa, Angola, Bahamas, Indian Ocean Territory, Brazil, Burma, Cape Verde Islands, Caroline Islands, Cayman Islands, Colombia, Comoro Islands, Cyprus, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Guadeloupe, Guatemala, Guyana, Haiti, Hawaii, Honduras, Indonesia, Israel, Jamaica, Japan, Kenya, Line Islands (Kiribati), Madagascar, Malaysia, Mozambique, Nicaragua, Panama, Papua New Guinea,



Map showing the Indian range and maximum concentration of *Chelonia mydas* (Linnaeus)

Peru, Phoenix Islands, Reunion and Dependencies, St. Brandon Island, Saudi Arabia, Senegal, Seychelles, Solomon Islands, Somalia, Sri Lanka, Tanzania, Thailand, Tokelau, Turkey, U.S.A., Venezuela and Yemen. In the Mediterranean Green Sea Turtles nest in the Lara areas in west Cyprus, Turkey, Mersin, Adama, Fernike, Yumurtalik, Samandigi and Israel. The species is generally distributed throughout Indian and Indo-Chinese waters. It is estimated that 200 females nest every year in India. Roughly between 3000-5000 Green Sea Turtles are being caught annually from Pamban, Cape Comorin, Rameshwaram and Mimisal coasts of India. Along the Puri coast of Orissa, 40-50 Green Turtles are caught daily. These turtles are also available in the vicinity of Andaman Islands.

Habits and Habitat: The Green Sea Turtle frequents inshore waters, less than 25 metres in depth and sheltered by reefs. Remote islands are the most favoured nesting sites, though mainland beaches are also used. Suitable sandy beaches are used for breeding. The mating season is from May to July. Female turtles usually congregate in large numbers on such beaches mainly between June and November to lay eggs. In the summer moonlight, the huge female turtle heaves itself into the shallows at high tide. Then with strenuous movements of its flippers hauls itself up the shelving beach, sometimes over the rocky areas. Ultimately it reaches the dunes above the high-tide mark and actual egg-laying commences. The pit of the nest is dug with sweeps of the front flippers and is generally more than a metre across and 60 centimetres deep. Then with the help of her hind flippers, the turtle digs an egg pit roughly about 45 centimetres deep and 25 centimetres across. Then egg laying starts during the early part of the night and within 15 minutes the pit is filled with the white eggs (Plate 40) about the size of ping pong balls and roughly with a diameter of 45 mm. The skin of the egg is not fragile but is tough and elastic. Each breeding female of Green Sea Turtle is estimated to lay between 350 and 600 eggs per year. The average clutch size is 110. Each female lays several clutches at an interval of 15 days, but will have a nesting season only after 3 years. The average temperature of the egg pit remains generally between 25°-30°C. The mother turtle finally covers up the egg pit carefully with her hind flippers and fills in the body pit faster with her front flippers. She moves forward 3 or 4 metres on all sides in order to hide the exact site of the egg pit. After the completion of this egg laying process she heads back to the sea, moving much faster downslope than when she went up. The incubation period varies between 40-91 days. Immediately after hatching the young ones dash towards the sea, guided by the brighter horizon. On the way up to the sea and after reaching the water, large hatchlings are killed and devoured by predators like crabs and fish. Nesting takes place all the year around with some strong seasonal peaks at various nest sites in the Indian Ocean and South-east Asia but is strictly seasonal elsewhere in the Caribbean, South Atlantic and Pacific Oceans. The mature females nest on fairly regular cycles of two to four years intervals. In the

wild state Green Sea Turtle becomes sexually mature between 15-20 years of age. Female turtles re-migrate at an interval of 2-4 years. After entering the sea, hatchlings pass 7-14 months at certain unknown places while drifting passively with pelagic algal mats and *Sargassum* grass. After passing this period, which is called as 'lost year', young turtles of 20-30 cm. length, initially migrate to the various inshore estuarine, coastal and reef-system habitats. The species migrates very long distances for food and egg laying. The normal mode of progression both in water and on land involves simultaneous sweeps by the front flippers. The adult Green Sea Turtle is entirely herbivorous and feeds on submerged marine algae, seaweeds and grasses. The distribution of the Green Sea Turtle coincides quite closely with the distribution of sea grass pastures. The sea grasses which are consumed by these turtles are *Thalassia testudinum*, *Halodule* spp., *Syringodium* spp., *Cymodocea*, *Halophila*, *Posidonia* and *Zostera*. Turtles select fresh green growth of the tender leaves of these grasses for feeding. In many areas of the range turtles consume red, green and other algae like *Hypnea* spp., *Caulerpa* spp., *Codium* spp., and *Ulva* spp. Hatchlings are mainly carnivorous and devour molluscs, crustaceans, and fish.

Status: This extremely migratory turtle has become quite endangered and its population has alarmingly dwindled throughout the world. Green Sea Turtle is heavily exploited and there is a large scale international trade for its flesh, cartilage, oil and eggs for food; stuffed adults, hatchlings, very young turtles, hide, skin and shell carvings are used for curios and for making various commercial products. This turtle is an important food source of people inhabiting the sea-shores and islands. Its cartilage is processed to make turtle soup, which is regarded as a delicacy.

While nesting both males and females occupy a narrow zone of 4-8 km. from the shore for the entire breeding season and as such become quite vulnerable. Adult females and their eggs are readily taken by man and other predators during nesting and egg laying. A large number of turtle hatchlings perish due to different pollutants which accumulate in the *Sargassum* weed mats by the local water currents of the sea. These weed lines (as already indicated above) provide the main shelter to the turtle hatchlings for the first year of their life. At this stage these turtles are voracious feeders and devour indiscriminately anything which comes across. As such they also consume accumulated oil particles, styrofoam, tar and numerous such chemical byproducts of the oil industry. The stress on the Green Turtle population can be very well judged by estimation of their egg laying at Sarawak during the last 55 years. In the year 1930 about 2,000,000 eggs were laid but the number gradually declined to 300,000 eggs only in the year 1970. The highest mortality of Green Sea Turtle on account of incidental catch or trapping by shrimp trawls has been recorded from Australia, Colombia, Equador, the Guianas, Malaysia, Peru and Pacific Central America.

Conservation: All over its range the species is partially or totally protected by law. Societies have been set up all over the world to protect this turtle and its nesting grounds. These societies are also engaged in hatching the turtle eggs by artificial incubation, and ultimately releasing the hatchlings to the natural habitat. These turtles enjoy total or partial protection at various nesting beaches which fall within National Parks and National Reserves. Some of these are Costa Rica: Tortuguero beach; Surinam; Galibi Sanctuary; Panama: Chirique Province Reserve; Venezuela: Aves Island; Galapagos Islands; Reunion Dependencies: Nature Reserve of Europa, Tromelin, Les Glorieuses and Jaun de Nova; Aldabra Nature Reserve; Australia: Rookeries in National Park, Queensland, Lady Musgrove, Fairfax, Hoskyn, Heron and Bushy Islands, Cape Range National Park, Bernier, Dorre Islands, Barrow Island and Lacepede Islands Nature Reserves; Indonesia: Sukamade beach (Meru Betiri Wildlife Park) in Java, Nusa Barung Island and Blambangan Wildlife Reserve; Thailand: Ko Kram beaches and Islands of Tarutao Marine National Park and Malaysia: Marine Turtle National Park near Sandacan.

The important Green Turtle hatcheries of the world which handle eggs are at Isla Los Roques, El Salvadore; Sukamade beach and Pangumbahan in Indonesia; Malaysia (Chendor in Pahang State, Dalam Ru and Pulau Perhentian in Kelantan State); Hawksbay in Pakistan; Lara in Cyprus; Ogaswara Islands in Japan; Maruta Bay and Colola in Mexico. Eggs are locally collected, transplanted to the hatcheries and then hatchlings are released at suitable places at definite intervals. The turtle has been listed in Appendix I of the Convention on International Trade in Endangered species of Wild Fauna and Flora (CITES). According to Appendix I listing, any international trade of the species mainly for commercial purposes is strictly prohibited by the law of the particular country in which the said species is found. The turtle populations of France, Italy, Japan and Surinam are not covered by the provisions of this listing.

Legislation should be enforced more strictly all over the world and the states with reservations must be convinced to withdraw them and allow their turtle population to be covered by Appendix I. As the Green Sea Turtle is highly migratory and has got a world wide range, there should be international co-ordination in establishing suitable conservation programmes for the species. The involved nesting beaches, feeding grounds, interesting habitats, migratory routes and hibernating spots must be protected strictly all over the world. All types of trawler operations should be banned within a reasonable distance of the turtle islands and coastal beaches. Restricted fishing zones should be established in areas of high turtle concentrations, particularly off major nesting beaches and top priority should be given to the improvement of the fisheries gear in order to prevent incidental catch of these turtles. As far as possible, turtle eggs should be left to hatch in natural conditions. People should be educated all over the

world in conservation methods to evoke public awareness in order to protect these turtles. It has been established that the sex ratio in marine turtles is controlled by a particular temperature. Any type of artificial or seminatural rearing of these turtles causes fluctuations in the temperature naturally required for incubation and as such disturbs the natural sex ratio of the newly hatched individuals.

Captive breeding: Various attempts for rearing these turtles in captivity have already been made all over the world, but large-scale closed-cycle captive breeding has not yet been found beneficial commercially anywhere. Captive breeding has been tried in Australia, Cayman Island, Indonesia, Malaysia, Mexico, Philippines, Reunion and Seychelles. The farming of sea turtles has been discussed most elaborately at the 1979 conference of the conservation of sea turtles, Washington D.C. The most important conclusions drawn are, that before attempting such a programme detailed studies on the biology and the implementation of economic factors pertaining to all the populations of this species are required.

Genus 3. *Eretmochelys* Fitzinger 1843

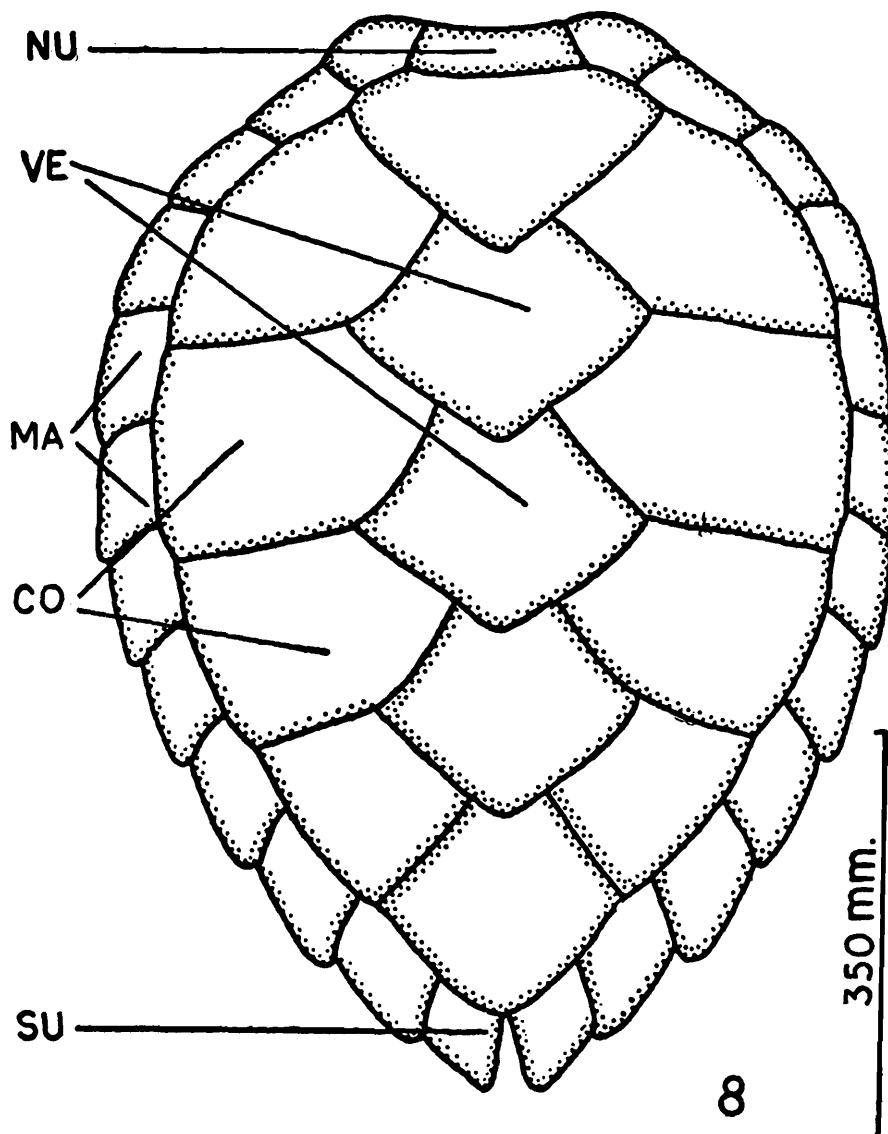
HAWKSBILL SEA TURTLE OR TORTOISE SHELL TURTLE

3. *Eretmochelys imbricata* (Linnaeus 1757)

(Plate 4; figs. 8, 9, 17, 21, 26)

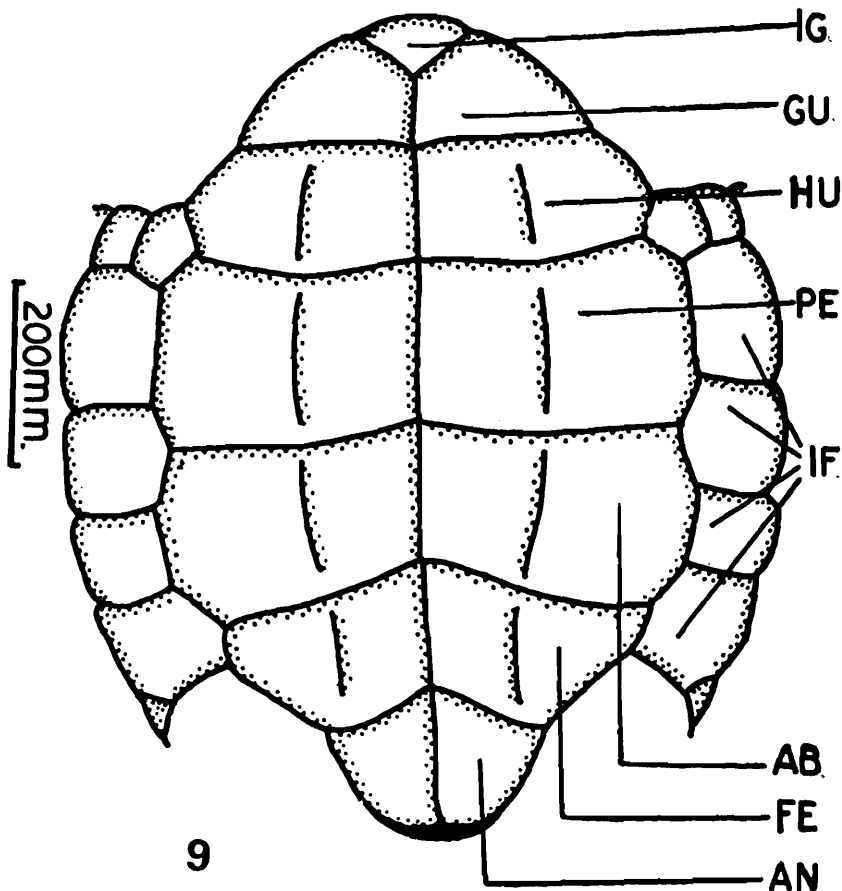
The Hawksbill or Tortoise Shell Turtle is one of the smallest but the most colourful species of the marine turtles. Beautiful yellow mottling on the rich brown background distinguishes this turtle from other sea turtle species. A large fully grown adult may develop a shell generally about a metre in length, but most individuals would be only about 60 to 65 cm. in length. The fully grown adult Hawksbill generally attains a weight between 60-120 kg; the largest record so far is 140 kg. Its head is very narrow, with distinct scales over it, and the snout tapers to a point. Its powerful ridged jaws, which look like a hawk's bill, allow it to break open molluscs, crabs and other hard animals and to pull them out from the crevices of rocks and coral reefs. Premaxilla is deeply excavated and not toothed terminally. Alveolar surface of upper jaw is with a single sharp-crested ridge. Jaws

are strongly hooked. Carapace (Fig. 8) is narrow and strongly serrated behind; in the juvenile it is covered with horny plates, with dark mottling. The general outline of the carapace is cordate and it elongates with the age of the turtle. The scutes on its shell are thicker and strongly overlapping in the young but with increasing of age the edges come to lie side by side. Dorsal scutes are horny, strongly imbricated; in very old individuals they are juxtaposed. Costal scutes are 4 on each side, first costal on each side is not in contact with the nuchal scute; neural or central scutes are 5; marginal shields are 25 (including one narrow precentral and a pair of postcentral or supracaudal scutes). The plastron (Fig. 9) consists of paired gular, humeral, pectoral, abdominal, femoral and anal shields, a single intergular and a series of inframarginal shields. Head is covered with symmetrical shields and with two pairs of prefrontal shields. The flippers are long and each one is provided with two claws. Tail is quite short in comparison to the body. Juveniles are brown above, blackish below. Carapace of the adult is amber coloured or greenish with violet markings or darkbrown to



8. Carapace of *Eretmochelys imbricata* (Linnaeus)

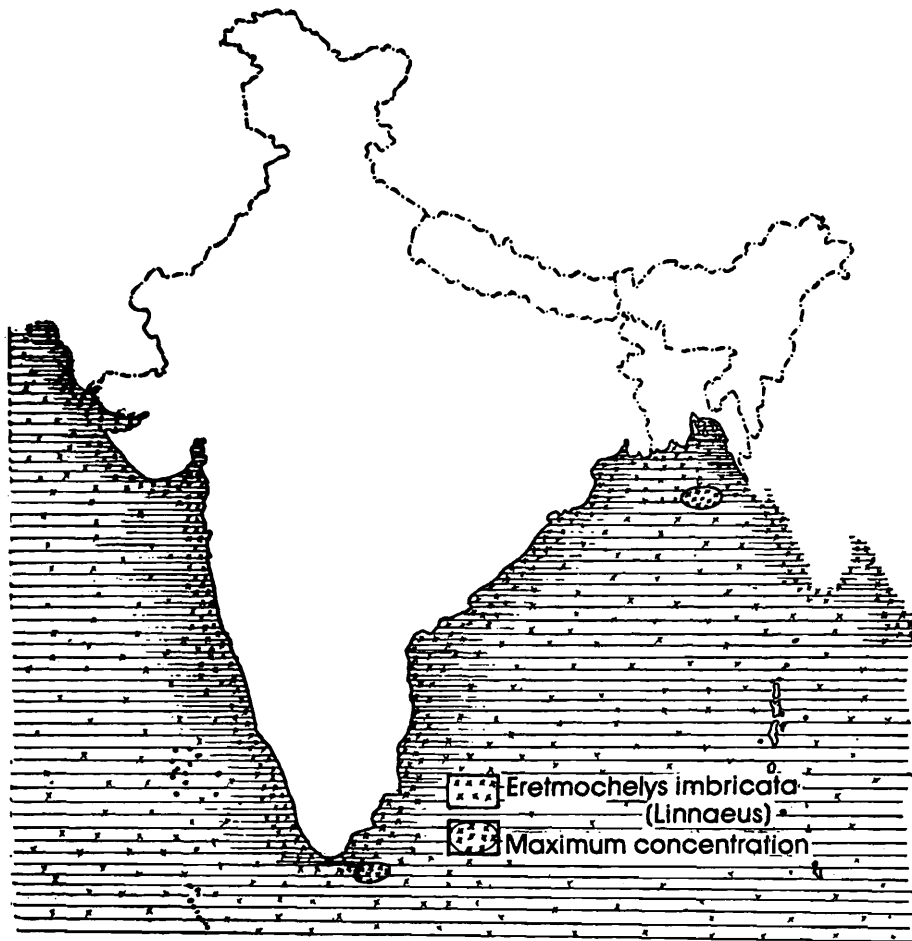
black with yellow mottlings or blotches and in all cases with radiating brown and black streaks on the scutes. The plastron is yellow, orange or reddish brown in colour. Skin of neck is yellow or creamish. Shields of head and limbs are dark brown with yellow borders.



9. Plastron of *Eretmochelys imbricata* (Linnaeus)

Distribution: Hawksbill Turtle is a circumtropical species, nesting mainly on beaches of tropical and subtropical zones of the Pacific, Atlantic and Indian oceans. The species occurs in the Mediterranean Sea also but does not breed there. The species is widespread in tropical waters but its nesting is sporadic and takes place during the night. Its populations all over the range are drastically depleted. Generally not more than 10 females are seen together for egg laying. Such populations, with a number of more than 10 emerging females for nesting on a particular beach, on a particular night have been recorded from Australia, Chagos Archipelago, Iran, Madagascar, Maldives, Martinique, Mozambique, Oman, Palau Islands, Panama, Papua New Guinea, Peoples Democratic Republic of Yemen, Solomon Islands, Sudan and Thailand. Low to moderate density nesting of the Hawksbill turtles still exists in Bahama Islands, Belize, Burma, Caicos

Islands, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Ethiopia, French Polynesia, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Hawaii Islands, Honduras, India, Indonesia, Jamaica, Kenya, Malaysia, Mexico, New Caledonia, Nicaragua, Peru, Philippines, Puerto Rico, Qatar, Reunion, Samoa, Saudi Arabia, Seychelles, Sri Lanka, St. Lucia, St. Vincent, Surinam, Tanzania, Tokelau, Trinidad, Tobago, U. S. A. and Venezuela. The Hawksbill is generally distributed in Indian and



Map showing the Indian range and maximum concentration of *Eretmochelys imbricata* (Linnaeus)

Indo-Chinese waters. In India these turtles are available and make nests on various islands in the Gulf of Kutch, Gulf of Mannar and in the vicinity of Lakshadweep, Andaman and Nicobar Islands.

Habits and habitat: The Hawksbill Turtle frequents shallow coastal waters with rocky coastal embankments and coral reefs with shallow vegetated bottoms as well as bays and lagoons with muddy bottoms lacking widespread submerged vegetation. Male turtles hardly emerge from the water and are seen propelling with their front flippers. The females only emerge from water during the night and come to the beaches for nesting. It is mainly a non-migratory species and covers short distances only in search of food. Records of its long distance migration are scanty. The hind feet are mainly used for steering and for excavation of the nest. The breeding season extends from end of August to end of February with peak

in October to January and is correlated with onset of the northwest monsoon. Age of the sexual maturity is unknown. Nesting takes place generally by night and the female turtle walks about extensively on the sandy bank before selecting a site for the nest. Nesting is aggregated at a few localities and only one or two nests are made there on any fixed night. In this process the Hawksbill Turtle differs markedly from other sea turtles. The nesting process is like that of the Green Sea Turtle. The cavity of the nest pit is like a round bottomed flask and its cavity reaches a depth of 45-50 cm. The mother turtle lays 96-182 eggs per clutch at a depth of 12-20 cm. in the nest pit during the day. The size of the egg clutch varies in different populations and is strongly correlated with mean carapace length. As such the exploitation of the largest laying female is most deleterious to the population. Eggs are round with a diameter of 4 cm. Generally 2-4 clutches are laid in one season, with a re-nesting interval of around 15-19 days. Re-migration takes place after 2-4 year's gap but three year remigration is predominant. Incubation period ranges from 58-64 days. Hatchlings at the time of emergence from egg-shell are 4.00-4.2 cm. long. Annual hatchling productivity per nesting female varies between 77 and 189. Hatchlings emerge at night so are subjected to the predation by nocturnal scavengers like crabs. The strongest predator is the Ghost crab, *Ocypode ceratophthalmus*, which is generally found in abundance in the habitats of these emerging hatchlings. Dogs, pigs and lizards are among the known egg predators. Hawksbill hatchlings those like in other sea turtles, after entering the sea, pass several months drifting along with the *Sargassum* weed mats. In experiments captive hatchlings preferred *Sargassum* grass to all other food offered during the first several weeks. As the turtle hatchlings grow in size their food choice also shifts towards various sea animals in addition to sea weeds. The fully grown adults become entirely omnivorous and a tremendous increase in their appetite has been noticed. Almost any marine animal (which can be captured and overpowered) and plant material is consumed. The food of this turtle thus comprises sponges, ascideans, echinoderms, coelenterates, ectoprocts, bryozoans, gastropod and bivalve molluscs, barnacles, crustaceans, soft corals and fishes. The vegetarian diet includes *Sargassum* and other sea grasses, fruits of mangrove plants and algal material.

Status: The Hawksbill has become extremely endangered and its population has widely depleted in many areas of its range, where it is killed in large numbers for the horny shields or keratin layer of its shell. This layer is much thickened and exhibits a remarkably beautiful yellow-brown translucence, when removed from the shell by heating. Keratin layer thus obtained is used for adornment and for making fashionable toilet articles and furniture. The cost of tortoiseshell ranges between Rs. 1100-2000 per kg. in the international market. Such a large profit tempts and instigates the turtle poachers to search even the most remote areas. During the last 15 years the international trade in tortoiseshell has increased enor-

mously and Indonesia alone exported about 320,000 kg. of unfinished raw shell in the year 1978 alone. The latest estimates indicate that at least 50,000 Hawksbill turtles are killed in Indonesia annually for this purpose. The main countries which are involved in the export of these turtles and their products are Indonesia, Philippines, Thailand, India, Fiji, Malaysia and Singapore. The major importers are countries like Japan, Taiwan, Hongkong, Italy and West Germany. The increasing tourist trade has also added devastating effects on the various populations of this sea turtle. The hatchlings and very young specimens are used as curios and there is a heavy demand for the polished shells for decorating purpose. The countries involved in tourist trade are Philippines, Indonesia, Thailand, the Maldives, the Seychelles, Madagascar, Caribbean countries, Hawaii, Sri Lanka, India, Malaysia and Singapore. In some places like Indonesia, Caribbean, Papua, New Guinea, these turtles and their eggs are frequently consumed. The flesh of this turtle sometimes becomes poisonous, since many invertebrates like sponges, consumed by it, are strongly toxic. Thus, sometimes its flesh, if consumed, causes sickness and even death in human beings.

Conservation: It is generally protected by legislation in various countries like Ascension Island, Australia, Indian Ocean Territory, Costa Rica, Cuba, Fiji, French Guiana, India, Israel, Mexico, Puerto Rico, Sabah, Sarawak, Seychelles, South Africa, Sri Lanka, Surinam, Tahiti, Thailand, Tonga, U. S. Pacific Trust Territory, Venezuela and many Caribbean countries.

During the last few years many hatcheries have been established in Malaysia to incubate Hawksbill eggs. The most important Hawksbill nesting beaches are on the Arnavon Islands (in Soloman group of Islands) which are strictly protected by law. The species is listed on Appendix I of CITES. France and Japan have kept their Hawksbill populations aside and these are not governed by the convention laid down by the CITES. For the survival and recovery of the existing populations of this turtle the only effective way will be to put a total ban on the international trading of this species in any form.

Captive breeding: Has not been attempted anywhere in the world so far.

Genus 4. *Lepidochelys* Fitzinger 1843

OLIVE RIDLEY TURTLE

4. *Lepidochelys olivacea* (Eschscholtz 1829)

(Plate 5; figs. 10, 11, 16, 20, 25)

The Olive Ridley is a small, broad and flattened marine turtle, whose carapace-length varies between 56.5 and 75 cm. A fully grown female at the time of breeding ranges from 40 to 55 kg. in weight. Its head is large and triangular in shape and individual bones do not become completely fused until late in life. Its maxillae are separated by the vomer. The orbits are distinctly large. The Carapace (Fig. 10) in adult is arched and devoid of keels, margin is slightly serrated on the posterior aspect. Shields of the carapace are juxtaposed and exhibit variations, in different populations.

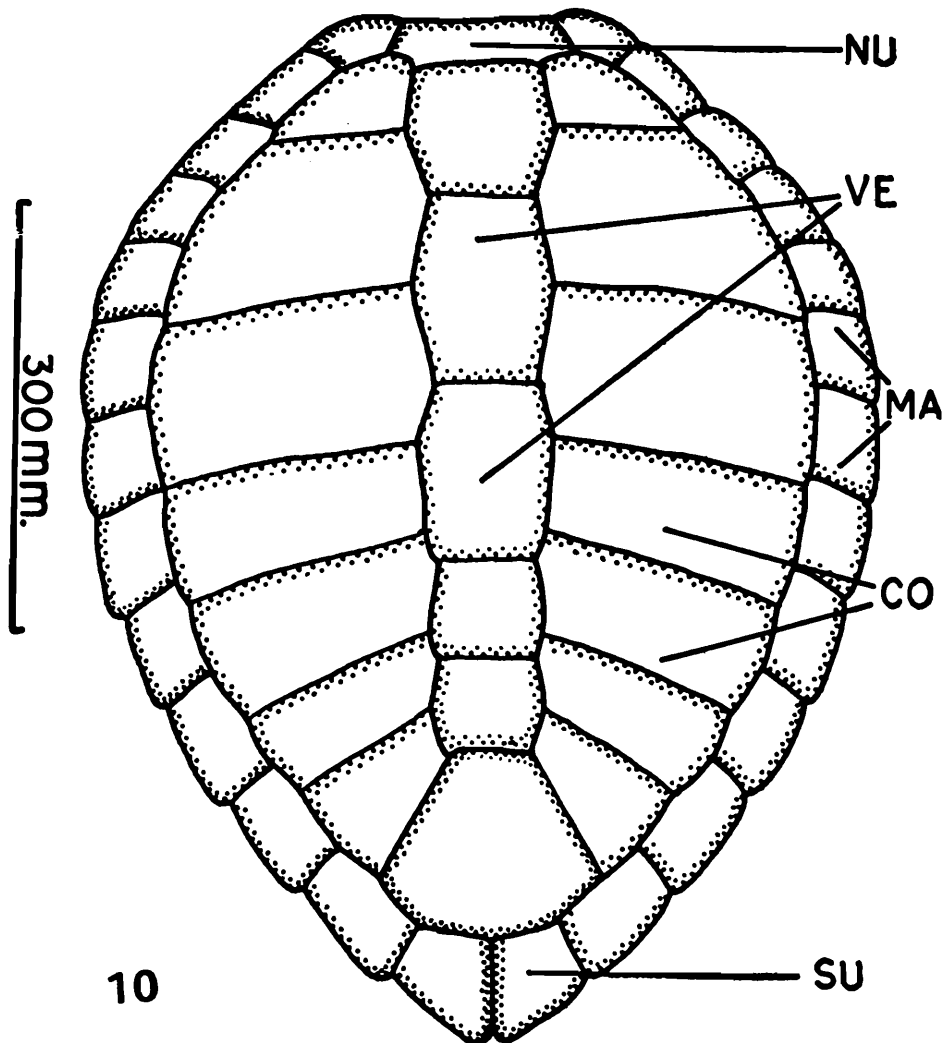
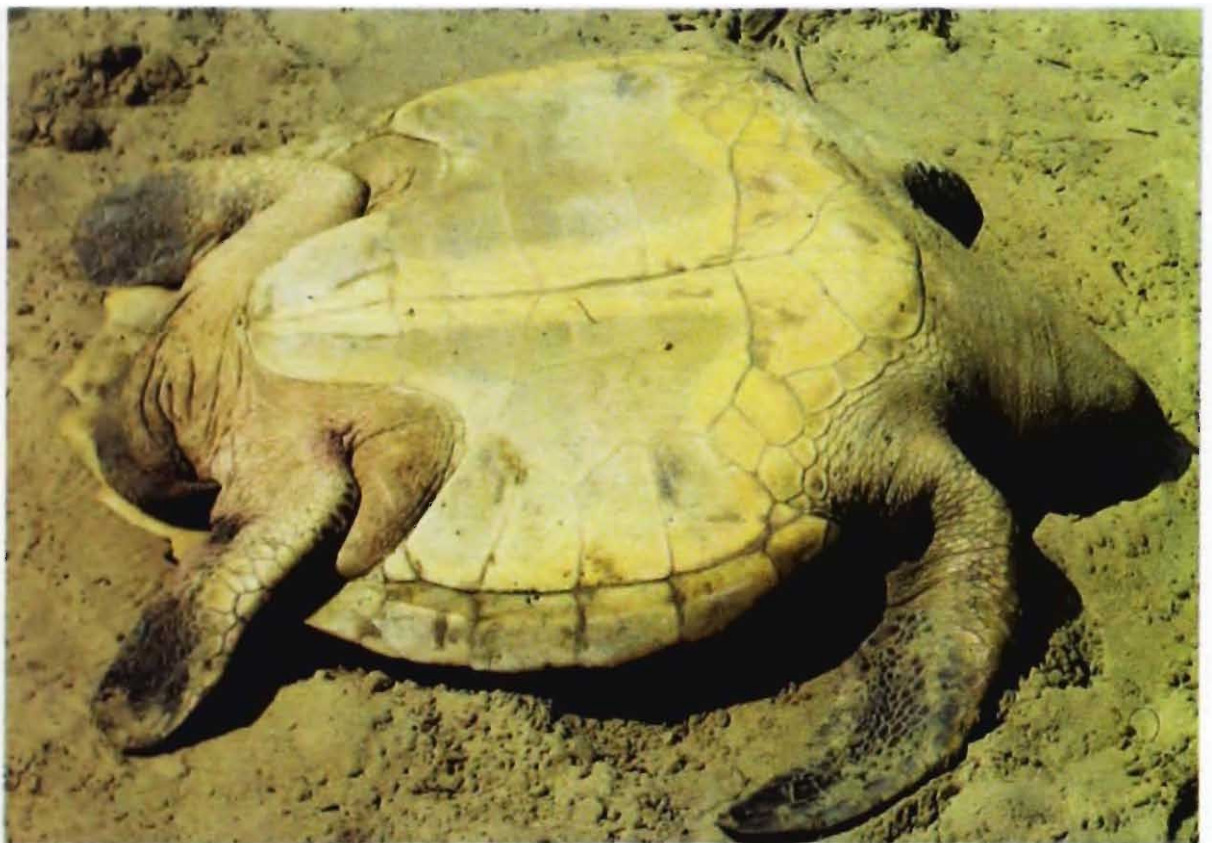
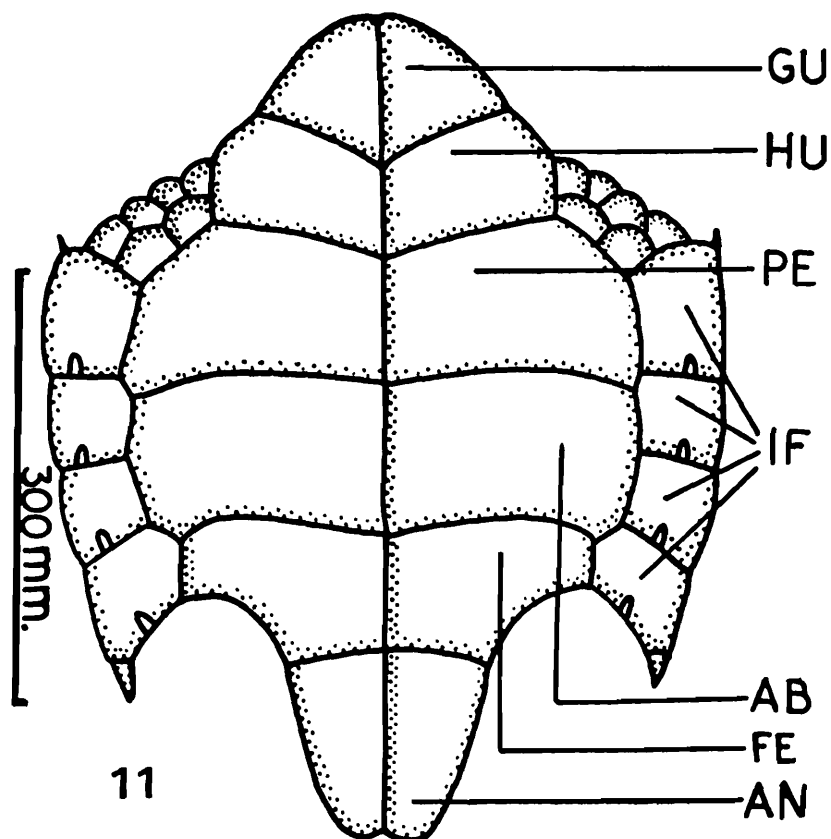
10. Carapace of *Lepidochelys olivacea* (Eschscholtz)

PLATE 5



Olive Ridley Sea Turtle—*Lepidochelys olivacea* (Eschscholtz) Dorsal view, Ventral view.

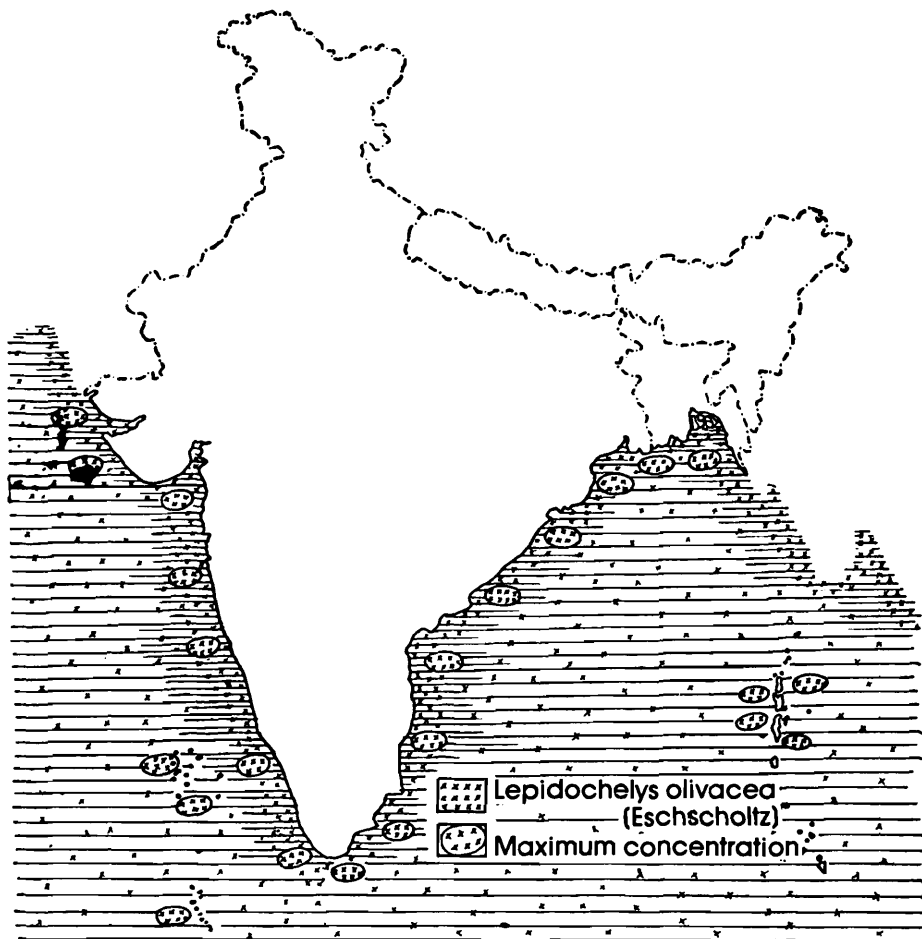


11. Plastron of *Lepidochelys olivacea* (Eschscholtz)

The costal scutes are 5-9 (generally 6 or 7) on each side; neural or central scutes are 8-9; marginal shields are 27-29 (including 1 precentral or nuchal and a pair of postcentral or supracaudal scutes), and the mid marginals are much wider. The plastron (Fig. 11) consists of paired gular, humeral, pectoral, abdominal, femoral and anal shields; intergular is variable, may be single, double or even absent; 4 pairs of inframarginals are on the bridge, each inframarginal is provided with pores on the hinder margin. Head is covered with symmetrical shields; two pairs of prefrontals are present. Three dorsal keels are present in small young turtles which become inconspicuous in adults. Single claw is present on each flipper. Tail is quite short in comparison to the body. Dorsal colouration is grey to olive-grey or olive-green, carapace is generally olive-grey. The top of the head is grey-brown, the shields yellow-white, the plastron creamy-yellow and the edges of the flippers light yellow-brown.

Distribution: Olive Ridley Turtle is a circumglobal species and is widely distributed in the tropical waters of the Pacific, Indian and Atlantic Oceans. Its nesting takes place mainly on mainland beaches all over the world; there is little nesting on the islands of the Indian Ocean and southeast Asia. No nestling records of the species are available from the Caribbean countries, Hawaii and islands of Oceania. At certain places in the world wherever the population densities of these turtles are still sufficiently high,

their females emerge to nest in very large numbers (in synchronised concentrations), sometimes up to 150,000 turtles. This phenomenon of mass emergences of the female Ridley turtles for nesting on the beaches in synchronised aggregations is popularly termed as 'arribada' (arrival) in Spanish. On account of the heavy commercial exploitation of these turtles throughout the world, such 'arribada' now occur only at two beaches of Orissa in India;



Map showing the Indian range and maximum concentration of *Lepidochelys olivacea* (Eschscholtz)

at two beaches in east Pacific Costa Rica; several parts of Pacific Mexico; Panama; Surinam and Sri Lanka. Though severely depleted throughout its range, low to moderate populations are still available in countries like Angola, Australia, Burma, El Salvador, French Guiana, Guatemala, Honduras, Indonesia, Madagascar, Malaysia, Mozambique, Nicaragua, Oman, Pakistan, Papua New Guinea, Senegal, Tanzania and Thailand. Major nesting sites of Olive Ridley in India and around are Gorai, Kihim, Manori and Versova in Maharashtra; south of Madras and Point Calimere in Tamil Nadu; Gahirmatha Beach in Orissa, middle Andaman and Rutland in Andaman Islands, and Nicobar Islands. The minor nesting takes place on the coasts of Goa, Kerala, Andhra Pradesh, Gulf of Kutch, Gulf of Mannar and Lakshadweep Islands. Very large scale nesting in India is restricted to Orissa coast where at least 300,000 female Olive Ridelies nest every year on a 35 km. beach at Gahirmatha

(within Bhitarkanika Wildlife Sanctuary) and a 3-4 km. mass nesting site about 100 km. south of Gahirmatha beach between Nadiakhia muhana and Akasia muhana.

Habits and habitat: The Olive Ridley Turtle is capable of foraging at great depth (up to 150 metres or more) in tropical neritic waters and undertake long journeys in search of suitable feeding grounds. They swim over considerable distances offshore and float calmly over deep sea waters, waiting for certain crustaceans which emerge to the surface of water only during the night. The Ridelys become sexually mature at the age from 8-10 years. In India (Orissa) small numbers of females emerge almost throughout the year but the large synchronized aggregations (*arribada*) involving 100,000 females, occurs in February-March. In Costa Rica major *arribada* occur during September-October and involve up to 150,000 females. The general breeding season all over the world is between September-March.

Nesting takes place mainly at night and the interval between *arribadas* during the peak season ranges from 14-48 days at Costa Rica. The construction of the nest is usually completed within an hour and the process is exactly like that of the Green Sea Turtle or other sea turtles. Egg-laying continues for 15-20 minutes in the relatively shallow nest cavity. Nest is refilled and covered after the egg-laying is over. Female roughs up the surface of the nesting site by compacting the soil by thumping with the shell. The clutch size ranges between 74-126 at Costa Rica, to 37-166 at Surinam and 90-140 at India and Sri Lanka. Eggs are round with a mean diameter of 37.5-40.5 mm. The incubation takes 49 to 62 days. Generally females nest two to three times during a season, at intervals depending on *arribadas*. Remigration of the females to the nests takes after one or two years. Hatch rate of eggs and survival of hatchlings is extremely low on account of the predators like Ghost crabs, flies, fungi, bacteria, hawks, vultures, caracaras, opossums, raccoons, coyotes, sharks, pumas, jaguars and human beings. Its food consists of crustaceans like crabs and shrimps, molluscs, jelly fish, tunicates, all small invertebrates, small fish and their eggs, larger planktons and marine algae.

Status: The Olive Ridley Turtle has become endangered on account of its commercial exploitation by man for flesh, skin, leather and eggs. The skin of the neck, shoulders and limbs of this turtle is utilized for the hide trade and the maximum consumption of this turtle skin takes place in Japan and various European countries (mainly Italy). Estimates show that various companies in Mexico, Equador and Pakistan (Baluchistan), trading in the turtle leather and flipper skin for luxury goods have slaughtered more than 464,000 fully grown adults since 1977. After a resolution was passed in the New Delhi CITES convention, now the commercial exploitation of the Olive Ridelys is absolutely prohibited since July 1981. In spite of the ban, human predation on the species for egg and flesh still

exists on a large scale in the various nesting sites in India, Sri Lanka, Mexico and Costa Rica. About 100,000 eggs and 500 adults from Gahirmatha (Orissa) alone were sold in the Calcutta market for human consumption in the year 1982. The predation on eggs and poaching for adult turtles is in the extreme in Mexico and Costa Rica. The major threat is through heavy incidental catch by shrimp trawlers. The most drastic of such shrimp fishery operations have taken place in the Live Ridley populations of Surinam, French Guiana, Venezuela, India (West Bengal, Orissa and Andhra Pradesh), southeast Africa and Mexico.

Conservation: This turtle is generally protected by law throughout its range but the enforcement is not rigid anywhere. In Costa Rica, Mexico, Central America and India predation on eggs and poaching on adults is increasing each season and eggs in very large numbers are removed even in the presence of guards. According to the latest legislation a strict ban has been imposed on all the trading of these turtles and the industrialized fisheries protection programmes of the nest beaches and the incubation of oviducal eggs have already been started. Effective conservation programmes for these turtles have already been implemented in Guatemala, Honduras, Nicaragua, Costa Rica, Panama, Ecuador, Surinam, Angola, Mozambique, Pakistan (Hawkes Bay and Sandspit beaches), India, Sri Lanka and Malaysia. The species has been listed on Appendix I of the CITES. Japan is the only country which has entered a reservation on Appendix I listing of Olive Ridley Turtle. Still there is time when a serious thought can be given for the protection of this turtle and laws for the protection should be adequately and most rigidly enforced. All the major nesting beaches of Olive Ridley Turtles should be declared as National reserves and there should be a total ban on leather trade and Japan must be asked to withdraw its reservation on Appendix I of CITES listing and should give up the temptation of earning profit by importing Olive Ridley leather and other products. There should be an international coordination in the formulation of conservation and management programmes and detailed investigations on the biology of this species should be carried out. Restricted fishing zones, National Parks Reserves, protected beaches and suitable hatching grounds should be established. Detailed study on the biology of hatchlings immediately after hatching is needed in all the possible details. Top-most priority should be given to the development of fishing equipment for preventing incidental catch of these turtles in trawl nets.

In India, the Central Marine Fisheries Research Institute (CMFRI) has proposed a crash programme on the conservation and effective management of sea turtles including the Olive Ridleys. The investigations will include: 1. Surveying and demarcating nesting grounds of marine turtles along the Indian Coast and the Bay Islands; 2. Monitoring incidental catch of turtles in fishing operations and finding ways and means of mini-

mising the same; 3. Developing hatchery and hatchling release programme; 4. Carrying out tagging of turtles to understand their population structure, migratory habits, growth, longevity and mortality rates; 5. Investigating biological aspects and behaviour of turtles and 6. Strengthening the Marine Living Resources Data Centre (NMLRDC) for acquisition and dissemination of data on marine turtles from our Exclusive Economic Zone (EEZ).

Captive breeding: Three hatchlings from a natural nest are reported to have been maintained in captivity at Madras Snake Park Trust for two years. No other information on captive breeding is available.

Family II. DERMOCHELYIDAE, Siebenrock 1909

The family comprises a single species of largest marine turtle whose dorsal bony shell is composed of numerous small polygonal plates of different size which do not articulate with the vertebral column and ribs. The largest of these plates compose seven absolutely regular longitudinal ridges, separated from one another by grooves. These ridges converge posteriorly and correspond to the dorsal keels of the living turtle. Posteriorly the bony shell forms a pointed supracaudal portion, and laterally it terminates into an irregular margin just external to the outermost dorsal keel. The ventral portion of the shell is devoid of such plates but is formed by five longitudinal incomplete rows of minute bony structures which are deeply embedded in the body tissues and correspond in position with the five ventral keels of the young. The complete body of the turtle is covered with a galvanised rubber-like skin. Nuchal scute is represented by a flat, butterfly-shaped bony plate which rests upon the last cervical vertebra. Plastron comprises an annulus of 8 delicate bones namely the epiplastron, hyoplastron and xiphiplastra. The entoplastron is not present in this family. Roofing (Plate 6) of the temporal region is complete. The neck is short and slightly retractile. The limbs are paddle-shaped, clawless and feet are scaleless. The digits of the fore-limb are much elongated and the phalanges are devoid of condyles. In the hatchlings vestiges of one or two claws may be present or absent. Nothing is known about the ancestry of this unique family with a single but quite distinct species of marine turtle.

Genus 5. *Dermochelys* Blainville 1816

LEATHERBACK SEA TURTLE

5. *Dermochelys coriacea* (Linnaeus 1766)

(Plate 7; figs. 12, 13, 22, 27)

The Leatherback Sea Turtle or Luth is the largest and heaviest of all living turtles and tortoises of the world. Its body shape is somewhat triangular in shape resembling the ancient musical instrument 'lute', as such its name as Luth comes after lute only. Its carapace-length varies between 140-200 cm. Its average weight is about 400 kg. and the maximum

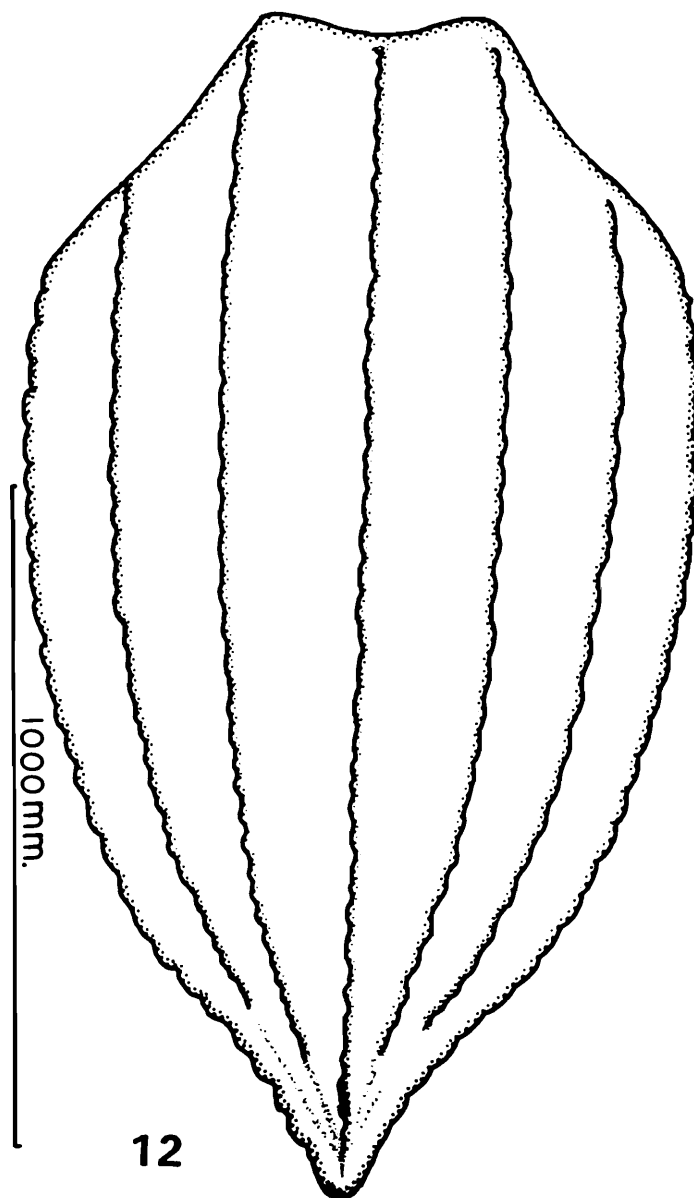
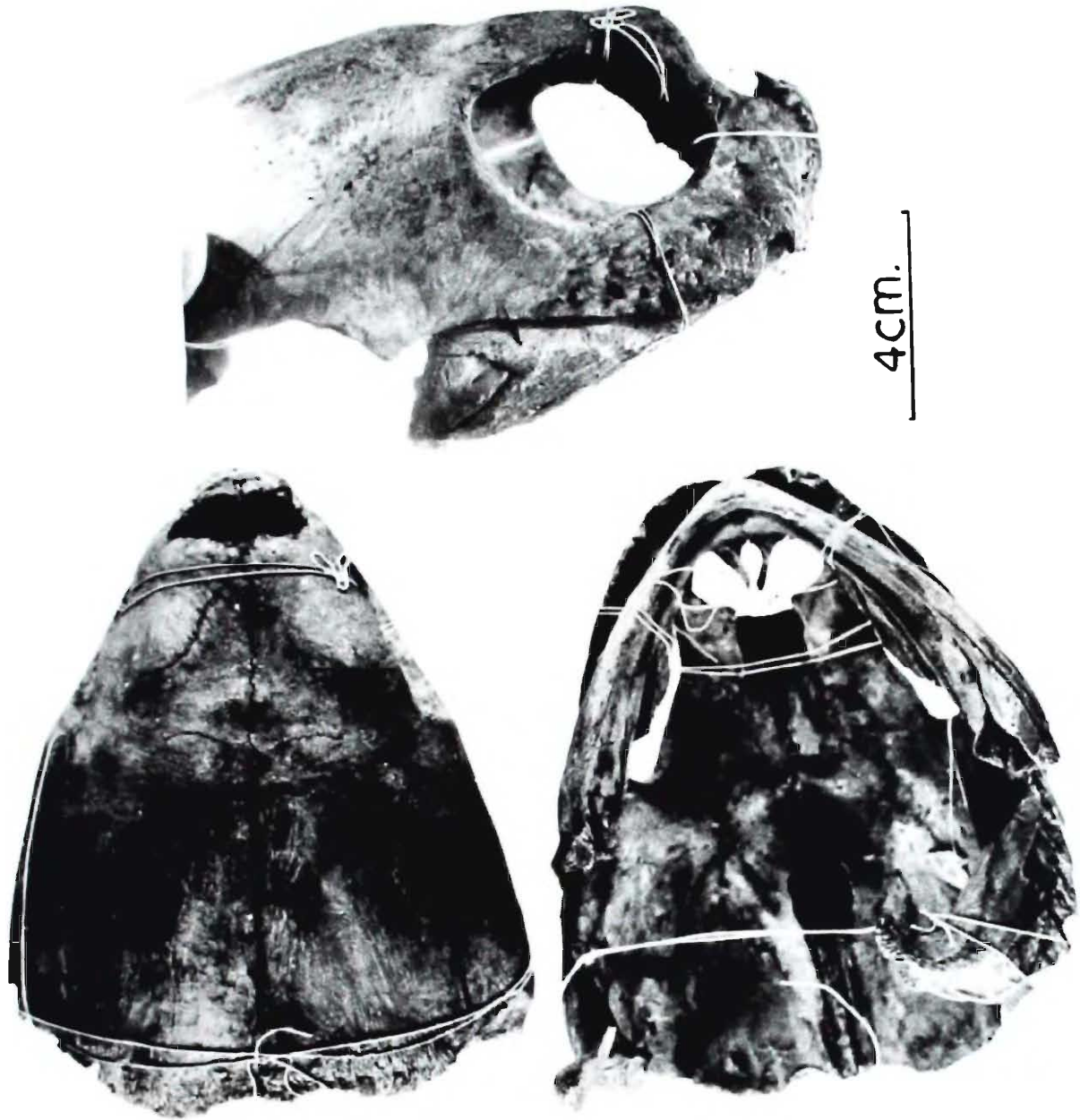
12. Carapace of *Dermochelys coriacea* (Linnaeus)

PLATE 6



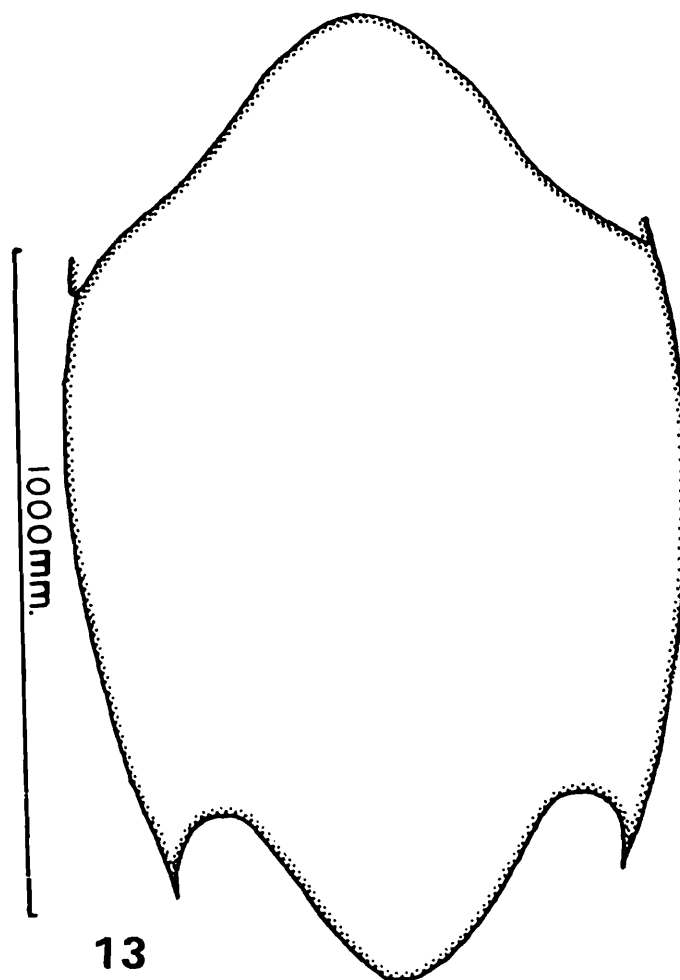
Skull—Family Dermochelyidae— Lateral view, Dorsal view, Ventral view.

PLATE 7



Leatherback Sea Turtle—*Dermochelys coriacea* (Linnaeus), lateral view.

recorded is 725 kg. The hatchlings and very young individuals have scales and their complete body and limbs are covered with small, irregular, polygonal shields which are largest upon the carapace and plastron. The top and sides of head in the young have symmetrical plates. The scaly and shielded pattern disappears as growth takes place and in the fully grown up adult they are replaced by smooth skin. The flesh and skin of the Leatherback are extremely oily and the species is devoid of all cornified epidermal structures. In the adult, the carapace (Fig. 12) is smooth-skinned and rubber-like and is made up of 7 strong, nodular longitudinal ridges which provide it considerable rigidity. There is no sharp angle between the carapace and the plastron (Fig. 13). In young 7 dorsal and 5 ventral

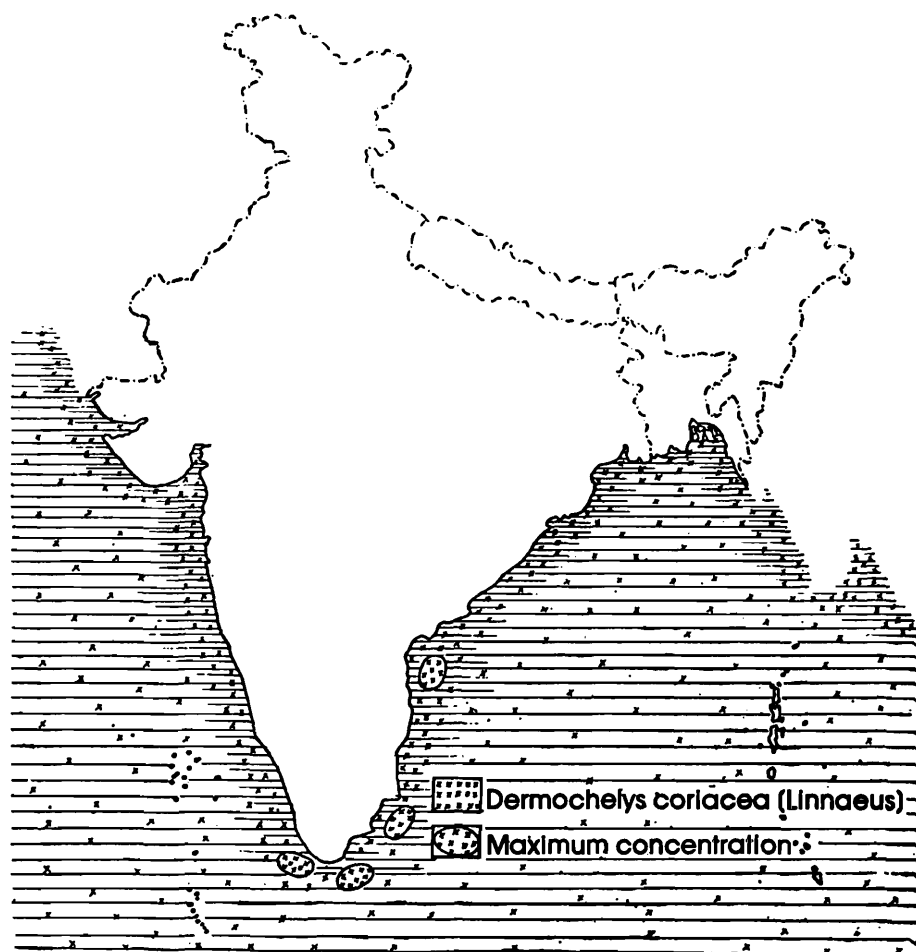


13. Plastron of *Dermochelys coriacea* (Linnaeus)

keels are available. The 5 ventral keels of the young become obliterated in the adult, as such the ventral plastral surface becomes absolutely smooth, but the 7 dorsal keels of the young are replaced by 7 strong ridges in the adult. The jaws of Leatherback are devoid of flattened horny plates or

alveolar surface but their margins are with sharp edges. The lower jaw bears a median hook and the upper jaw a pair of strong cusps flanked by 3 deep notches. Its head is large and the neck is massive. The limbs are paddle-shaped and clawless. Its front flippers are triangular, extremely long, enlarged and powerful, their span in a 2 metre long turtle is roughly up to 2.8 metres when fully extended. The hind flippers are broad and are connected to the tail by folds of thick skin. Tail is quite short in comparison to the body. The carapace is slaty black with white spots; ventral colouration is variable and is generally a mixture of pink, white and black. Sometimes the spots have a pink or bluish tinge. In mature females, the crown of the head has a pink spot. The tail is black.

Distribution: The Leatherback Turtle is a circumglobal species and its nesting takes place on the beaches of tropical seas of the Atlantic, Pacific and Indian Oceans. Occasionally it migrates to subtropical and Mediterranean water also. Most of the breeding and nesting spots are situated between 30°N. and 20°S. It migrates considerable distances in the warmer and tropical waters for feeding. Rarely this animal explores the very cool waters of Iceland, Norway and Alaska. The southern range of its migra-



Map showing the Indian range and maximum concentration of *Dermochelys coriacea* (Linnaeus)

tion extends up to Uruguay and New Zealand. Its largest nesting populations have been recorded from the Pacific Mexico at Michoacan, Guerrero and Oaxaca; Playa Naranjo beach of Costa Rica; French Guiana; Surinam; Trengganu in Malaysia and Kepala Burung area of Irian-Jaya in Indonesia.

This turtle prefers nesting on the mainland beaches instead of islands and its low to moderate breeding populations (in addition to those stated above) are available in Angola, Australia, Burma, Colombia, Dominican Republic, India, Mozambique, Puerto Islands, Solomon Islands, South Africa, Sri Lanka, Thailand, Tobago, U.S.A. and U.S. Virgin Islands. In India its nesting has been reported from Quilon on the Kerala Coast, Goa and certain parts of the east coast. Moderate aggregations of nesting Leatherbacks occur every year on certain isolated beaches of the Andaman, Nicobar and Lakshadweep Islands. The populations of emerging Leatherbacks are said to be highest on Great Nicobar and Little Andaman Islands.

Habits and habitat: The Leatherback Turtle is virtually a pelagic species depending on land simply for nesting. The large, bulky, thick-skinned, oil-saturated body with a low surface helps the creature in maintaining sufficient temperature while foraging in cool waters of certain temperate zones. It is a powerful swimmer with a strong instinct for migration and prefers to stay in the open seas. The longitudinal ridges and grooves on the carapace and streamlined, boat-shaped body also provides extraordinary capacity to this turtle in maintaining high-speed swimming. This is a most secretive animal and rarely can be seen away from its nesting areas. The nesting season varies from place to place, it is between March and July on all the nesting beaches on North Atlantic and ranges from October to February in the countries of the East Pacific. It breeds three or four times a year but the peak period is during May and June. The nesting takes place at night and the nesting female ascends on the sandy beaches after emerging from the water. Its massive egg-loaded body is heaved quickly, on the sandy beach with the help of powerful and simultaneous movements of the front flippers. The general nesting process is like that of the other marine turtles. The female turtle scoops a shallow nest-pit 60-100 cm. deep, by making vigorous movements by using all the four limbs and tail. It enlarges the nest cavity by excavating the nest soil and throwing it back by making powerful, steady alternating thrusts of the hind limbs. The female remains most undisturbed at the time of egg deposition. After egg laying the nest cavity is refilled and surrounding area is compacted by the use of hind flippers and the body weight. The sand is disturbed all over the vast area surrounding the nesting spot by the vigorous backward strokes of the fore flippers. After hiding the nest spot the much lightened and agile female returns back to the sea. An individual may nest as nine times in a season at intervals of about 10 days. Re-migration takes place after an interval of 2 or 3 years. A normal clutch includes

80-85 eggs but the mean number of fertile eggs ranges from 66-104. Several clutches are laid during a year. Eggs are white, generally spherical with a diameter of 53 mm. The incubation period ranges from 56-70 days and successful hatching varies from 63-76 per cent. The hatchlings are 55-63 mm. in length. The predators of eggs and hatchlings of this turtle comprise Ghost crabs, pigs, monitor lizards, birds, small mammals and sharks. Adults are devoured by sharks. The main food of this large turtle comprises various species of jellyfish like *Cyanea capillata*, *Rhizostoma cuvieri*, *Rhizostoma pulma*, Cabbage head jellyfish *Stomolophus meleagris*, *Catostylus mosaicus* and the Portuguese Man of War *Physalia utriculus*, tunicates like *Salpa*, *Pyrosoma*, and ascidians. This turtle lives almost entirely on jellyfish—a peculiar diet for a large animal as jellyfish contains more than 96 per cent water. When fish, molluscs, shrimps and other marine animals are found in its stomach, it is because they were first eaten by the jellyfish.

Status: The species has become endangered on account of excessive consumption of eggs and adults for food. Adults are also used for oil and as a shark-bait. Incidental catch in shrimp trawls and squid nets, and habitat disturbance are other major factors for population decline. No international trade in Leatherback parts or derivatives has been reported from anywhere. The flesh of this turtle is considered not very suitable for human consumption in major parts of its range but still the exploitation for its meat as food, for shark bait and for its oil for caulking boats is at a alarming level in certain countries like Trinidad, Papua New Guinea, Indonesia, Soloman Islands, Lark Island, Virgin Islands, Grenadines and Panama. The maximum exploitation of this turtle for eggs takes place in Mexico, Trengganu, India, Sri Lanka, Thailand, Dominican Republic and Trinidad. In various countries of its range Leatherback populations have been threatened on account of habitat destruction or disturbance for urbanisation on or near the nesting beaches. The populations also decline on account of tourist trade, in accidents with ship propellers and in becoming entangled in lobster-pot lines. Considerable mortality of nesting females have been reported by the turtles becoming entangled in masses of dead mangrove roots found along many beaches.

Conservation: The species is generally protected by legislation in various countries like Australia, Costa Rica, Dominican Republic, French Guiana, Indonesia, Malaysia, Mexico, Mozambique, South Africa, Sri Lanka, Surinam and U.S.A. The operation of driftnets, which entrap turtles is prohibited along various nesting beaches during the nesting season. The species is listed on Appendix I of CITES and also as Endangered under the 1973 U.S. Endangered Species Act. For the survival of the species and for preventing decline in its existing populations the most effective way will be to put a total ban on its exploitation for any purpose. All the laws for protection must be enforced

with strict rigidity. The people who are engaged in the trade of this turtle for eggs and meat should be provided with alternative jobs for their survival. In the effective areas of exploitation general public awareness for the conservation of this species must be evoked. Certain beaches where large scale nesting of this turtle takes place must be fenced off. Restricted fishing zones should be established in areas of high Leatherback concentrations.

Captive breeding: This is absolutely a free living pelagic marine turtle and dislikes any unnatural habitat like a holding tank for captive breeding. Hatchlings do not survive in captivity for more than few months. Efforts for captive breeding are being made in U.S.A. and Japan but nowhere it seems to be a success so far.

Family III. EMYDIDAE Gray 1825

This family comprises the largest number of living freshwater and terrestrial Tortoises or Terrapins, whose neck is completely retractile within the shell. The shell is covered with the epidermal scutes; carapace is oval, arched or flattened; nuchal shield is devoid of properly developed costiform process. Plastron is composed of nine bones and is in contact with the marginal shields of carapace. Hinder aspect of ear chamber is not completely closed and as such stapes is exposed; temporal region is not roofed over; a bony temporal arch may be present or absent. Digits are usually webbed; toes usually elongated, median digits with three phalanges; metacarpals elongate; claws are four or five. Top of the head is covered anteriorly with smooth undivided skin, on the posterior portion of the top of head the skin is divided into many moderate to large shields. Eggs are oval or elongate. Axillary and inguinal scent-glands are present. The family has got a world wide distribution except Australia and Papuasias and is represented by 31 genera and 142 species. This work which is exclusively on Indian species comprises 7 genera and 13 species.

*Key to the Genera of the family EMYDIDAE***I. Vertebral shields short-sided anteriorly**

A. Axillary and inguinal buttresses well developed and extend almost up to vertebral shields; alveolar surface of jaws broad with one or two median ridges.

a. Fourth vertebral shield small as long as broad, smaller than third vertebral shield; fore limbs with 4 claws only **Batagur**

b. Fourth vertebral shield moderate not longer than broad, not longer than third vertebral shield; fore limbs with 5 claws **Hardella**

c. Fourth vertebral shield elongate, large, much longer than third vertebral shield; fore limbs with 5 claws **Kachuga**

B. Axillary and inguinal buttresses short, do not extend even half way along the costal plates.

Alveolar surface of jaws broad or narrow, without a median ridge **Geoclemys**

II. Vertebral shields short-sided posteriorly

A. Plastron united to carapace by a ligamentous tissue and is provided with a distinct hinge, not closing the shell completely, provided with a short but distinct bridge, its front lobe is feebly movable

Cyclemys

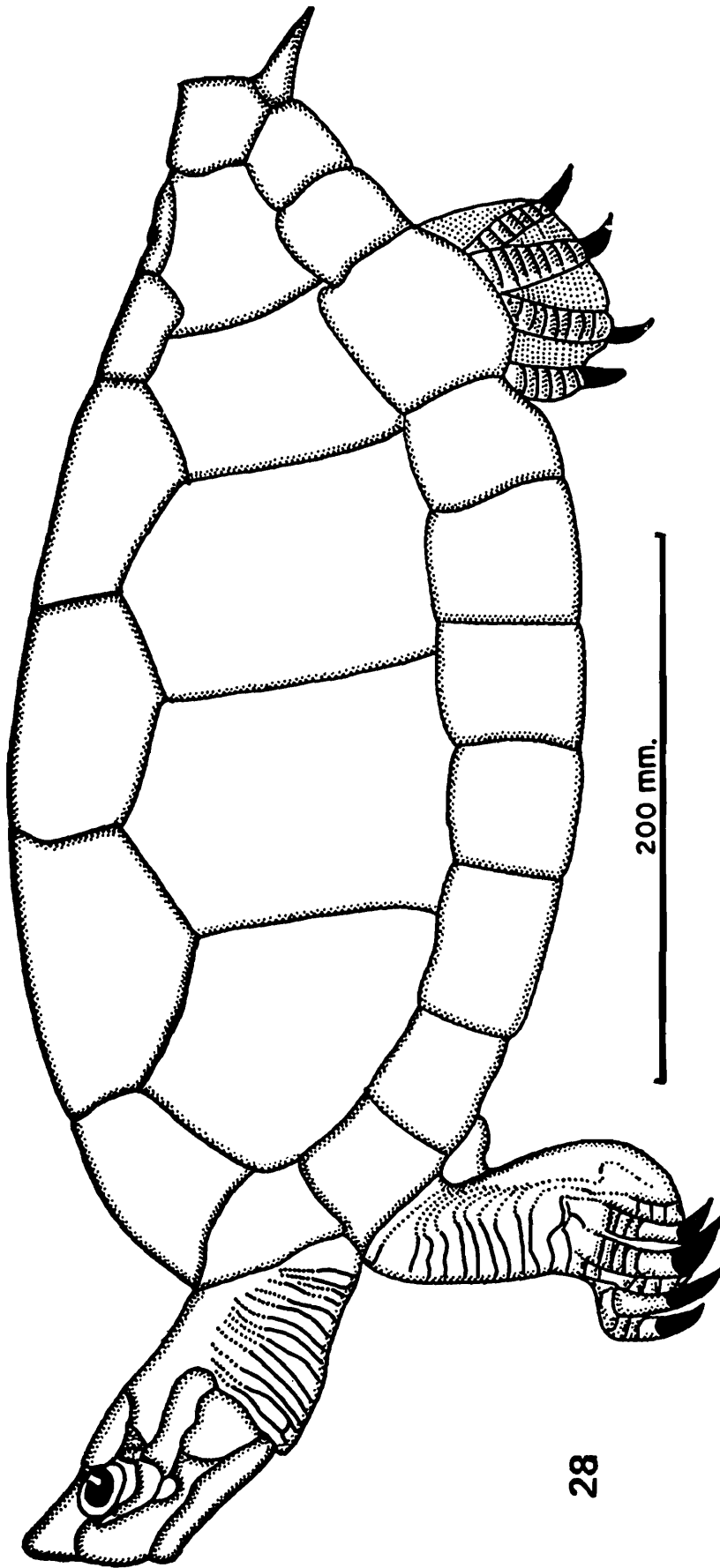
B. Plastron united to carapace by a suture

a. Bony temporal arch and squamosal bone not present; upper jaw hooked; skin of hinder part of head divided into moderately large shields; hind limbs club shaped; fingers one third webbed

Heosemys

b. Bony temporal arch and squamosal bone present; upper jaw feebly notched at the middle; skin of hinder part of head divided into very large shields; hind limbs flattened; fingers half webbed; more than half webbed or fully webbed

Melanochelys



28. Entire sideview of *Batagur baska* (Gray)

Genus 6. *Batagur* Gray 1855

BATAGUR RIVER TERRAPIN

6. *Batagur baska* (Gray 1831)

(Plates 8-9 ; figs. 28, 29, 30)

The *Batagur* is a moderately large, web-footed, aquatic species of terrapin, reaching a length of 61 cm. Adults weigh up to 18 kg. when fully mature. The head is comparatively small with an upturned, pointed and strongly projecting snout. The skin of the posterior portion of head is divided into small shields. The skull (Plate 8) is characterised by having a bony temporal arch, quadrato-jugal in contact with the jugal and post-orbital, bony choanae on level with the posterior part of the orbits, alveolar surface of jaws very broad with two strong, denticulate ridges placed in the middle of both the upper and lower jaws. Upper jaw is provided with a notch at the middle. The carapace (Fig. 29) is smooth, shining, sub-truncated anteriorly, rounded posteriorly, heavy and moderately depressed. In the young an interrupted keel is present, which reduces gradually as growth takes place and ultimately disappears in the fully mature adult. The nuchal shield is subquadrangular, quite broader than long in posterior aspect. Vertebral shields are 5 in number, the second and the third are subequal,

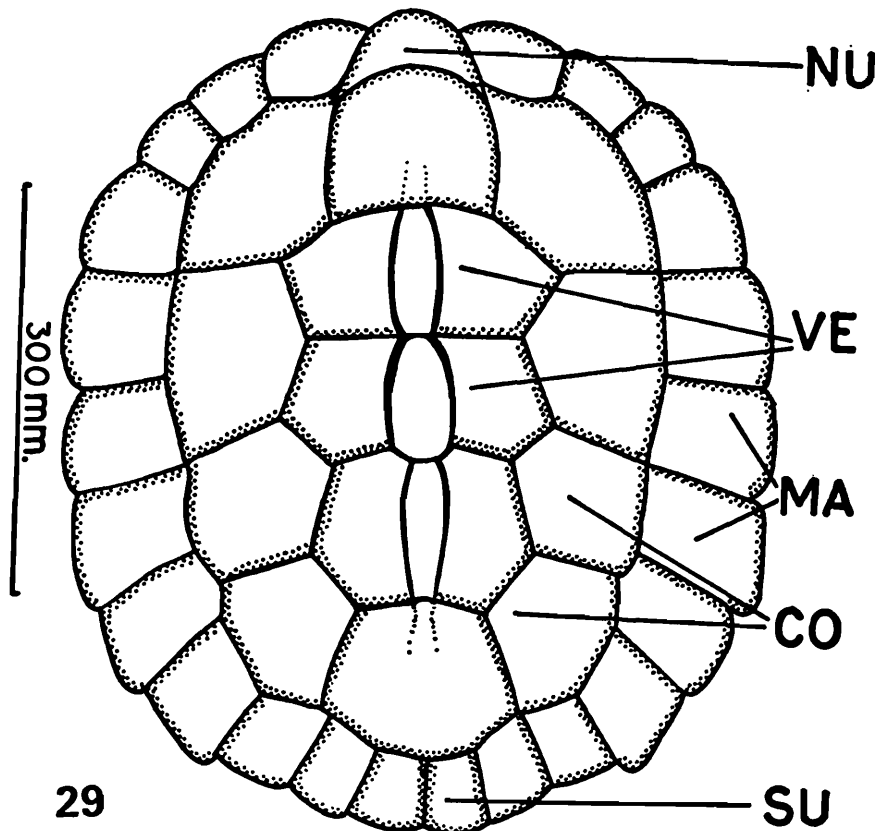
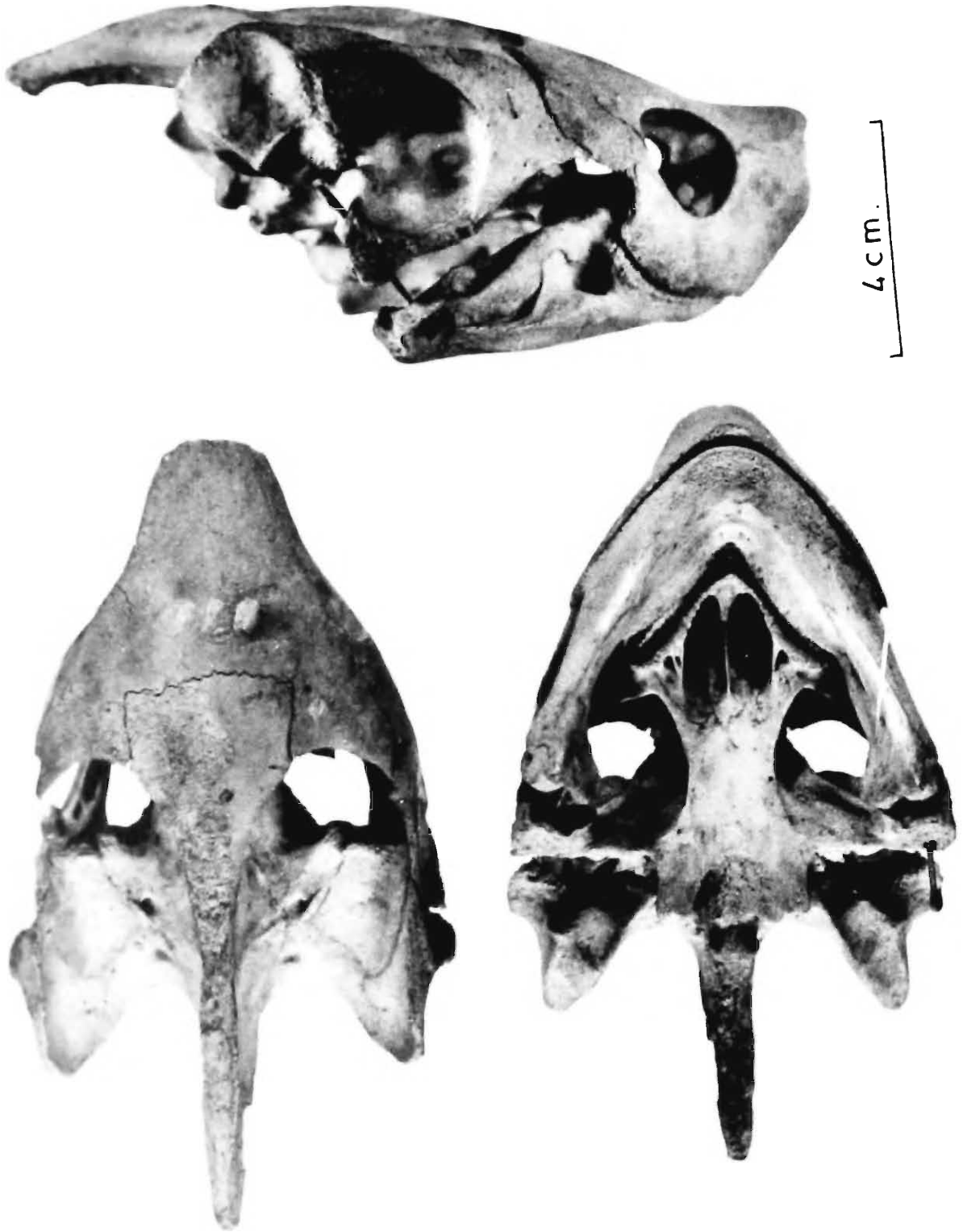
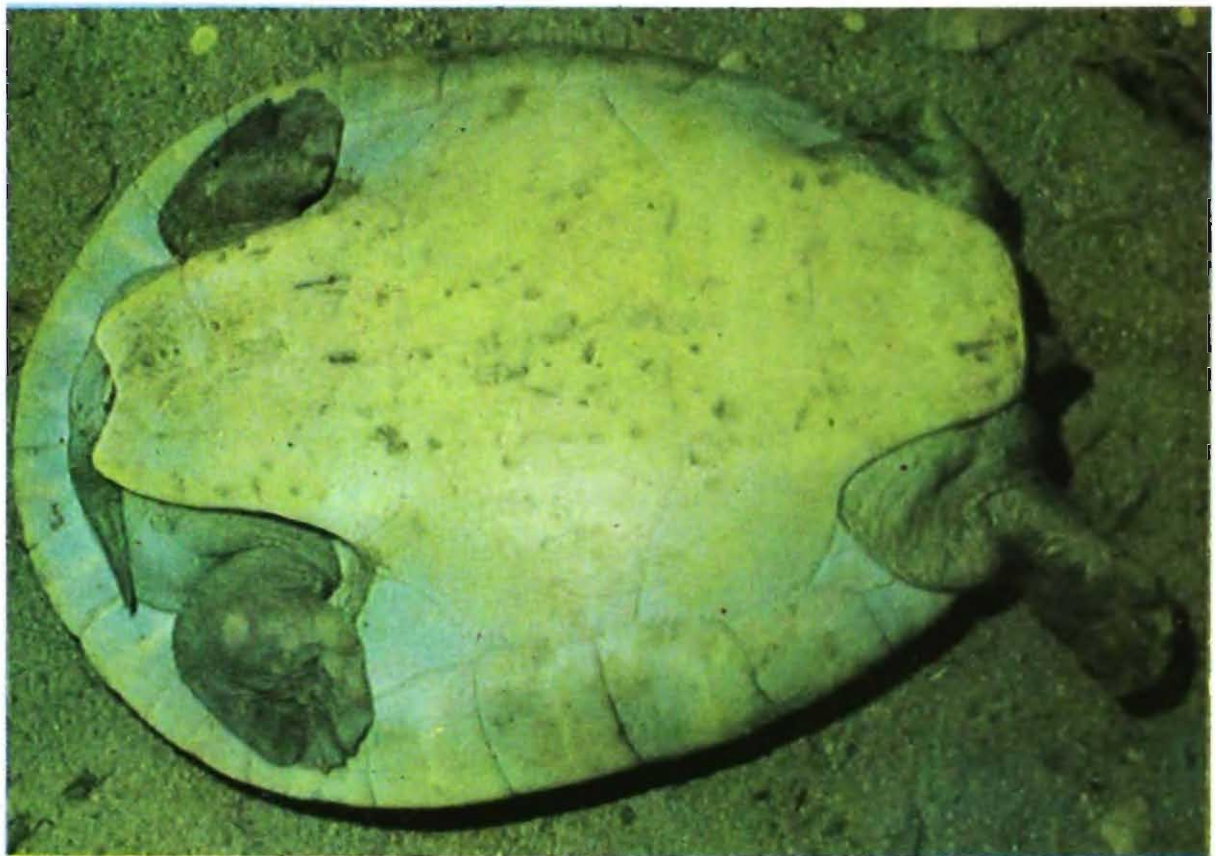
29. Carapace of *Batagur baska* (Gray)

PLATE 8

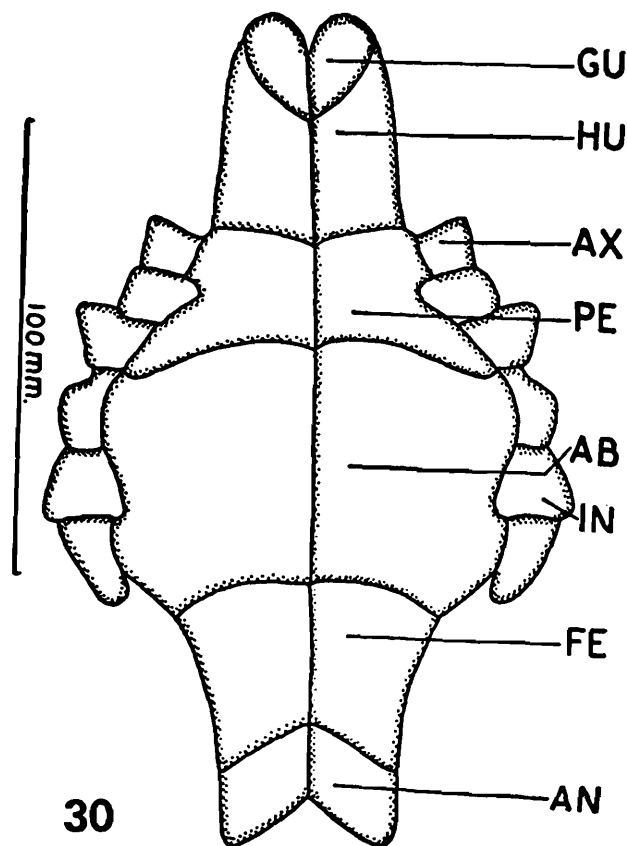


Skull—Family Emydidae— Lateral view, Dorsal view, Ventral view.

PLATE 9



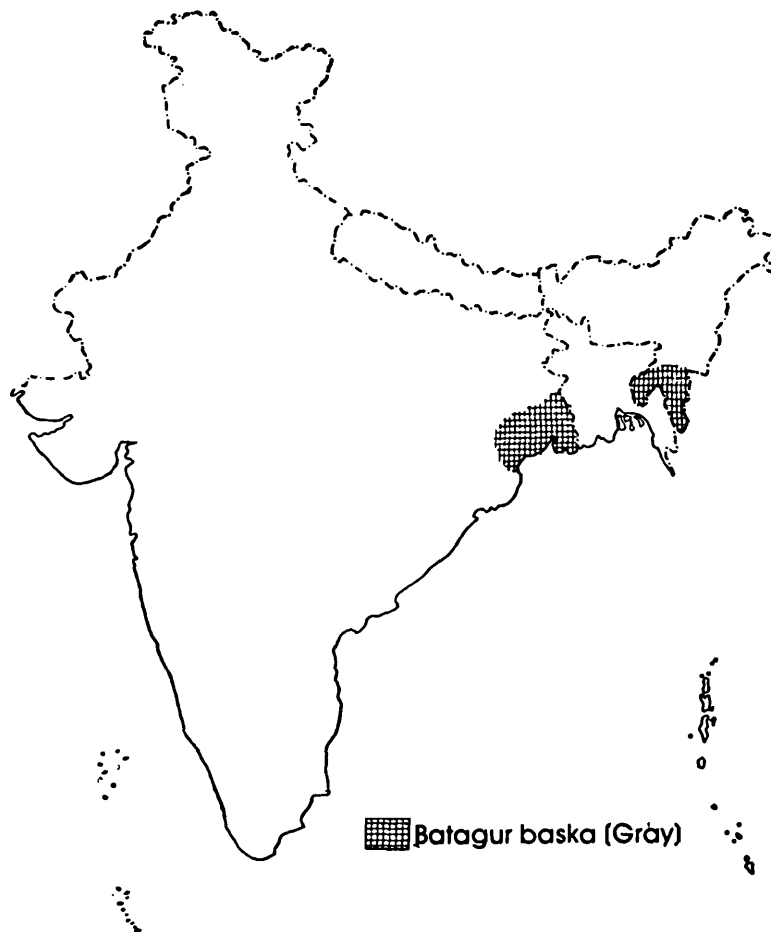
Batagur River Terrapin—*Batagur baska* (Gray)—Dorsal view, Ventral view



30. Plastron of *Batagur baska* (Gray)

fourth is smaller. Vertebrae are much broader than long in young individuals but in adult they are almost as broad as long and a little narrower than the costal shields in adults. Costal shields are 4 on each side. Marginal shields are generally 25, rarely 26 (including one nuchal and a pair of supracaudal shields). The plastron consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. The plastron (Fig. 30) is much smaller than the shell opening, laterally angulated in the young and rounded in the adult, truncated anteriorly and notched posteriorly. The inguinal shield of the plastron is larger than the axillary. The width of the bridge of plastron is more than the length of the hind lobe; the longest median suture is between the abdominal shields and the shortest between the gular shields. Limbs are with narrow transversely enlarged scales, digits fully webbed and are provided with four claws. Tail is extremely short in comparison with the body. Its shell is uniformly brown, olive brown or greenish; the head and the under surface of the neck are brown. In the breeding season, the male assumes a brilliant colouration, the nostrils becoming pale blue, iris from yellow-cream to white, the head deep black, and the neck and the front limbs deep crimson to black. The hind part of the *Batagur* remains dull reddish purple and eyes greenish yellow throughout its life.

Distribution: This terrapin is available in Sumatra, West Malaysia, Thailand, Bangladesh, Burma and the Sunderbans of India. Records are also available from Kampuchia, and Vietnam. Prehistoric remains of this turtle indicate that it was widely distributed in the Ganga river system up to twelfth century A.D. Fragments of this species have also been recorded from the Mohanjodaro and Harappa sites.



Map showing the distribution of *Batagur baska* (Gray) in India.

Habits and habitat: The Batagur is found in fresh, brackish or even salt waters. It occurs in freshwater lakes, canals or other water bodies. But its most favourite habitat is the shallow, muddy, tidal regions at the wide river mouths, lined with mangrove or other vegetation. It has been observed that many individuals at Trengganu (Malaysia) come above most tidal influence. At this place the river is quite shallow with sandy gravel bottom, less than 450 feet wide and banks are sandy with sparse or no vegetation. It is an omnivorous terrapin but generally prefers a vegetarian diet consisting of stems, leaves and fruits of river-side plants. It also feeds on molluscs, crustaceans and fish. Mating takes place between September and November. During this period the males assume brilliant breeding colours as stated above. The Batagur prefers to nest in a colony on large sandy banks with slopes and also on river islands. Large number of females sometimes upto 500 individuals or more, emerge every year on the sandy river banks from January to March for nesting and egg-laying. Nesting

females are site-specific and observe a definite period for egg deposition every year and at that time they are extremely sensitive to any disturbance. The female digs a body pit for the nest by employing the four limbs, then a 15-30 cm. deep egg-chamber is excavated within it. About 50-60 oblong eggs (measuring up to 70 mm. in length) are deposited in the egg-chamber in three clutches (generally 10-30 eggs in each clutch). The interval of egg-laying varies from 15 to 20 days. The incubation period under natural conditions ranges between 80 and 100 days. Then the nesting spot and its surrounding area is covered with sand by the mother terrapin and this takes a long time, almost twice as long as digging and egg laying. The process of sand compacting by the female is most interesting and is accomplished by the repeated raising and dropping of its body on the ground. This phenomenon of sand compacting by large number of terrapins on a beach creates a drumming sound, which can be heard from a considerable distance and is called as 'tuntong' (means drumming) in Malaysia. As the females return to the water they throw sand backwards over the nesting sites and sometimes also dig false nest pits to confuse the predators. Adult Batagur is predated upon by man, sharks and the saltwater crocodile *Crocodylus porosus*. Eggs and hatchlings are devoured by otters, dogs, monitor lizards, fishes and crocodiles.

Status: The species is endangered over much of its range, on account of large scale exploitation for its eggs and flesh for food. Batagur was over-exploited in Bengal in the mid-nineteenth century and its fat was much used for the manufacture of soap in Calcutta. It is occasionally sold in Bangladesh at Bagerhat and Chalna Bazar, close to the Sunderbans. In Malaysia most adults for sale are caught accidentally by fishermen and are consumed by Chinese and native people. Eggs are considered as delicacy and even cost more than the marine turtle eggs. The habitat destruction is also a most important factor for the decline of this terrapin in Malaysia, Thailand and India. The various factors which are responsible for the habitat destruction of this species are mining, removal of riverside sand, clearing of riverside vegetation and exposing the banks to erosion, construction of dams and barrages, urbanisation along the banks and increase in the steamer traffic in the rivers.

Conservation: It is generally protected by legislation throughout its range. During the last 35 years many hatcheries have been established in Malaysia to incubate Batagur eggs. The hatchlings are raised and kept in separate concrete pools according to different age groups for one to seven years. Hatchlings and juveniles of different age groups are released in the river from time to time. It is estimated that about 10,000 hatchlings have been released in Perak river since 1969. The success of such hatching programmes cannot be fully confirmed until artificially hatched females are themselves shown to nest successfully. The species has been listed in Appendix I of the CITES. Further protection by law for the species and

its habitat in all aspects must be provided to all the existing populations throughout the range. Conservation and proper management will help in providing a valuable protein-rich food for numerous people within the range of this terrapin.

Captive breeding: Forty-eight *Batagurs* have been raised from eggs hatched in 1968 at Batu Gajah, Perak, but significant results on breeding are not available as yet.

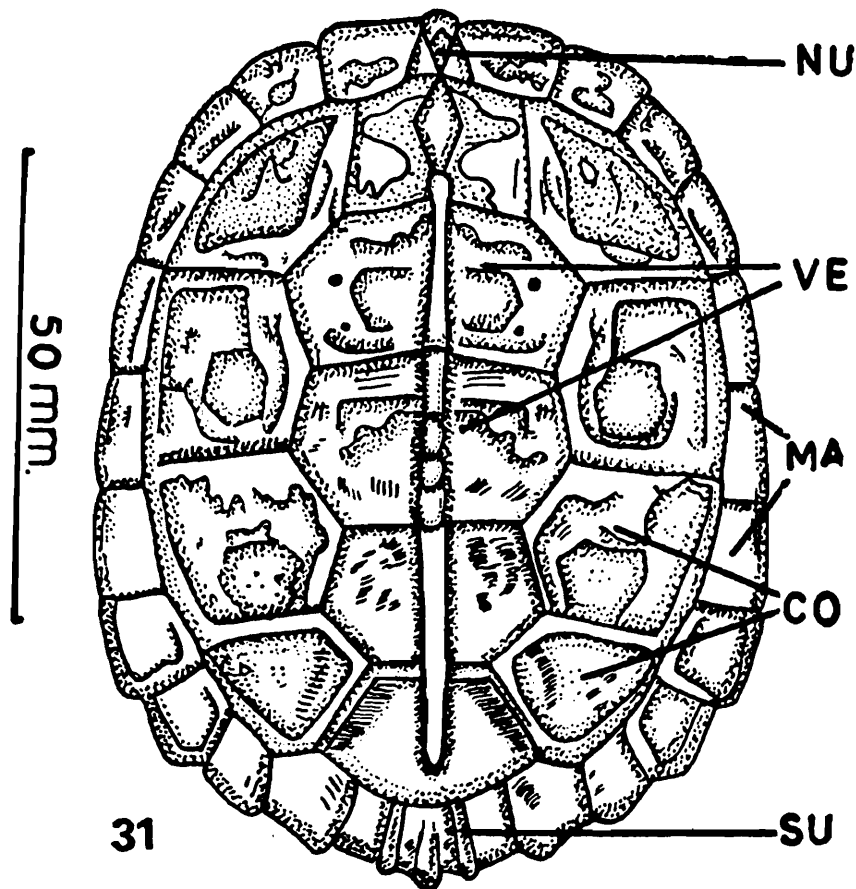
Genus 7. *Hardella* Gray 1870

BRAHMINY RIVER TURTLE

7. *Hardella thurgi* (Gray 1831)

(Plates 10 & 40; figs. 31, 32)

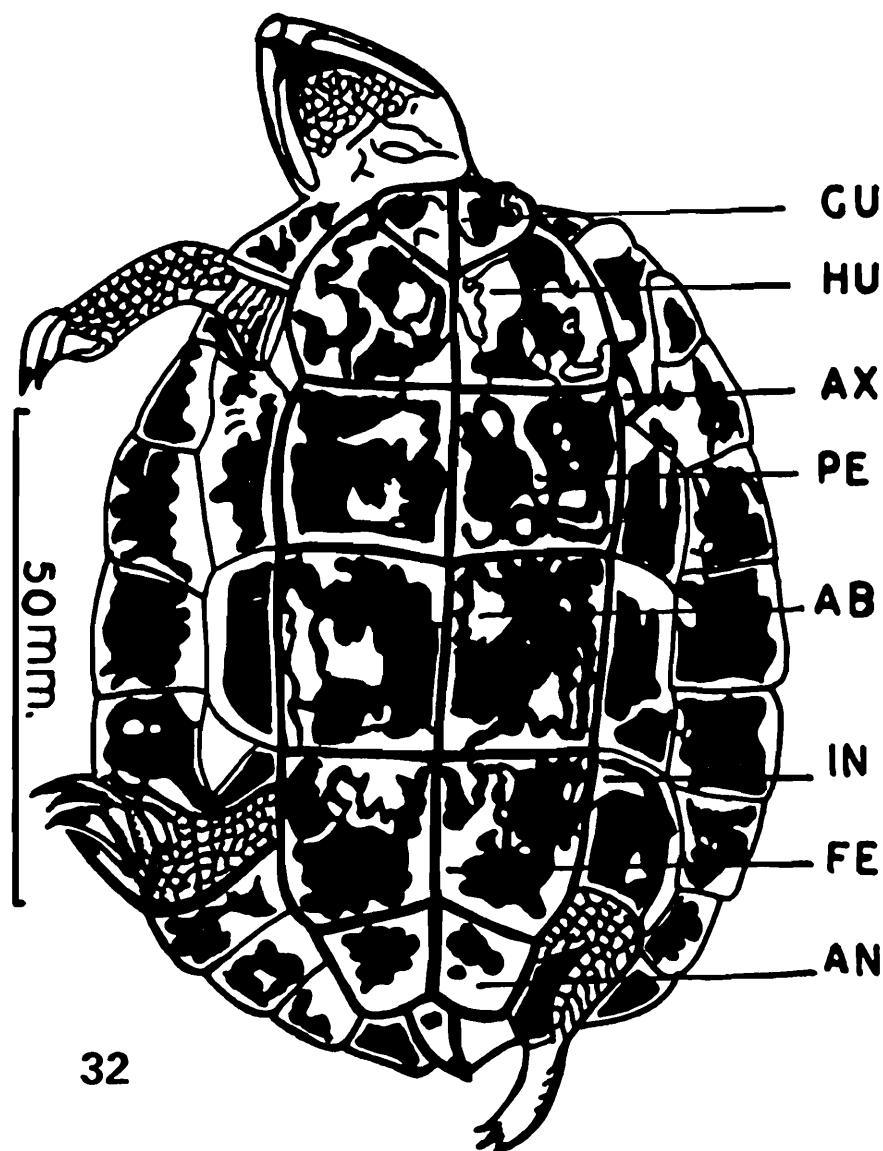
This is a most interesting completely aquatic river tortoise showing extraordinary sexual dimorphism. Its females reach to a length of 65 cm. while males attain a maximum length up to 20 cm. The head is moderately large with a pointed and extremely projecting snout. The skin of the posterior portion of head is divided into a large number of small scales arranged in transverse rows. The skull is with a bony temporal arch. The quadratojugal is in contact with the jugal and post-orbital; carotid canal lies between pterygoid and prootic; the chamber for paracapsular sac completely opens posteriorly; alveolar surface of jaws is very broad and provided with a strong ridge in the middle; margins of jaws strongly denticulated and upper jaw is bicuspid. The carapace (Fig. 31) is moderately depressed, the unicarinate, and the posterior portion of each vertebral shield has a knob-like structure. Vertebrae are elongate, somewhat hexagonal with a short anterior margin. The posterior margin of the carapace is slightly serrated. Nuchal shield is not very large and is broadest posteriorly. The first vertebral is generally longer than broad and its anterior margin is shorter than the posterior. Second to fourth vertebrae are generally broader than long in young individuals but are as broad as long and much narrower than the costals in the adult specimens. The plastron (Fig. 32) consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. It is almost as long as the carapace, angulate laterally in juveniles, truncate anteriorly; its hind lobe is much narrower than the opening of the shell, considerably shorter than the width of the bridge, notched



31. Carapace of *Hardella thurgi* (Gray)

posteriorly, the longest median suture is between the abdominal shields; the shortest between the gular, axillary and inguinal shields large. Plastron is intimately united to carapace by a suture. The axillary and inguinal buttresses are very prominent and extend almost to the vertebrae. The axillary is connected with the first rib. Ectoplastron is situated anterior to the humero-pectoral suture. Limbs are with fully and broadly webbed digits and have narrow transversely enlarged scales. Fore limbs are provided with five claws. Tail remains quite short throughout life and exhibits no difference in juveniles and adults. General dorsal colouration is dark brown-black with a yellow margin in juveniles and adults. This yellow margin fades out in very large and aged individuals. The keel and the inner margins of the first three costals are blackish to dark black. Ventrals are pale yellow with two large black spots on each side on the plastral bridge. Anterior mid portion of the plastron is with a blackish tinge. Abdominal scutes are with large black spots. Other parts of the plastron are also spotted with black. Head is dark-brown to black; curved orange yellow bands are present on the top of the snout, below the nostrils up to eyes, behind the eyes emerging on the neck above the tympanum and along the rami of the lower jaws. Limbs are brownish, margined with yellow behind.

Distribution: Available in the Ganga, Brahmaputra, and Sind River systems, ranging from Sind (Pakistan) to Sylhet (Bangladesh), in the east.

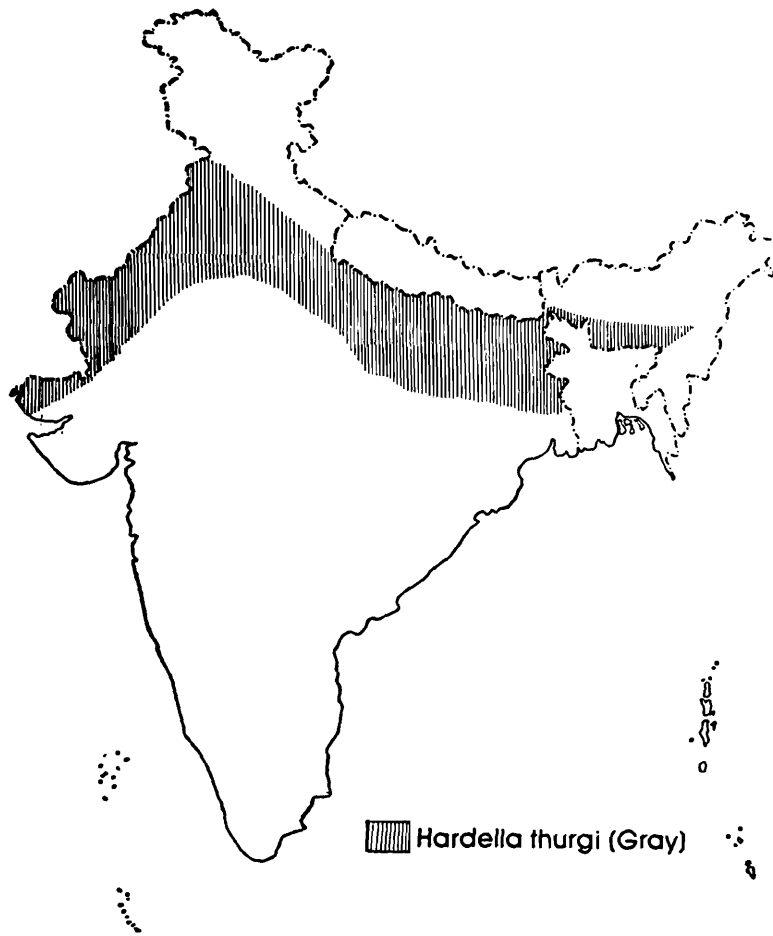


32

32. Plastron of *Hardella thurgi* (Gray)

Habits and Habitat: It is entirely aquatic inhabiting stagnant ponds, canals and backwaters and hardly emerges for basking. The Brahminy river turtle generally avoids fast flowing water. The species is entirely herbivorous and devours fruits and vegetables. The species is most docile and never bites even on rough handling. Eggs are oval and look exactly like the hen's eggs (Plate 40).

Status: The species is extremely vulnerable. The main threat to the species is through over-exploitation of adults and their eggs by animal predators and man for food and habitat destruction. Its flesh is consumed



Map showing the distribution of *Hardella thurgi* (Gray)

on a very large scale throughout its range and is said to be excellent. Large numbers of Brahminy turtles are still brought into markets in Bengal and their flesh is sold for food.

Conservation: Generally protected by legislation throughout its range but the conservation measures are not effective in many areas. Conservation and management of the species has the potential to provide a valuable protein-rich food source for the people of India and Pakistan, if suitable programmes of sustained utilization are followed.

Genus 8. *Kachuga* Gray 1869

Neural bony shields are hexagonal with a shorter anterior aspect. There is an intimate sutural connection between the carapace and plastron. The axillary and inguinal buttresses of plastron are strongly developed and extend almost up to the neural shields. The axillary buttress has a connection with the first rib. Entoplastron lies anterior to the humero-pectoral

suture. Skull is with a bony temporal arch. The quadrato-jugal articulates with the post-orbital and jugal. Jaws have markedly broad alveolar surfaces and that of the upper jaw is with a prominent median ridge. Bony choanae are on a level with the middle or hinder portion of the orbit. Fourth vertebral shield is much longer than broad, longer than the third; overlapping four or five neural bones. Skin of the posterior upper part of head is divided into many shields. Limbs are with fully webbed digits. Tail remains short throughout life. At present five species of this genus inhabit India. Fossils have been recovered from the Pleistocene deposits of the Siwalik Hills and Narbada Valley.

Key to the species of the Genus Kachuga

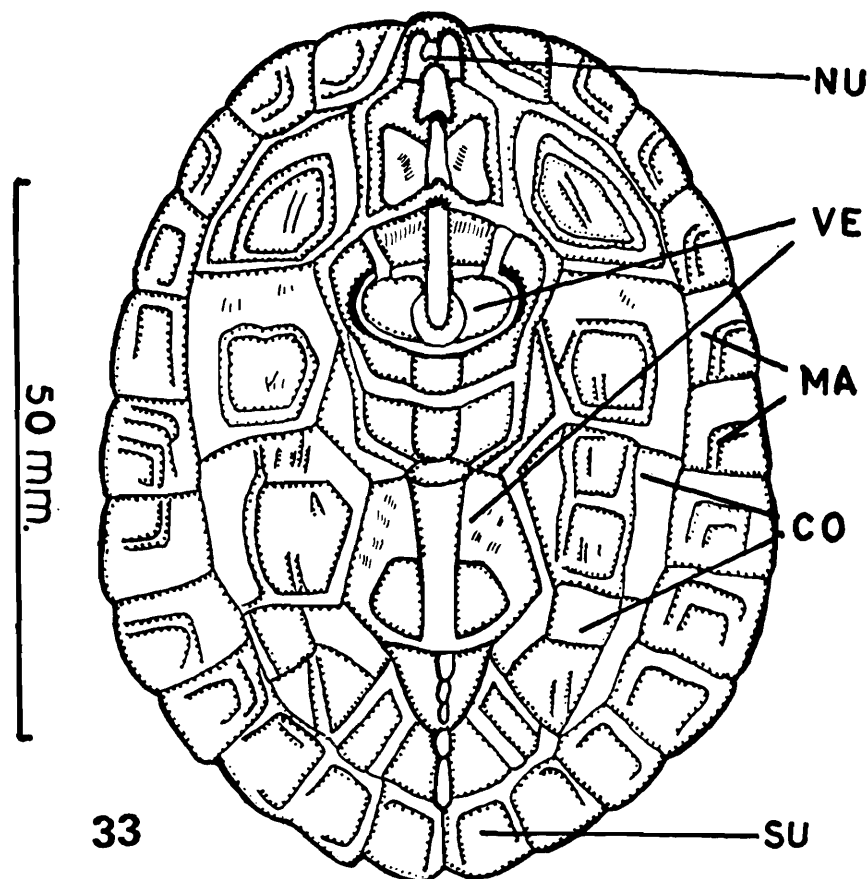
- A. Broad suture is formed between the third and fourth vertebral shields. The fourth vertebral shield overlaps 4 neural bones which are always longer than broad.
1. Second vertebral shield is pointed and overlaps the third vertebral; humero-pectoral suture of plastron is straight *K. dhongoka*
 2. Second vertebral shield with a straight transverse posterior margin; humero-pectoral suture is curved or forming an obtuse angle *K. kachuga*
- B. Fourth vertebral shield is pointed anteriorly, having a slight contact with the third vertebral and overlap five neural bones.
1. 24 marginal shields are present; posterior margin of carapace is not or feebly serrated. Third vertebral shield elongate, quadrangular or pentagonal (in young) and with almost straight posterior border. The keel of the third vertebral shield terminates in a rounded projection *K. smithi*
- Third vertebral shield is not much elongate, always pentagonal and pointed behind. The keel of the third vertebral shield terminates in a backwardly projecting spine.
- Second vertebral shield longer than third *K. tecta*
 - Second vertebral shield shorter than third *K. tentoria*
2. 26 marginal shields are present; posterior margin of carapace is strongly serrated *K. sylhetensis*

DHONGOKA TURTLE

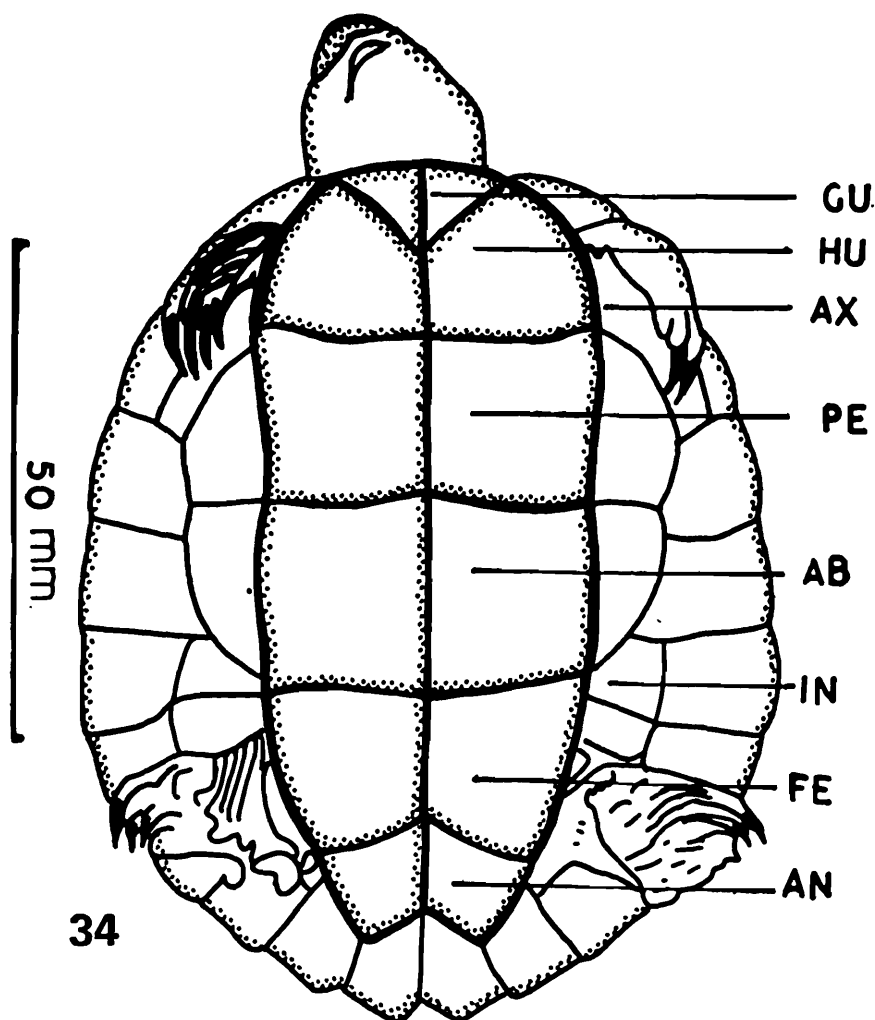
8. *Kachuga dhongoka* (Gray 1834)

(Plates 11 & 41; figs. 33, 34)

This is a moderately large turtle, whose females are larger and reach a maximum length of 40 cm. Males never exceed 20 cm. in length. The head is moderately long with a pointed snout which projects beyond the lower jaw and is shorter than the orbit. Skin of the posterior portion of head is divided into shields. Skull is with a bony temporal arch. The quadrato-jugal being in contact with the jugal and the post-orbital. Alveolar surfaces of jaws very broad, that of the upper jaw with a strong median ridge which is nearer to the inner than to the outer margin; bony choanae are on a level with the middle part of the orbits. Upper jaw is feebly bicuspid. The carapace (Fig. 33) is smooth, depressed, unicarinate, the keel interrupted, most prominent upon the second and third vertebral shields, where it terminates in a pointed knob in the young and becomes less marked with advancing age; posterior margin feebly crenulated. Nuchal shield is not very large and broadest at the posterior aspect. First vertebral is longer than broad, more or less constricted in the middle; second broader than

33. Carapace of *Kachuga dhongoka* (Gray)

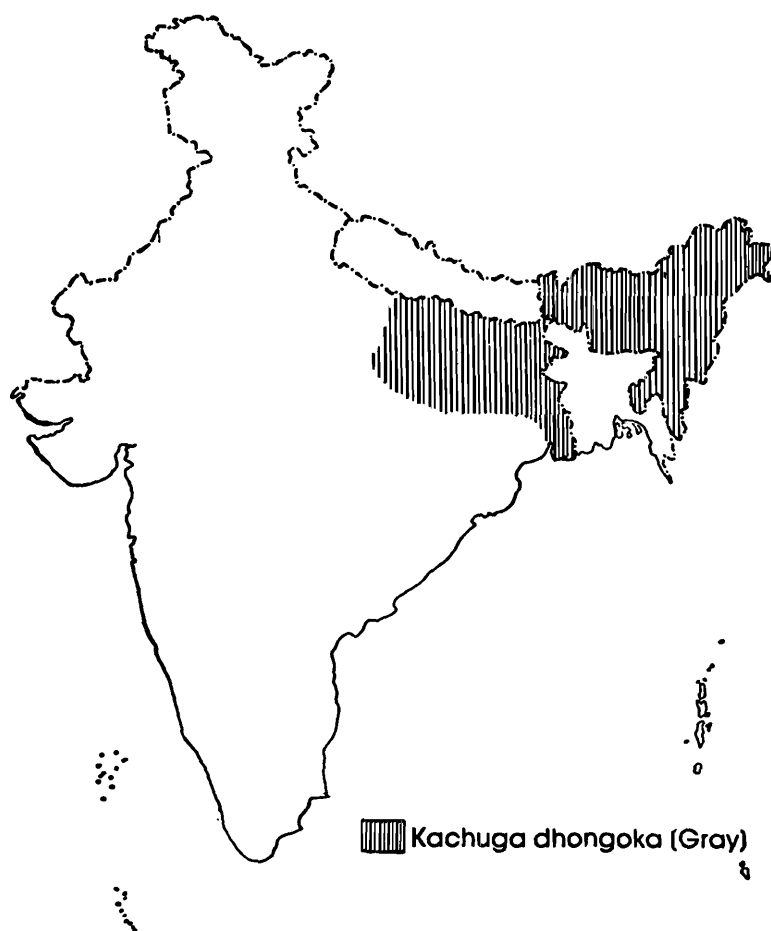
long in the young, longer than broad in the adult, narrowing posteriorly, its posterior margin is produced and fitting into an emargination of the third shield, which is shorter than the second or fourth; third vertebral shield forming a broad suture with the fourth, which overlies parts of four or five neural bones; neural plates much longer than broad. The plastron (Fig. 34) consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. It is long and narrower than the opening of the shell, angulate laterally in the young, truncate anteriorly, notched posteriorly; the width of the bridge considerably exceeds the length of the posterior lobe. The longest median suture is between the abdominal shields, the shortest between the gular; humero-pectoral suture straight; inguinal shield large, axillary smaller. Limbs are with fully and broadly webbed digits and have transversely enlarged scales. Fore limbs are provided with five claws. Tail remains quite short throughout the life and exhibits no difference between juveniles and adult. General dorsal colouration is olivaceous or brownish with black vertebral stripe. In young individuals two black lateral stripes are present. Ventrums is yellowish. All the shields of plastron are generally having a large reddish-brown patch in the juveniles. Soft parts are olivaceous or yellowish, a yellow stripe



34. Plastron of *Kachuga dhongoka* (Gray)

runs along the side of the head starting from the nostrils and passing above the eye and the tympanum.

Distribution: Eastern Ganga River system as far west as Allahabad and north to Nepal. The species has also been recorded from the Brahmaputra. Fossils have been found in the Siwalik hills.



Map showing the distribution of *Kachuga dhongoka* (Gray)

Habits and habitat: The species is entirely aquatic and lives on vegetable matter. About 30 to 35 elongate eggs measuring 55×33 mm. are deposited on the sandy banks in a single clutch (Plate 41).

Status: The species is extremely vulnerable. The main threats of the species are over-exploitation of adults and their eggs by animal predators and man for food and habitat destruction. The flesh of the species is much esteemed as food.

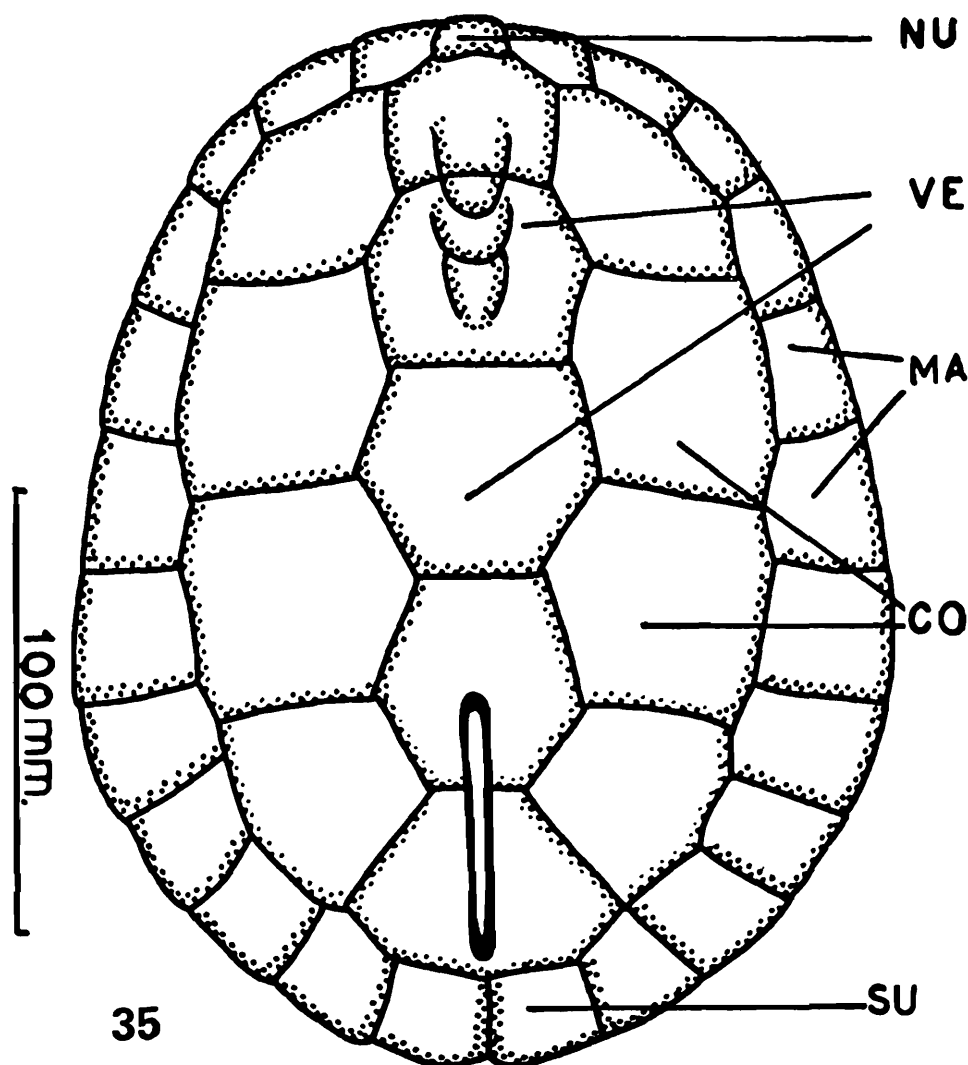
Conservation: Generally protected by legislation throughout its range but the conservation measures are not effective.

BENGAL ROOFED TURTLE

9. *Kachuga kachuga* (Gray 1831)

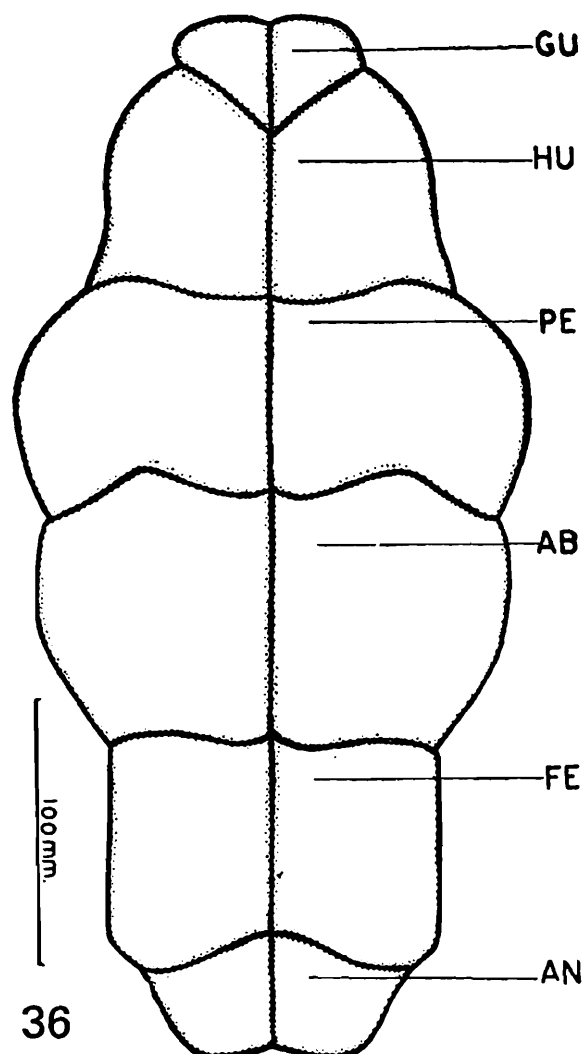
(Plates 12 & 41; figs. 35, 36)

This is a moderately large turtle in which also females are larger than males and reach a maximum length up to 39 cm. The head is moderately long snout is pointed, slightly upturned, shorter than the orbit and projecting much beyond the lower jaw. Skin of the posterior portion of head

35. Carapace of *Kachuga kachuga* (Gray)

is divided into shields. Skull is with a bony temporal arch. The quadratojugal is in contact with the jugal and the post-orbital. Alveolar surfaces of jaws very broad, that of the upper jaw with a strong and prominent median ridge which is medially situated between the inner and the outer margins. Bony choanae on a level with the posterior portion of the orbits. Upper jaw is feebly bicuspid in the adult individuals. The carapace (Fig. 35) is

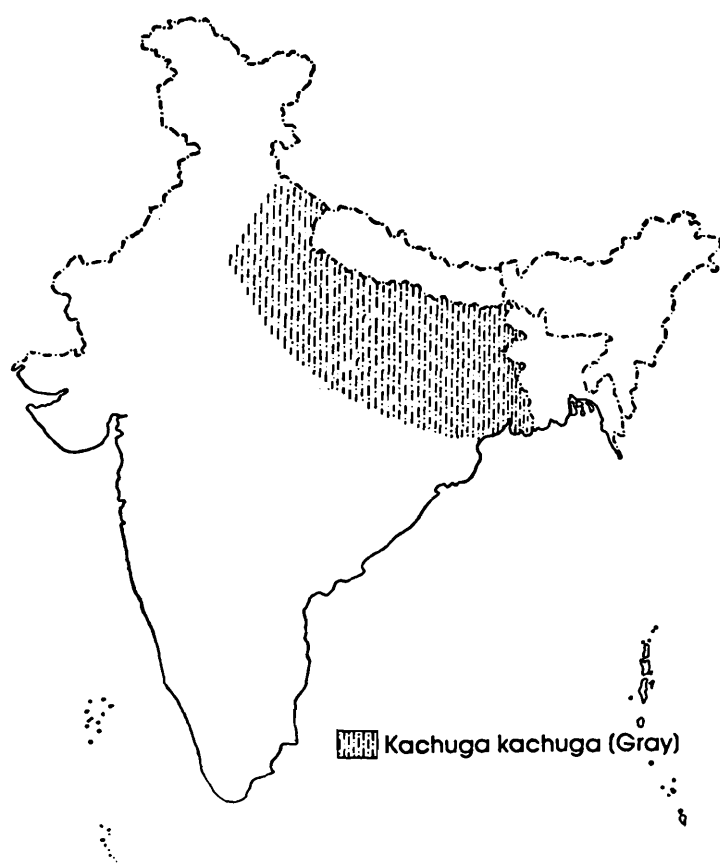
depressed, unicarinate, the keel is interrupted and remains most prominent upon the second and third vertebral shields, where it terminates in a pointed knob-like structure in the juveniles but disappears gradually in the adult individuals. Posterior margin of the carapace is crenulated in the young. Nuchal shield is not very large, broadest at the posterior aspect. First vertebral shield as long as broad; second vertebral shield broader than long in the young, about as broad as long in the adult, longer than the third vertebral, with which it forms a straight transverse suture; fourth vertebral is longest and forms a broad sutural margin with the third vertebral. The plastron (Fig. 36) consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. It is long and narrow, considerably narrower than the opening of the shell, angulate laterally in the young, truncate anteriorly, openly emarginate or notched posteriorly; the width of the plastral bridge exceeds the length of the hind lobe of plastron. The longest median plastral suture is between the abdominal shields, the shortest between the gular; humero-pectoral suture curved or forming an obtuse angle; inguinal shield large, axillary smallest. Limbs are with fully and broadly webbed digits and have



36. Plastron of *Kachuga kachuga* (Gray)

narrow, transversely enlarged scales. Forelimbs are provided with five claws. Tail remains quite short throughout life and exhibits no difference between juveniles and adults. General dorsal colouration is olivaceous or brownish. Ventrums are yellowish. Neck is light brown, with seven reddish longitudinal stripes. Lateral aspects of head bluish; throat with a pair of oblong red or yellow markings. Top of head in male has a brilliant red colour during the breeding season.

Distribution: The species is available in the Ganga River system of Bengal, Bihar and Uttar Pradesh in India, Bangladesh and Nepal. Occurrence of the species in Godavari and Krishna River systems has not been established so far.

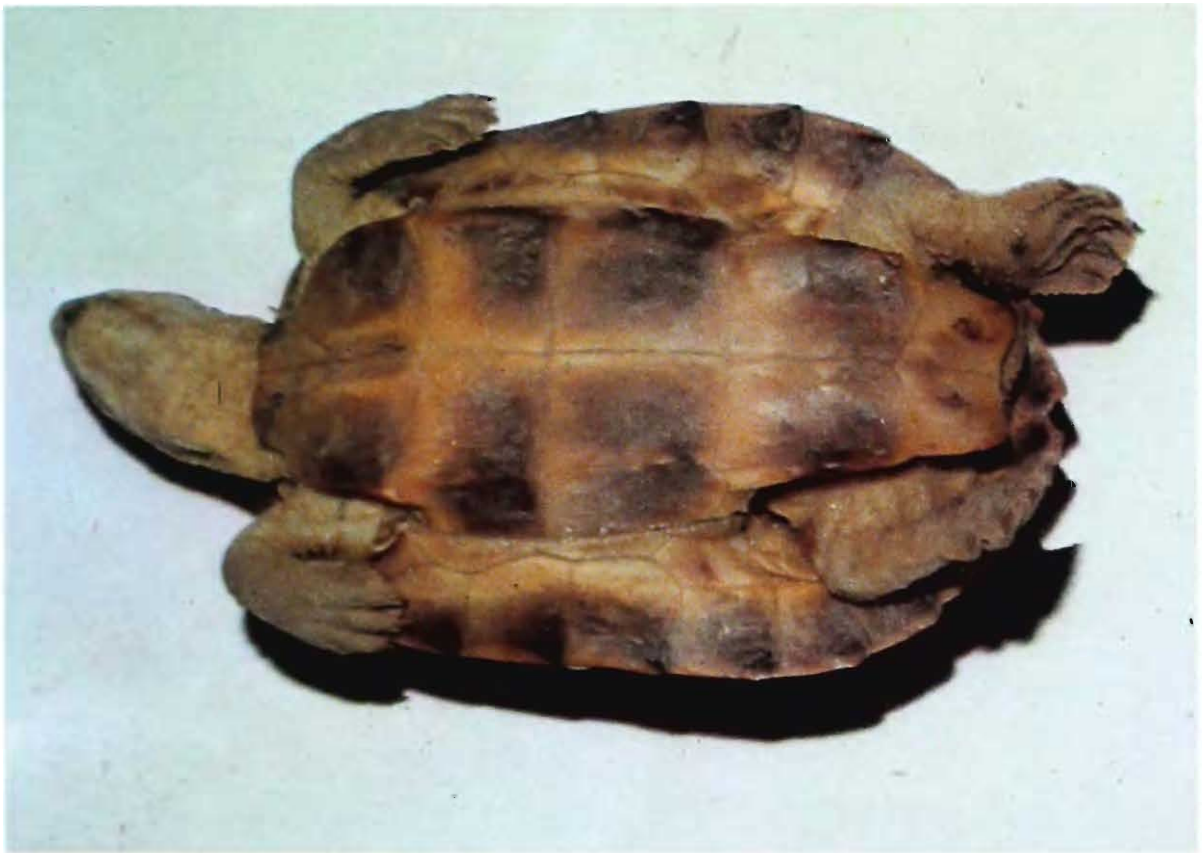
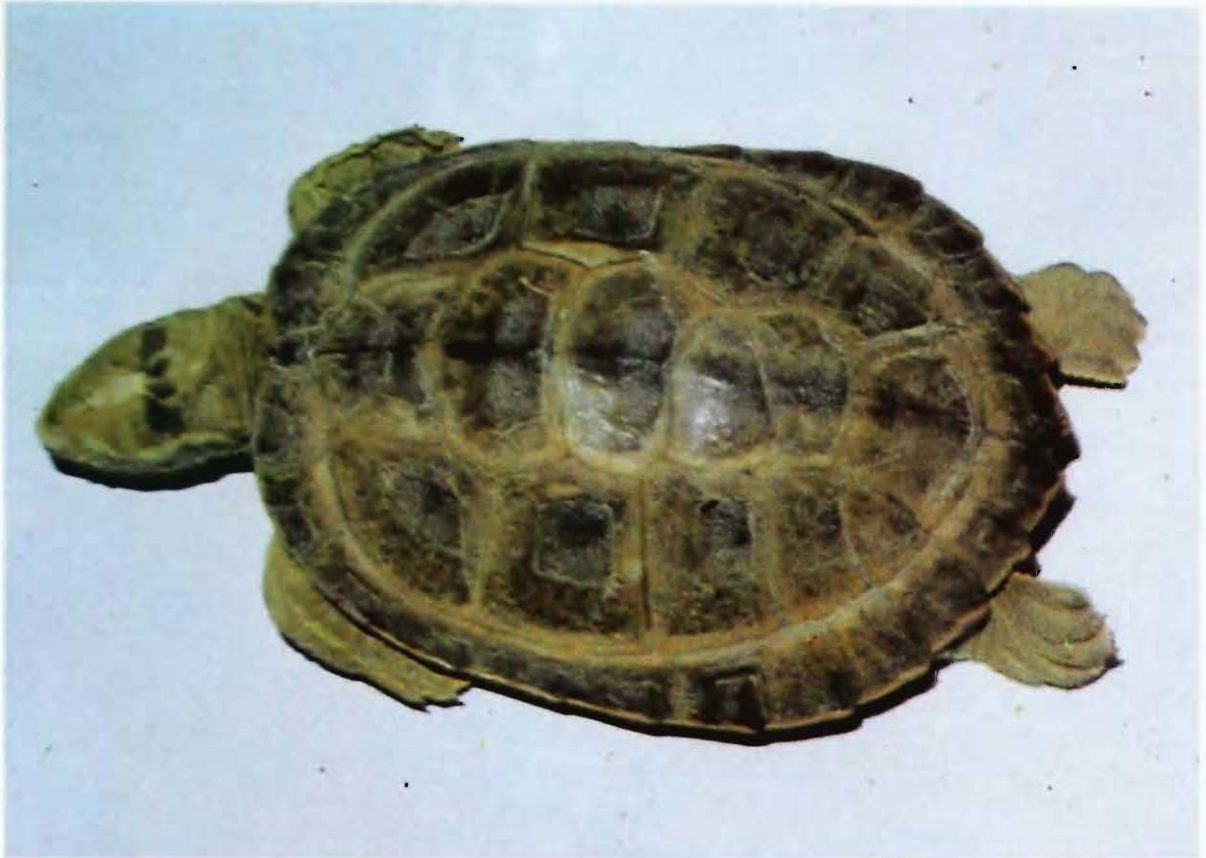


Map showing the distribution of *Kachuga kachuga* (Gray)

Habits and habitat: The species is entirely aquatic and inhabits fresh-water bodies with plenty of aquatic vegetation. It is mainly herbivorous. Eggs are laid on the sandy banks of Ganga during March (Plate 41).

Status: The species is extremely vulnerable. The population is towards decline in recent years on account of large scale exploitation for food and on account of habitat destruction and abrupt changes in ecology.

PLATE 10



Brahminy River Turtle—*Hardella thurgi* (Gray) Dorsal view, Ventral view.

PLATE 11



Kachuga dhongoka (Gray) Dorsal view, Ventral view.

PLATE 12



Kachuga kachuga (Gray) Dorsal view, Ventral view.

PLATE 13



Brown River Turtle—*Kachuga smithi* (Gray) Dorsal view, Ventral view.

caused by the construction of various dams and reservoirs in the area. These turtles used to be common 20 years ago but on account of excessive killing by man in the recent past, the numbers now have been reduced considerably. Though exact figures are not known, illegal trade exists all over its range. Nesting areas on the banks of the Ganga and other rivers are destroyed by the removal of earth for commercial purposes. This causes a sudden loss of aquatic and other vegetation on the banks, thus creating scarcity of food for turtles, and gradually their population declines on account of starvation. On account of various Hydroelectric and other projects like dams, many portions of the river systems in the range of species remain dry for a considerable period in the year and cause a sudden and radical change in the ecology of these water loving creatures and ultimately force them to die.

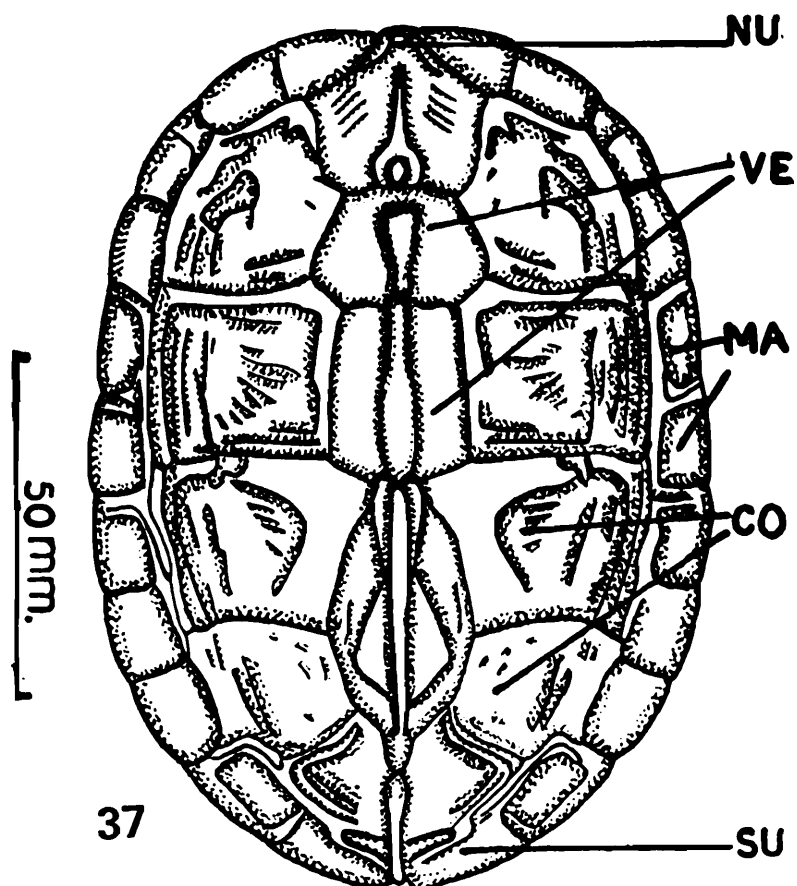
Conservation: Generally protected by legislation throughout its range but the conservation measures are not adequate.

BROWN RIVER TURTLE

10. *Kachuga smithi* (Gray 1863)

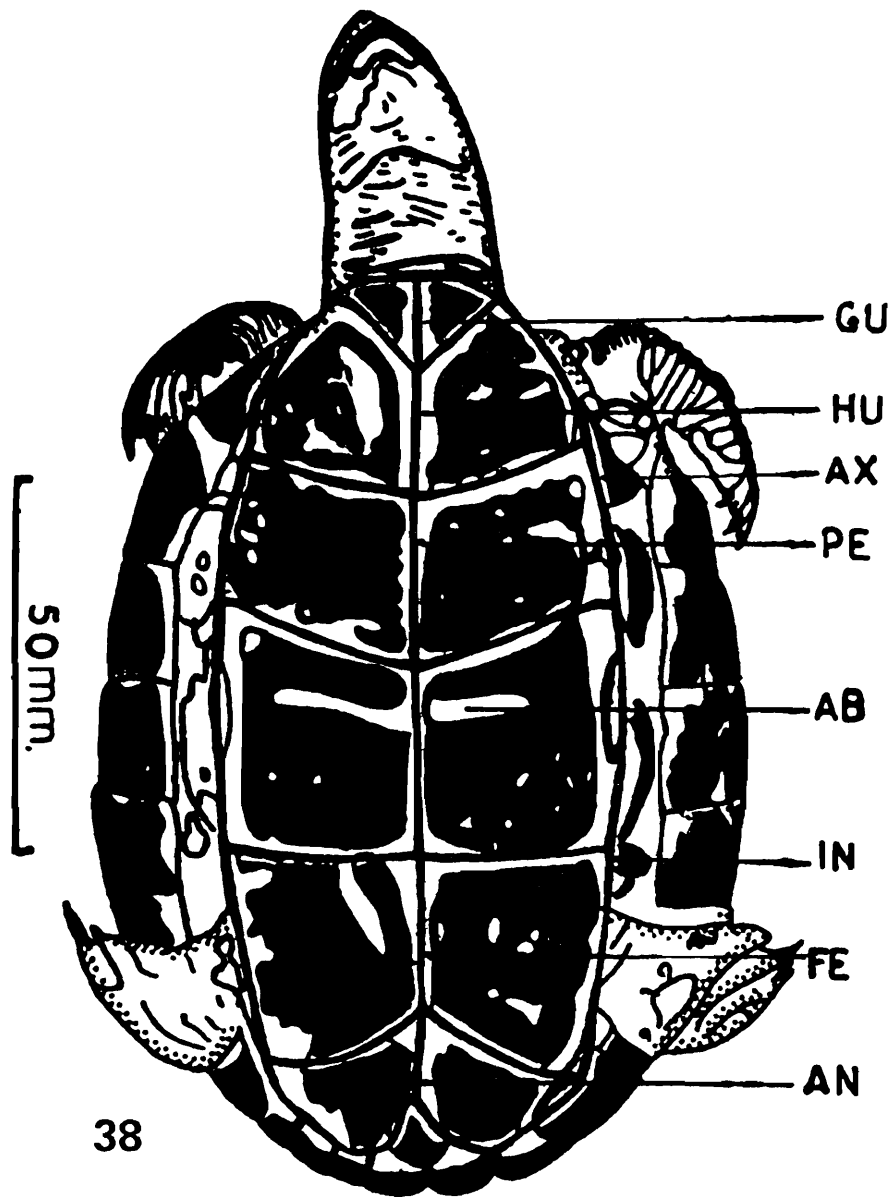
(Plates 13 & 42; figs. 37, 38)

This is a small turtle and reaches maximum length of 23 cm. The head is moderately small, snout is pointed, shorter than the orbit and projecting much beyond the lower jaw. Skin of the posterior portion of head is divided into shields. Skull is with a bony temporal arch. The quadratojugal is in contact with the jugal and the post-orbital. Alveolar surface of jaws is very broad, that of the upper jaw with a prominent median ridge, which is nearer to the inner than the outer margin. Upper jaw is not notched at the middle. The carapace (Fig. 37) is depressed, with obtuse, interrupted, vertebral keel; its posterior margin may be regular or in certain cases feebly serrated. Nuchal shield is not very large, broadest at the posterior aspect. First vertebral shield is longer than broad in the adult; second shortest, broader than long and almost with a straight posterior aspect; third longer than broad, pentagonal in the young but subquadrangular in the adult, its posterior border is almost straight; fourth vertebral



37. Carapace of *Kachuga smithi* (Gray)

longest, with a narrow, pointed anterior margin forming a narrow sutural articulation with the third vertebral; fifth vertebral distinctly broader than long and much broader than other vertebral shields. The plastron (Fig. 38) consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. It is almost equal in length to the carapace, strongly angulate laterally in juveniles, truncate anteriorly; hind lobe of the plastron narrower than the shell-opening, notched posteriorly, shorter than the width of the plastral bridge. The longest median suture is between the abdominal shields, the shortest between the gular; inguinal shields large, axillary shield is smallest. Limbs are with fully and broadly webbed digits and have transversely enlarged scales. Fore limbs are provided with five claws. Tail remains quite short throughout life and exhibits no difference between juveniles and adults. General dorsal colouration is pale olive. Vertebral keel is blackish. Ventrums are yellow and each plastral shield is provided with a dark brown tinge. In many individuals the shields of plastron are completely black with narrow white borders. Top of the head is black. Prominent reddish or pink spots are present behind the eyes. Neck has got light brown longitudinal stripes.

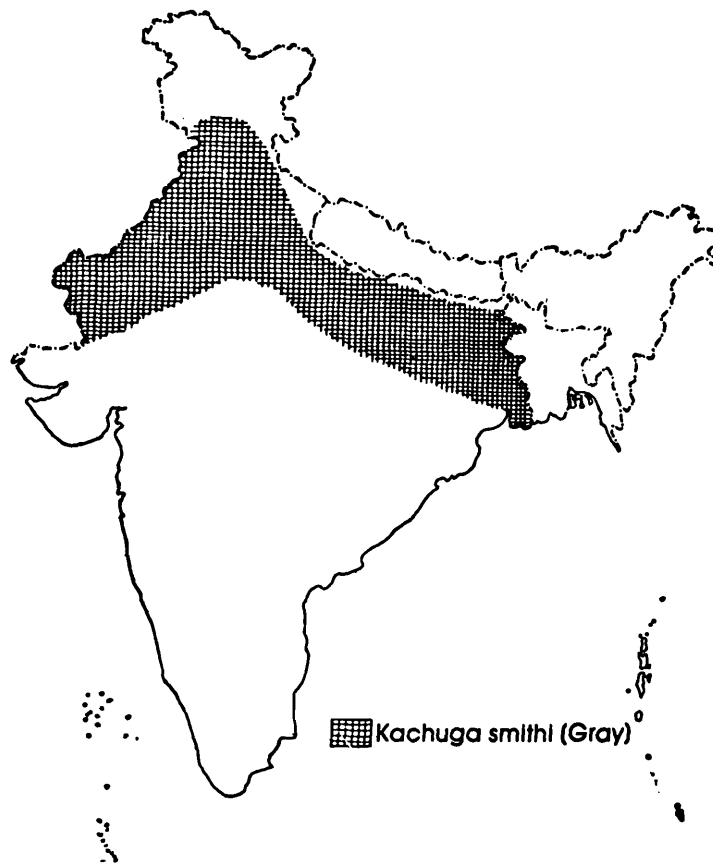


38. Plastron of *Kachuga smithi* (Gray)

Distribution: The species is available in the Ganga and Sind river systems. Records are also available from the Bangladesh.

Habits and habitat: The species is entirely aquatic and is a rapid swimmer. It is omnivorous and devours flesh readily. Lays five to eight eggs on the sandy banks of rivers in a single clutch (Plate 87); eggs measure 33 mm in length and 24 mm in width.

Status: The species is vulnerable. Population is considerably reduced in recent years owing to mass exploitation for food and habitat destruction.



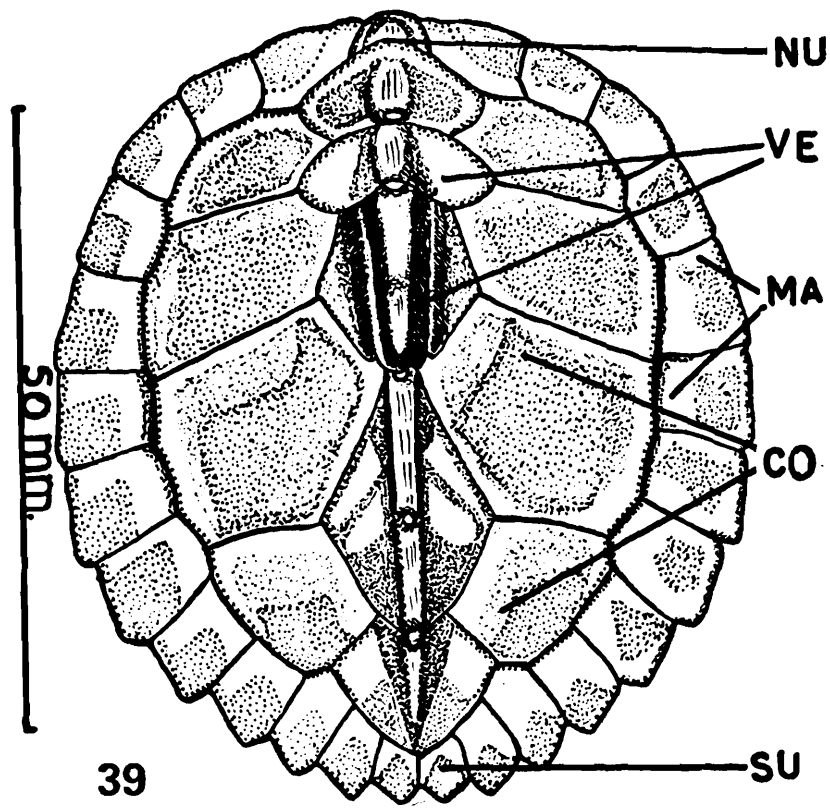
Map showing the distribution of *Kachuga smithi* (Gray)

ASSAM SAW-BACK TURTLE

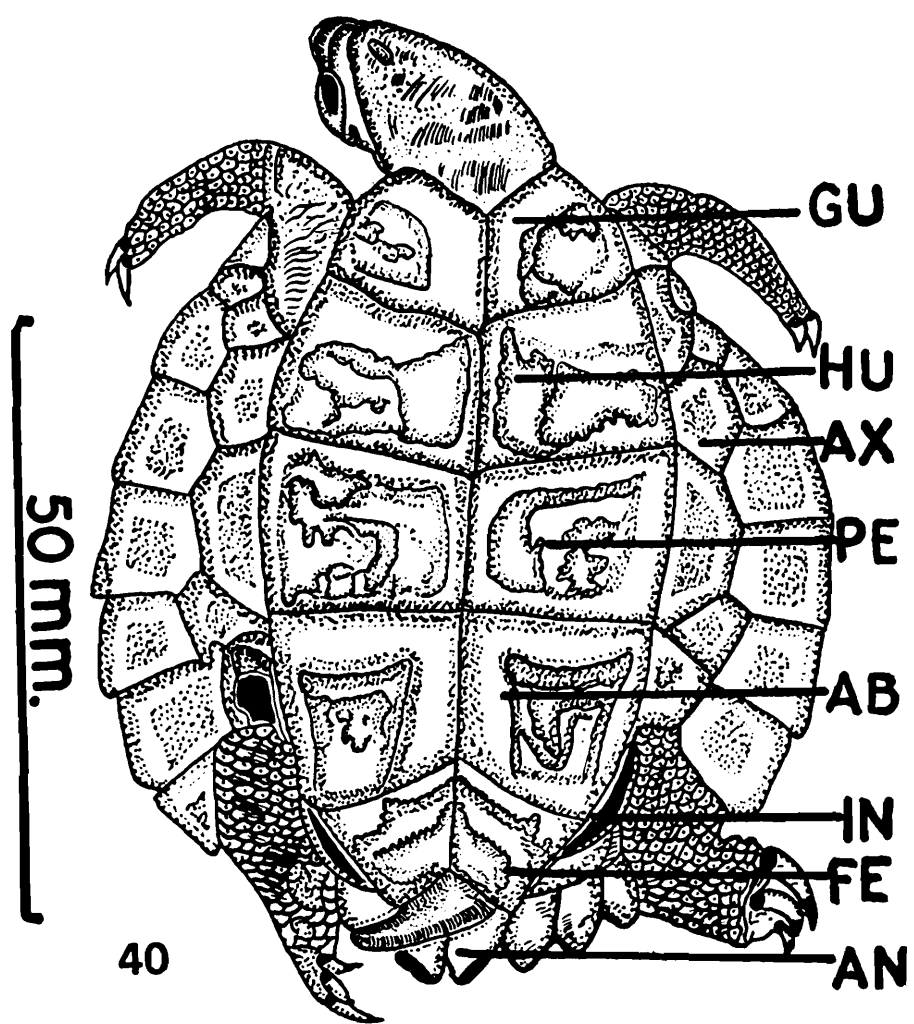
11. *Kachuga sylhetensis* (Jerdon 1870)

(Plate 14 & 42; figs. 39, 40)

This is a small and rare species which hardly reaches to a length of 18 cm. The head is moderately small, snout pointed, shorter than the orbit and projecting much beyond the lower jaw. Skin of the posterior portion of head is feebly divided. Skull is with a bony temporal arch. The quadrato-jugal is in contact with the jugal and the post-orbital. Alveolar surfaces of jaws very broad, that of the upper jaw with a strong and prominent median ridge. Upper jaw is hooked. The carapace (Fig. 39) is elevated, with a prominent vertebral keel which is abruptly transformed into a tough backwardly projecting spike at the posterior margin of the third vertebral shield. Posterior margin of the carapace is very strongly serrated. Nuchal shield is not very large; first vertebral shield is broader

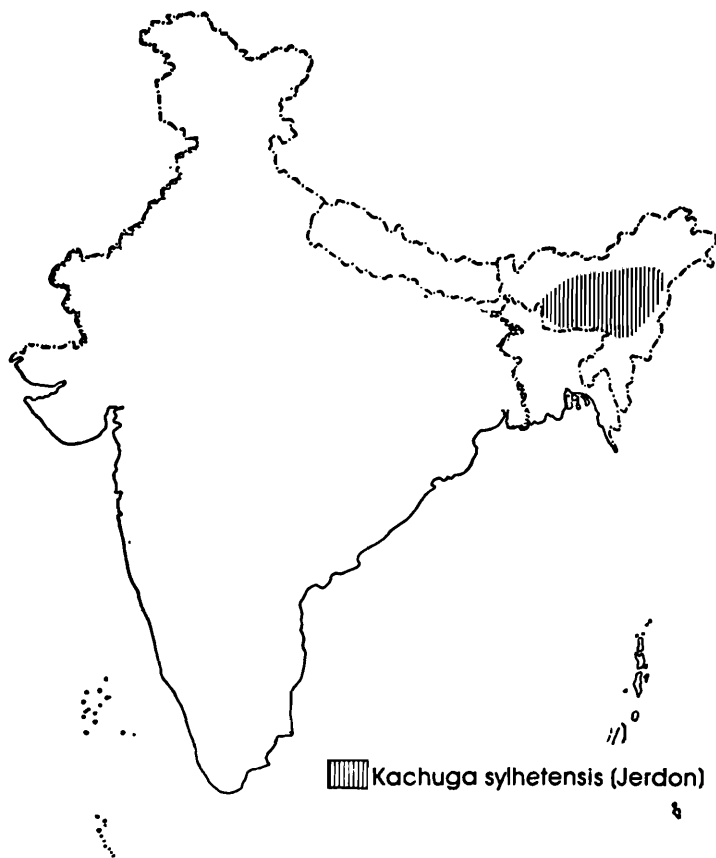


39. Carapace of *Kachuga sylhetensis* (Jerdon)



40. Plastron of *Kachuga sylhetensis* (Jerdon)

in front than behind in the juveniles but the width is constant all over the length in the adults. Second vertebral shield is broader than long with an almost straight posterior border and is shortest among all the vertebral shields. Third vertebral shield is distinctly longer than broad, obtusely pointed posteriorly and its tip touching the sharp anterior tip of the fourth vertebral shield. Fourth vertebral shield has the longest anterior extremity among the vertebral shields. Fifth vertebral shield is longer than broad and is obtusely pointed at the posterior margin. Marginal shields are 26 in number (including the paired supracaudals). The plastron (Fig. 40) consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. It is as long as the carapace, angulate laterally, truncate anteriorly; hind plastral lobe is smaller than the shell opening, notched posteriorly, its length slightly less than the width of the bridge; the longest median suture is between the abdominal shields, the shortest between the gular; axillary and inguinal shields are comparatively large. Limbs are with fully and broadly webbed digits and have transversely enlarged scales. Tail remains quite short throughout the life and exhibits no difference between juveniles and adults. General dorsal colouration is olivaceous or brownish. Vertebral keel is paler. Ventrums are yellow. Each plastral shield is with a large dark brown spot. Head and limbs



Map showing the distribution of *Kachuga sylhetensis* (Jerdon)

brownish. There is a yellow wavy transverse stripe across the back of the head and another along the lower jaw. Neck has many light yellow longitudinal streaks.

Distribution: The species is available in the Garo, Khasi and Naga Hills in India.

Habits and habitat: The species is fully aquatic and inhabits stagnant and slow running waters in the hilly terrain with plenty of aquatic vegetation. It is mainly herbivorous. Not much is known about its breeding habits except that the species lays elongated somewhat oval eggs (Plate 42).

Status: Insufficiently known. Rare.

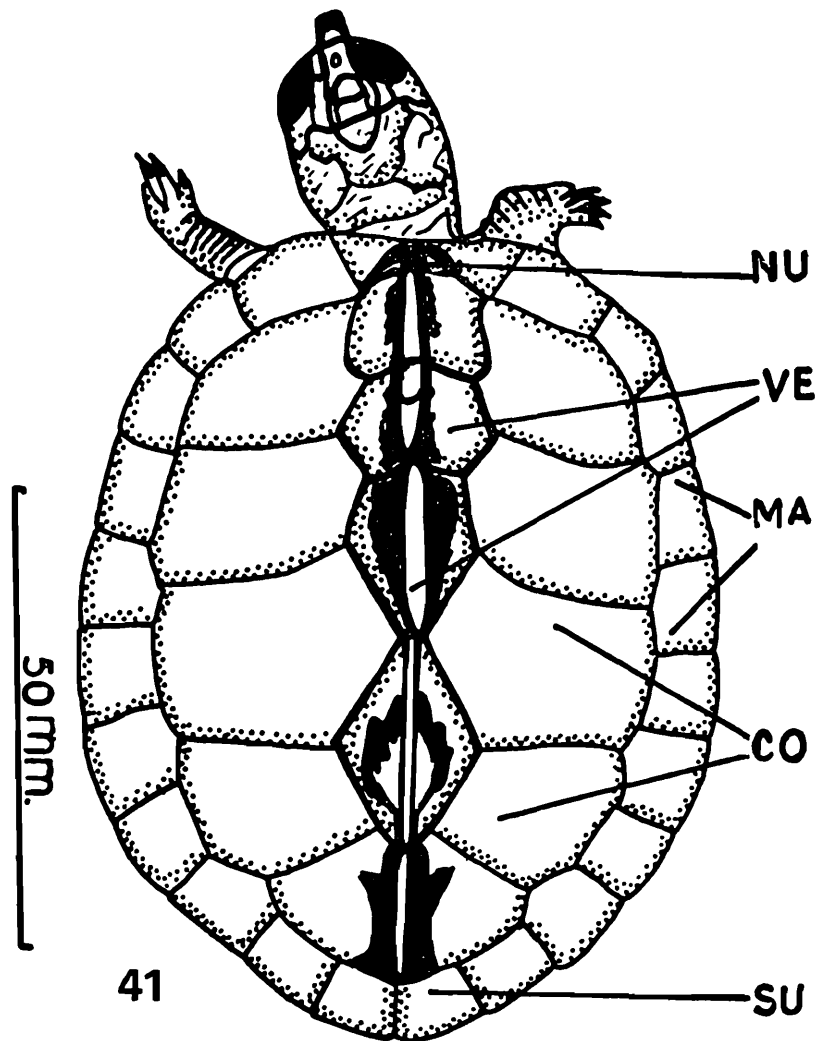
NORTH INDIAN ROOFED TURTLE

12. *Kachuga tecta* (Gray 1831)

(Plates 15 & 43; figs. 41, 42)

This is a small species and the females never reach more than 23 cm. in length, males are still smaller. The head is moderately small, pointed, shorter than the orbit. Skin of the posterior part of head is divided into large shields. Skull is with a bony temporal arch. The quadrato-jugal is in contact with the jugal and the post-orbital. Alveolar surfaces of jaws quite broad, that of upper jaw with a prominent median ridge which is nearer to the inner than the outer margin. Upper jaw is not notched. The carapace (Fig. 41) is elevated and rounded in adult individuals. Vertebral keel is prominent, abruptly transforms into a strong spinous process at the posterior margin of the third shield. Posterior margin of the carapace is generally not much serrated. Nuchal shield is usually broadest at the posterior margin; first vertebral shield is variable in shape, with straight lateral margins in juveniles, the anterior portion of this shield becomes narrower in the adults; second vertebral shield is generally longer than the third, and obtusely pointed posteriorly; third vertebral is pointed behind and touches the pointed extremity of the fourth vertebral; fourth vertebral shield is much longer than the other vertebral shields; fifth vertebral shield is broader than long and is much broader than other vertebrals. The plastron (Fig. 42) consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. Plastron is almost as long as the carapace, angulate laterally, truncate anteriorly;

hind plastral lobe is smaller than the shell opening, notched posteriorly, its length is slightly less or almost equal to the width of the plastral bridge; the longest median suture is between the abdominal shields, the



41. Carapace of *Kachuga tecta* (Gray)

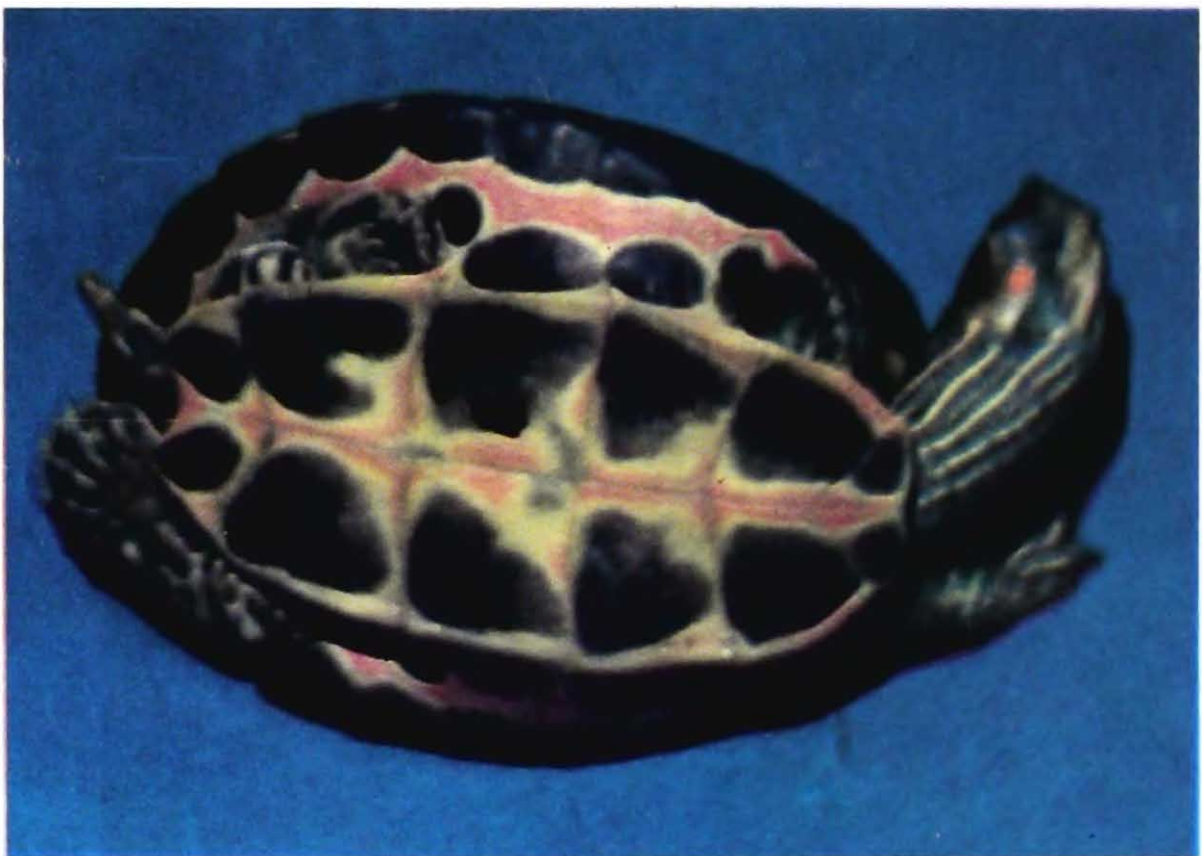
shortest between the gular or the anal; axillary and inguinal shields are almost equal. Limbs are with fully and broadly webbed digits and have transversely enlarged scales. Tail remains quite short throughout life and exhibits no difference between juveniles and adults. General dorsal colouration is olivaceous with minute black spots and orange or reddish vertebral stripe. The vertebral stripe is most distinct on the anterior dorsum extending up to first three shields. In the adults colouration becomes dark olive-brown and the spots become inconspicuous. The rim of the shell remains pinkish-yellow throughout the life. Ventrums are reddish, yellowish or reddish-yellow with large dark brown or almost black spots. Head is blackish, temporal region orange or yellow, neck is blackish with thin yellow longitudinal lines, limbs dark olive with yellow spots, back of thighs with dark transverse streaks.

PLATE 14



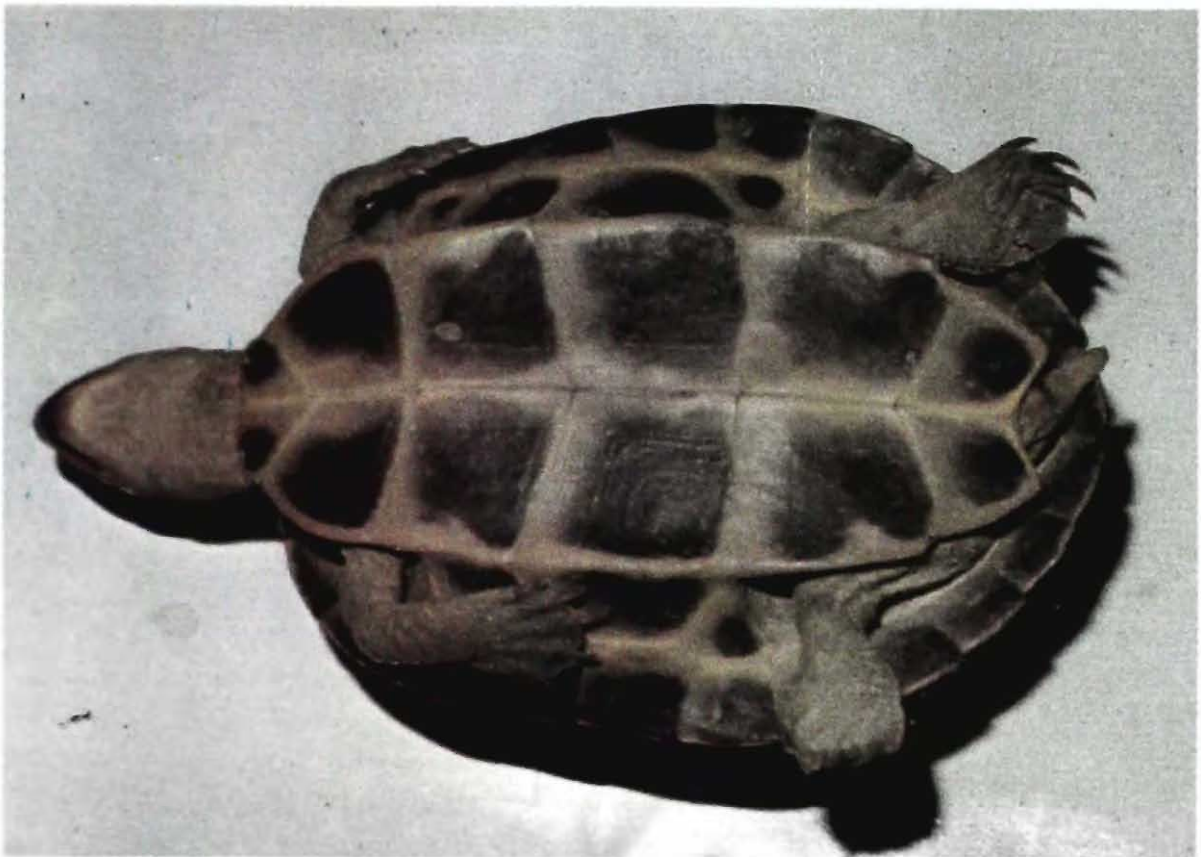
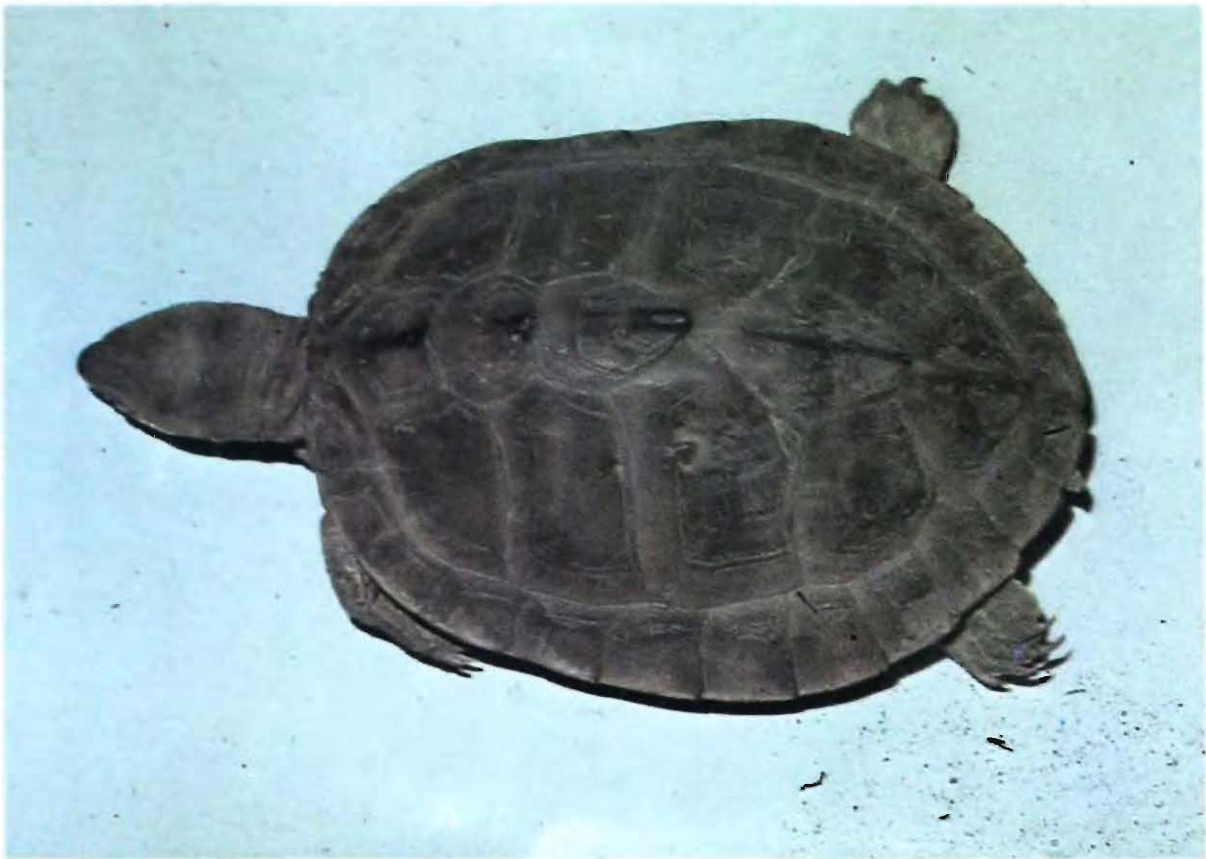
Assam Saw-back Turtle—*Kachuga sylhetensis* (Jerdon) Dorsal view, Ventral view.

PLATE 15

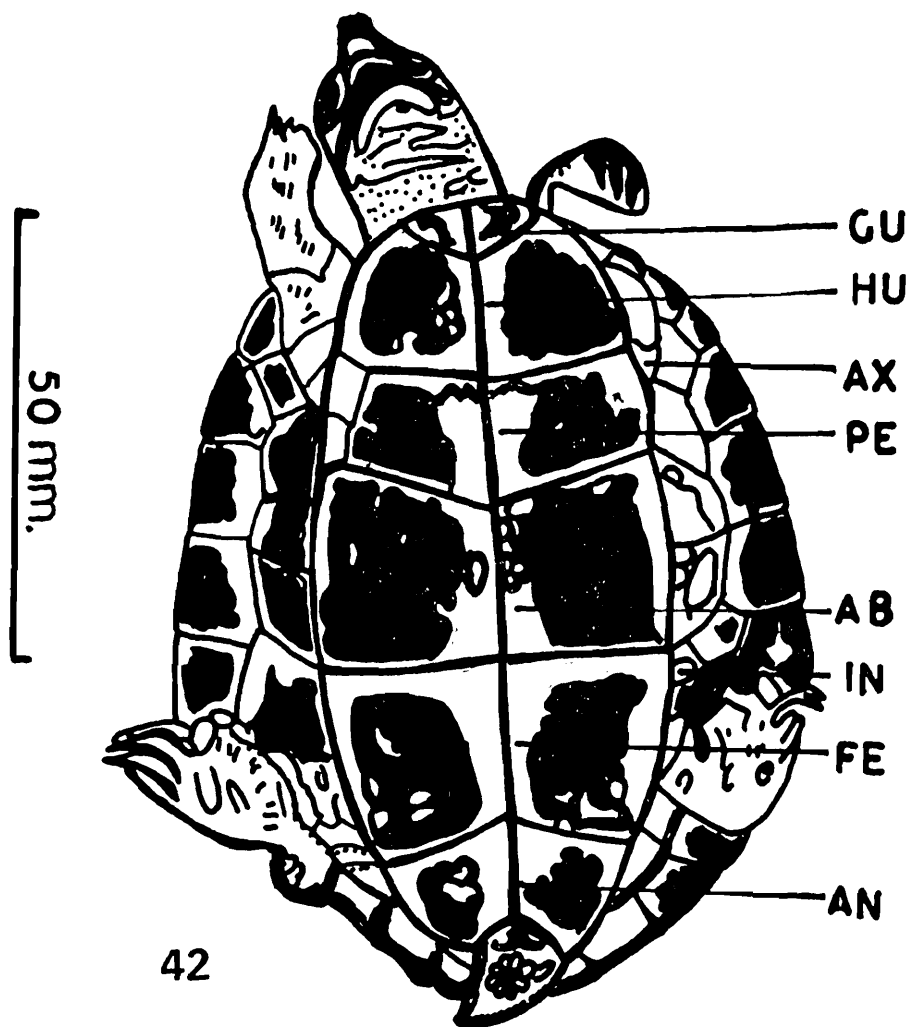


North Indian Roofed Turtle—*Kachuga tecta* (Gray) Dorsal view, Ventral view.

PLATE 16



South Indian Roofed Turtle—*Kachuga tentoria* (Gray) Dorsal view, Ventral view.



42. Plastron of *Kachuga tecta* (Gray)

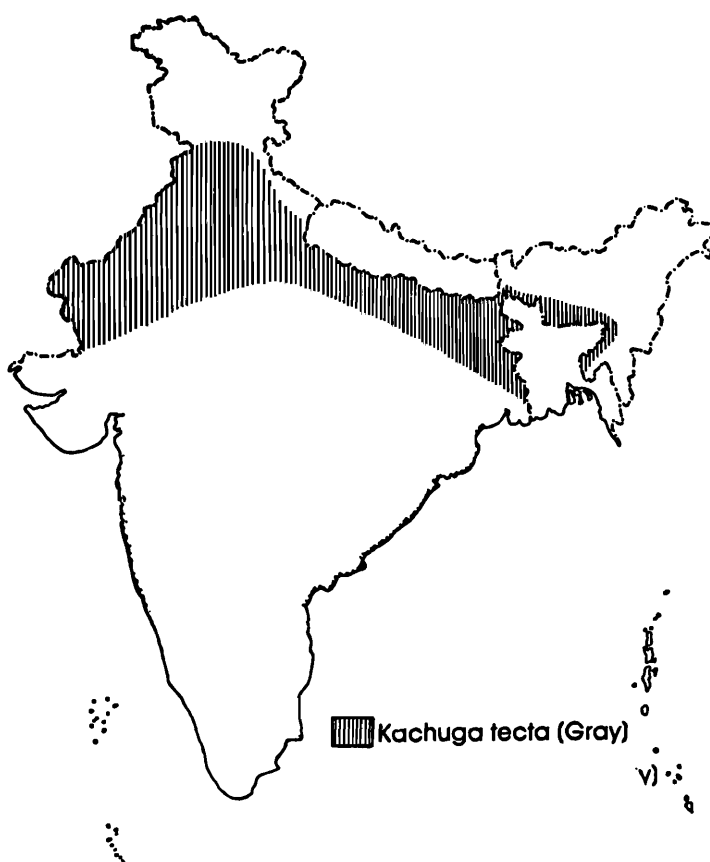
Distribution: The species is available in the Ganga, Brahmaputra and Sind River systems of India and Pakistan. Fossils have been recorded from the Pleistocene deposits of the Siwalik Hills.

Habits and habitat: The species is fully aquatic and inhabits fresh-water bodies with plenty of aquatic vegetation. It is a less active species and comparatively a poor swimmer. It feeds chiefly on vegetable matter. Not much is known about its breeding habits. Eggs are round or oval in the same clutch (Plate 43).

Status: This most familiar species has become extremely vulnerable and its population has been reduced enormously due to over exploitation (eggs as well as adults) for food. Habitat destruction is also a most important threat. The nesting areas of the species are destroyed by removing the sand for commercial purpose and as such aquatic vegetation is lost.

These factors create the scarcity of food for these turtles and the population declines automatically. The construction of various Hydroelectric projects also has a bearing on the habitat destruction of these turtles.

Conservation: Nominally protected by legislation. The detailed ecological investigation of this species will help in ascertaining the approximate numbers, distribution pattern and ecological preference with a view to design suitable conservation and management plans.



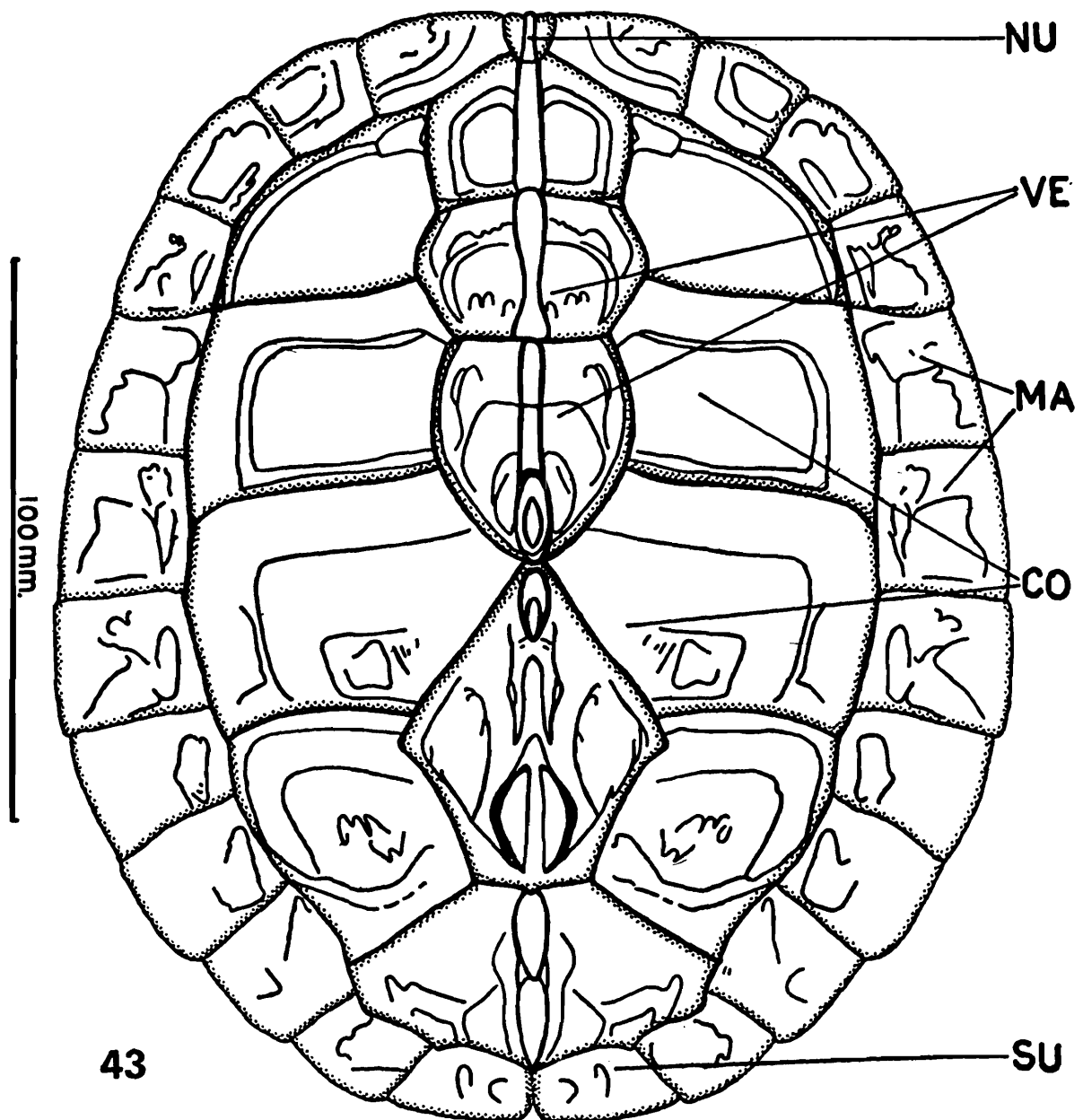
Map showing the distribution of *Kachuga tecta* (Gray)

SOUTH INDIAN ROOFED TURTLE

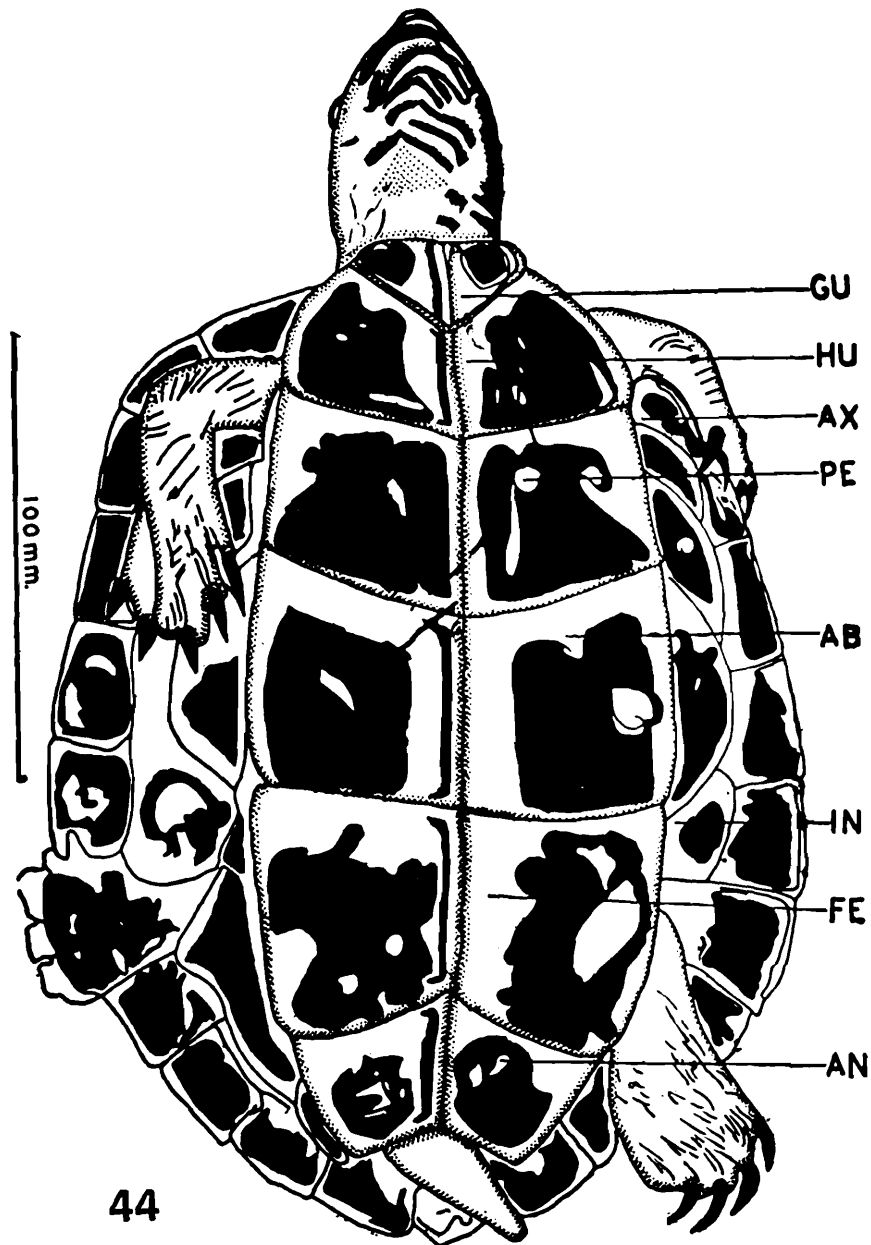
13. *Kachuga tentoria* (Gray 1834)

(Plate 16; figs. 43, 44)

This is a small species in which the adult female is similar to *Kachuga tecta* in size and maximum length never reaches beyond 19 cm. The head is moderately small and pointed, shorter than the orbit and feebly

43. Carapace of *Kachuga tentoria* (Gray)

projecting beyond the lower jaw. Skin of the posterior part of the head is divided into large shields. Skull is with a bony temporal arch. The quadrato-jugal is in contact with the jugal and the post-orbital. Alveolar surface of jaws quite broad, that of upper jaw with a prominent median ridge which is nearer to the inner than the outer margin. Upper jaw is not notched. The carapace (Fig. 43) is elevated and rounded in adults. Vertebral keel is prominent and abruptly forms a strong spinous process at the posterior margin of the third shield. Posterior margin of the carapace is generally not serrated. Nuchal shield is usually broadest at the posterior margin; first vertebral shield is much variable in shape, with straight lateral margins in juveniles, anterior part of the shield becomes narrower in adults; second vertebral shield is most variable, generally shorter than the third, obtusely pointed posteriorly; third vertebral is pointed behind and touches

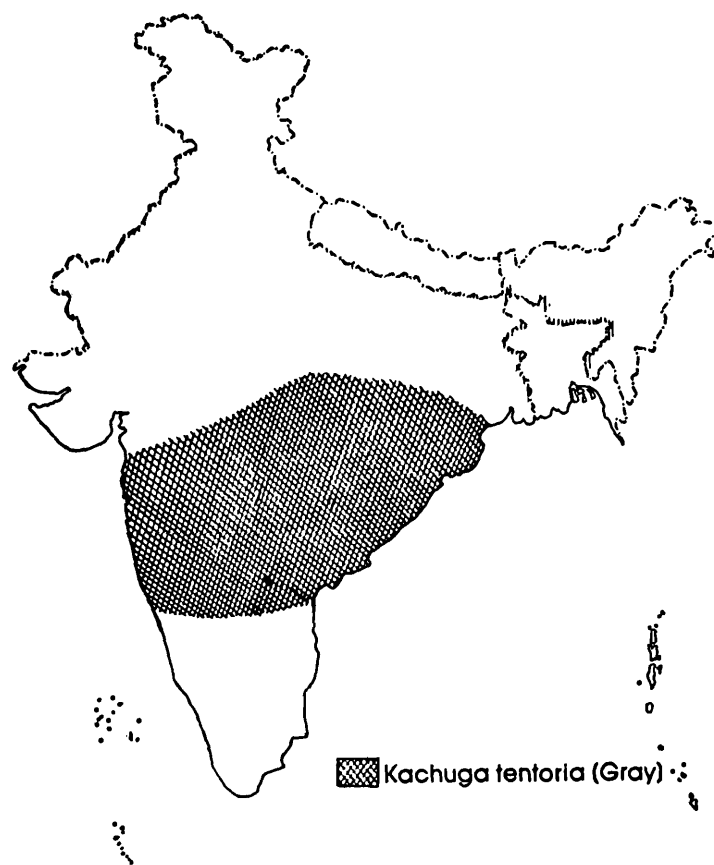


44. Plastron of *Kachuga tentoria* (Gray)

the sharp pointed extremity of the fourth vertebral, fourth vertebral shield is much longer than the other vertebral shields; fifth vertebral shield is broader than long and is much broader than other vertebrals. The plastron (Fig. 44) consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. Plastron is almost as long as the carapace, angulate laterally, truncate anteriorly; hind plastral lobe is smaller than the shell opening, notched posteriorly, its length is slightly less or almost equal to the width of the plastral bridge; the longest median suture is between the abdominal shields, the shortest between the gular or the anal; axillary and inguinal shields are semiequal. Limbs are with fully and broadly webbed digits and have transversely enlarged scles. Tail remains quite short throughout the life and shows no difference between juveniles and adults. General dorsal colouration is pale olivaceous. Yellow

streaks on neck are absent or indistinct. The head is dull olive and devoid of coloured spots on the temporal region; there is a distinct red marking behind the tympanum; limbs are devoid of spots and the dark bars at the back of the thighs are numerous.

Distribution: Available in the Mahanadi, Godavari and Krishna river systems of Peninsular India.



Map showing the distribution of *Kachuga tentoria* (Gray)

Habits and habitat: The species is absolutely aquatic and inhabits the slow running water near the banks and still water pools on the river side. It is an active swimmer and is mainly herbivorous. Nothing is known about its breeding habits.

Status: Species has become vulnerable on account of large scale habitat destruction. Its flesh is not considered suitable for consumption.

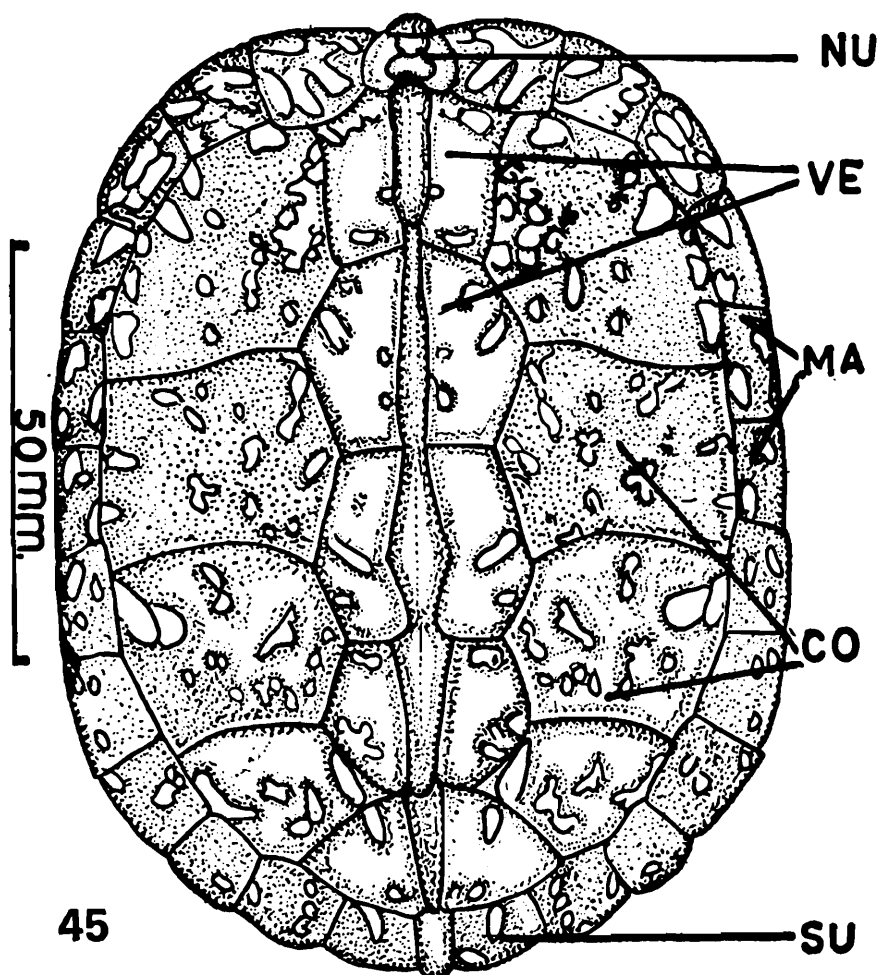
Conservation: Nominally protected by legislation.

NORTH INDIAN FRESHWATER TORTOISE
OR
BLACK-SPOTTED POND TURTLE

14. *Geoclemys hamiltoni* (Gray 1831)

(Plate 17; figs. 45, 46)

This is a fairly large species reaching up to 31 cm. in length. The head is large, broad, snout rounded, as long as the orbit and slightly projecting beyond the lower jaw. Skin of the posterior portion of head is divided into large shields. Skull with a bony temporal arch, the quadrato-jugal being separated from the post-orbital by the jugal. Alveolar surfaces of jaws very broad, without median ridge; bony choanae on a level with the hinder part of the orbits; the upper jaw broadly emarginate in the middle. The carapace (Fig. 45) is tricarinate, strongly convex with three interrupted keels in addition to the vertebral and costal keels; posterior margin serrated. The nuchal shield is not very large, broadest at the posterior aspect. First

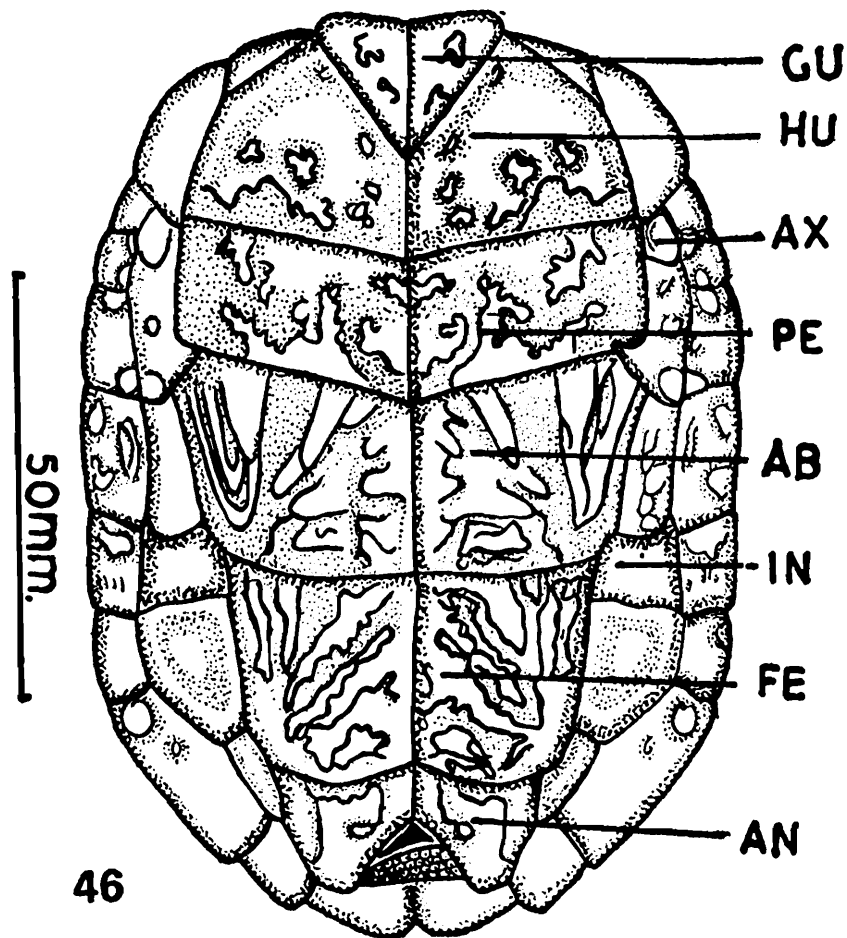


45. Carapace of *Geoclemys hamiltoni* (Gray)

PLATE 17



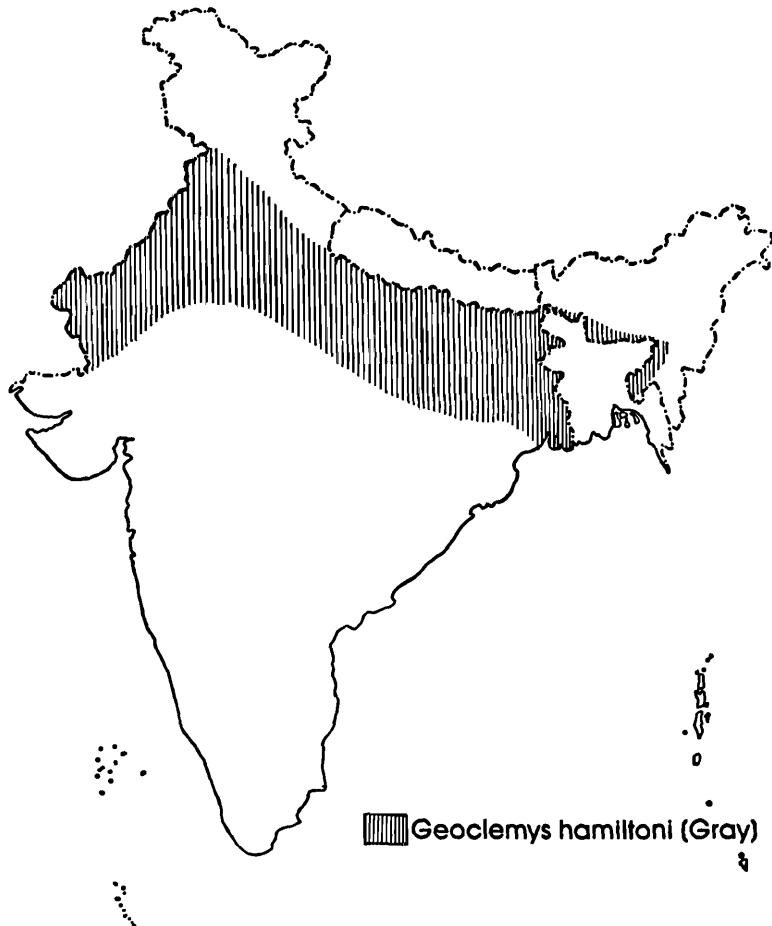
North Indian Freshwater Tortoise—*Geoclemys hamiltoni* (Gray) Dorsal view, Ventral view



46. Plastron of *Geoclemys hamiltoni* (Gray)

vertebral shield longer than broad; second and third vertebrae broader than long in juveniles, about as broad as long in the adult individuals but these are narrower than the costals. The plastron (Fig. 46) consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. Plastron intimately attached to the carapace by suture, axillary and inguinal buttresses are strong but short and extend only up to the outer ends of the costal shields. Entoplastron is situated quite anterior to the humero-pectoral suture. Plastron is almost equal to the carapace in length, angulate laterally, truncate anteriorly, posterior plastral lobe is much narrower than the opening of the shell and as long as the width of the plastral bridge, deeply notched posteriorly, the longest median suture is between the abdominal shields and shortest between the anal or the humeral, axillary and inguinal shields large. Limbs are with fully webbed digits and have transversely enlarged scales. Tail quite short in comparison to body, covered below with small granular scales. General dorsal colouration is dark brown to black and richly spotted and streaked with deep yellow. Soft parts dark brown to black with numerous round yellow spots which are largest on the head and neck.

Distribution: The species is mainly restricted to the Ganga and Sind river systems. Records are available from Sind (Pakistan) to West Bengal. Fossils have been recorded from the Siwalik Hills.



Map showing the distribution of *Geoclemys hamiltoni* (Gray)

Habits and habitat: The species is absolutely aquatic and prefers to live in quite shallow and clear water with plenty of aquatic vegetation. This is a carnivorous turtle and its diet mainly consists of snails. In captivity it relishes raw meat and fish but rejects any vegetable matter. Nothing is known about its breeding habits.

Status: The species is extremely vulnerable. This turtle was fairly abundant in the early 20th century from Sind to Bengal but in recent years the species has been depleted drastically all over its range, owing to the over exploitation of eggs and adult individuals for food. Habitat destruction constitutes the second most significant threat to the survival of this species. Nesting areas are lost for commercial removal of sand on the one hand, and cleaning of riverside aquatic vegetation on the other. This causes scarcity of food sources and exposes the banks to soil erosion. The construction of recent hydro-electric dams and barrages has checked the movement of the species to its nesting sites during breeding seasons.

Conservation: Nominally protected by legislation throughout its range.

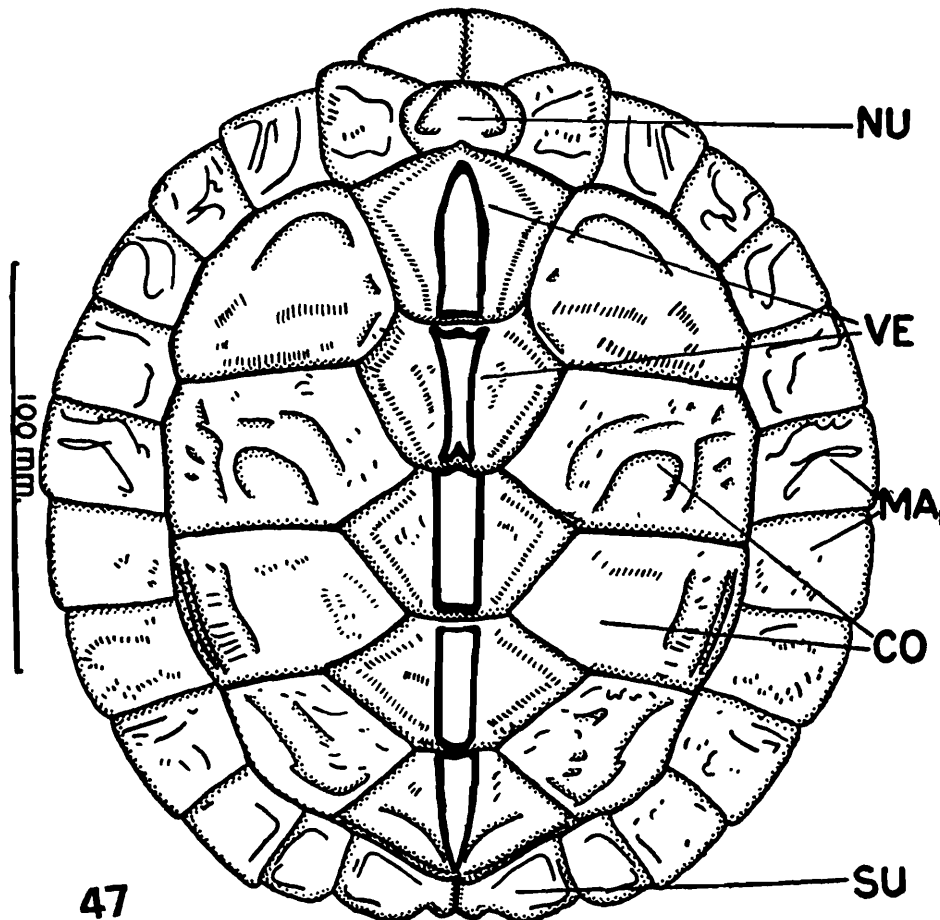
Genus 10. *Cyclemys* Bell 1834

GARO AND KHASI HILLS TORTOISE

15. *Cyclemys dentata* (Gray 1831)

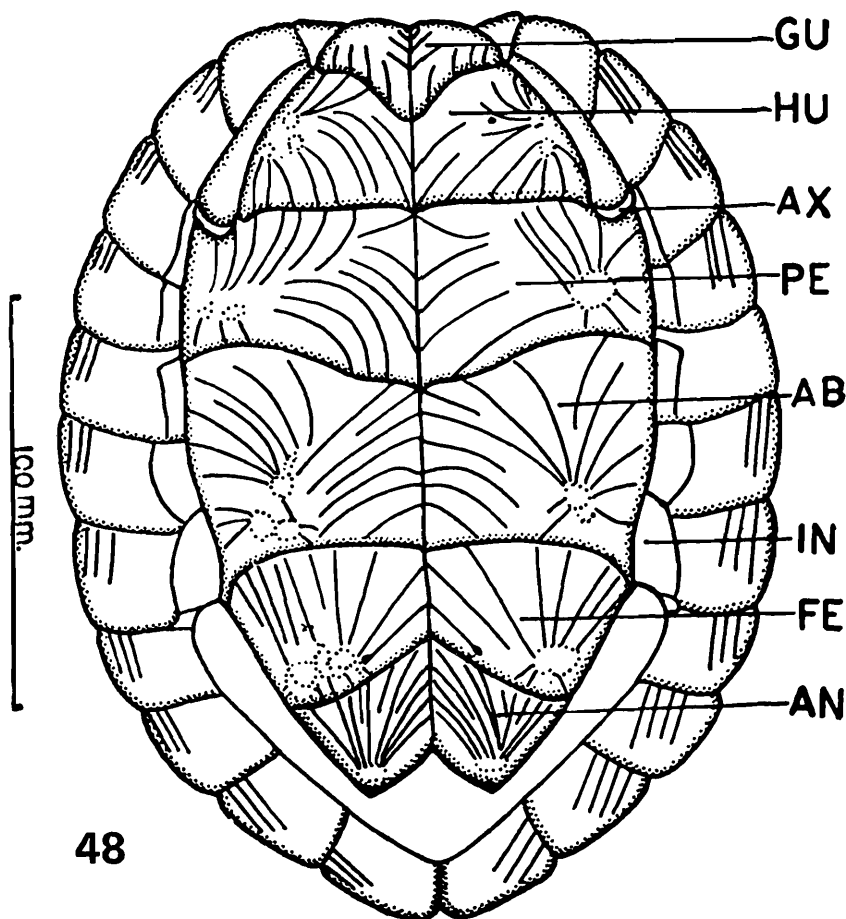
(Plates 18 & 43; figs. 47, 48)

This is a moderately large species reaching up to 24 cm. in length. The head is moderately large, snout shorter than the orbit, slightly projecting beyond the lower jaw. Skin of the posterior portion of head is divided into large shields. Skull with a bony temporal arch. Alveolar surfaces of jaws narrow, and upper jaw is feebly bicuspid and hooked. The carapace

47. Carapace of *Cyclemys dentata* (Gray)

(Fig. 47) is depressed and considerably flat, almost as broad as long in the juveniles, slightly more convex and elongate in the fully grown individuals. Neural plates of the carapace hexagonal and with a narrow posterior margin. Vertebral region with a strong obtuse keel in the young but disappears in the aged individuals. The posterior margin of the carapace strongly

serrated in the young but comparatively less so in the adult. The nuchal shield is not very large; first vertebral broader in the front than behind in the young but the reverse is the case in fully grown individuals, where it has wavy lateral margins; second to fourth vertebrals are as broad as long or slightly broader than long but always narrower than the costals. Plastron (Fig. 48) narrower than the opening of the shell, truncate, openly emerginate anteriorly, notched posteriorly, not completely closing the shell, united to the carapace by ligamentous tissue, with a short but absolutely distinct bridge; with an indistinct hinge between the hyo- and hypoplastral bones; only the front plastral lobe is movable; entoplastron intersected by the humero-pectoral suture; the longest median suture is between the pectoral shields, the shortest between the humeral or the gular shields and a small inguinal shield may be present. Limbs are with fully webbed digits and have transversely enlarged scales. Tail moderate, thin and pointed, longer in the young than in the adult. Colouration of this species is most variable. General dorsal colouration is dark brown or olive brown or black, in many individuals dark rays are available on carapace, juveniles are generally with a chestnut tinge all over the dorsum. Head is brownish generally with black spots. Neck is light yellow with dark longitudinal streaks.



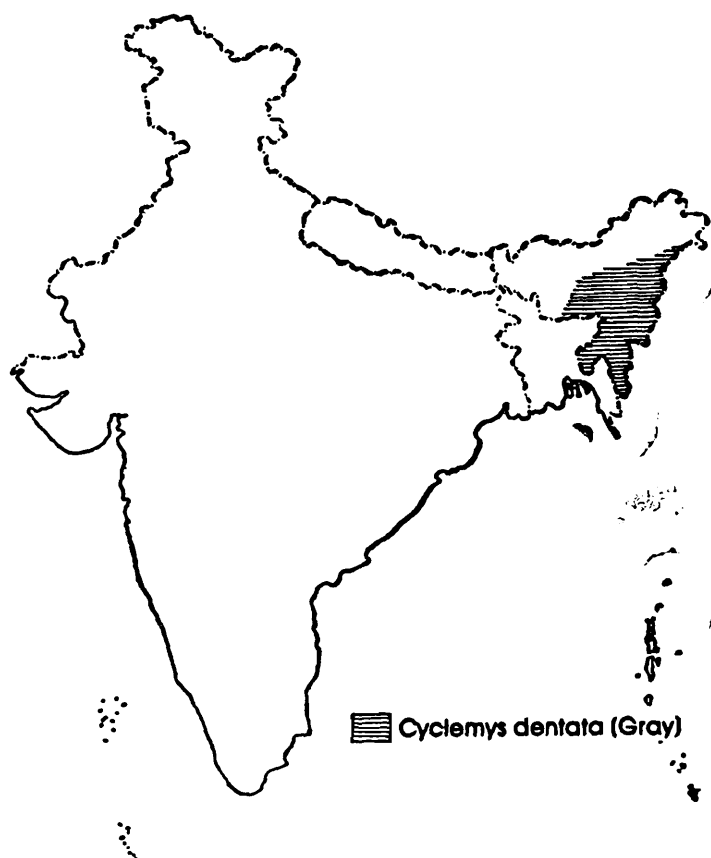
48. Plastron of *Cycllemys dentata* (Gray)

Distribution: The species is available in Burma, India (Assam), Indonesia (Borneo, Java, Sumatra and other islands), Malaysia, Philippine Islands, Thailand and Vietnam.

Habits and habitat: The species is most active, and is omnivorous; juveniles are absolutely aquatic and prefer to live in the hill streams. Adults are entirely terrestrial. It lays from two to four eggs in a single clutch, and measuring 52-57 mm. in length and 27-30 mm. in width (Plate 43).

Status: Insufficiently known.

Conservation: No conservation measure has so far been taken on the species. As a protective measure it has already been proposed for the inclusion of the species in Appendix I of the Indian Wildlife Act.



Map showing the distribution of *Cycllemys dentata* (Gray)

ASSAM FRESHWATER TORTOISE

16. *Cyclemys mouhoti* (Gray 1862)

(Plates 19 & 44; figs. 49, 50)

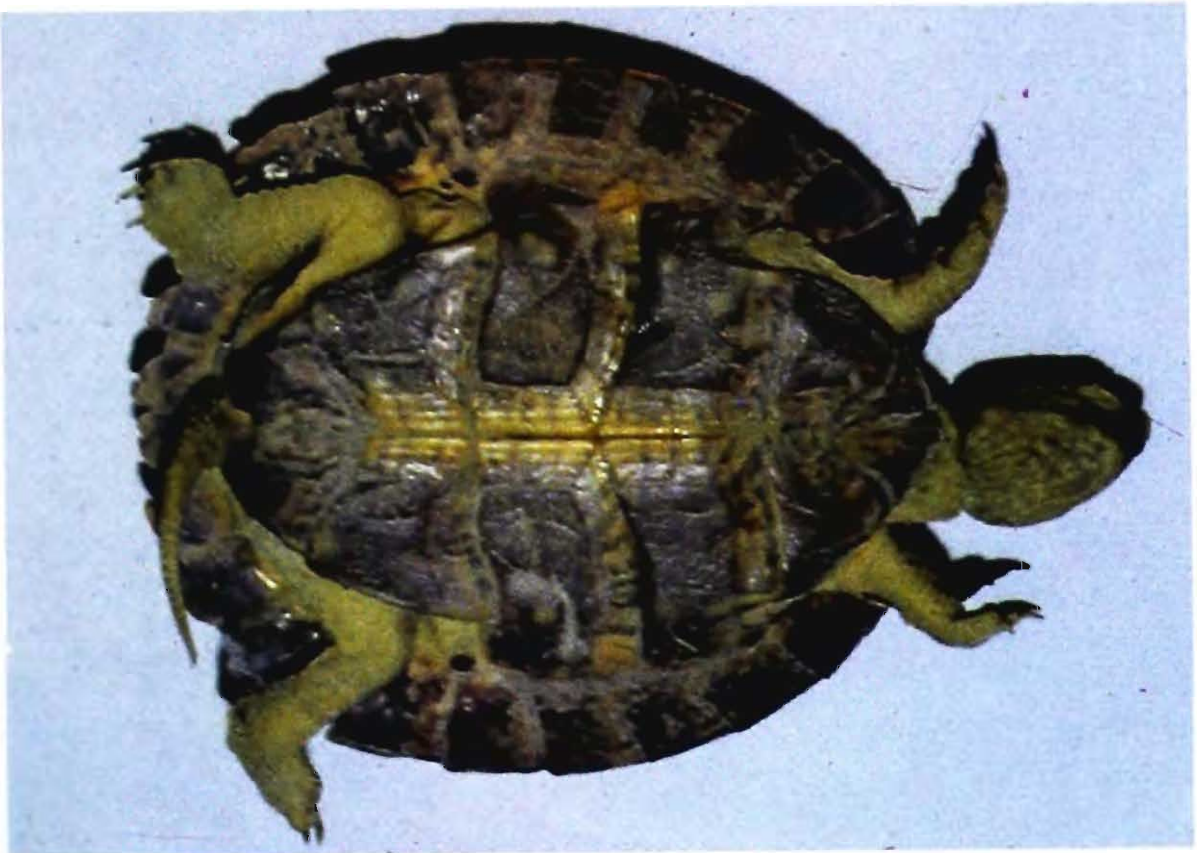
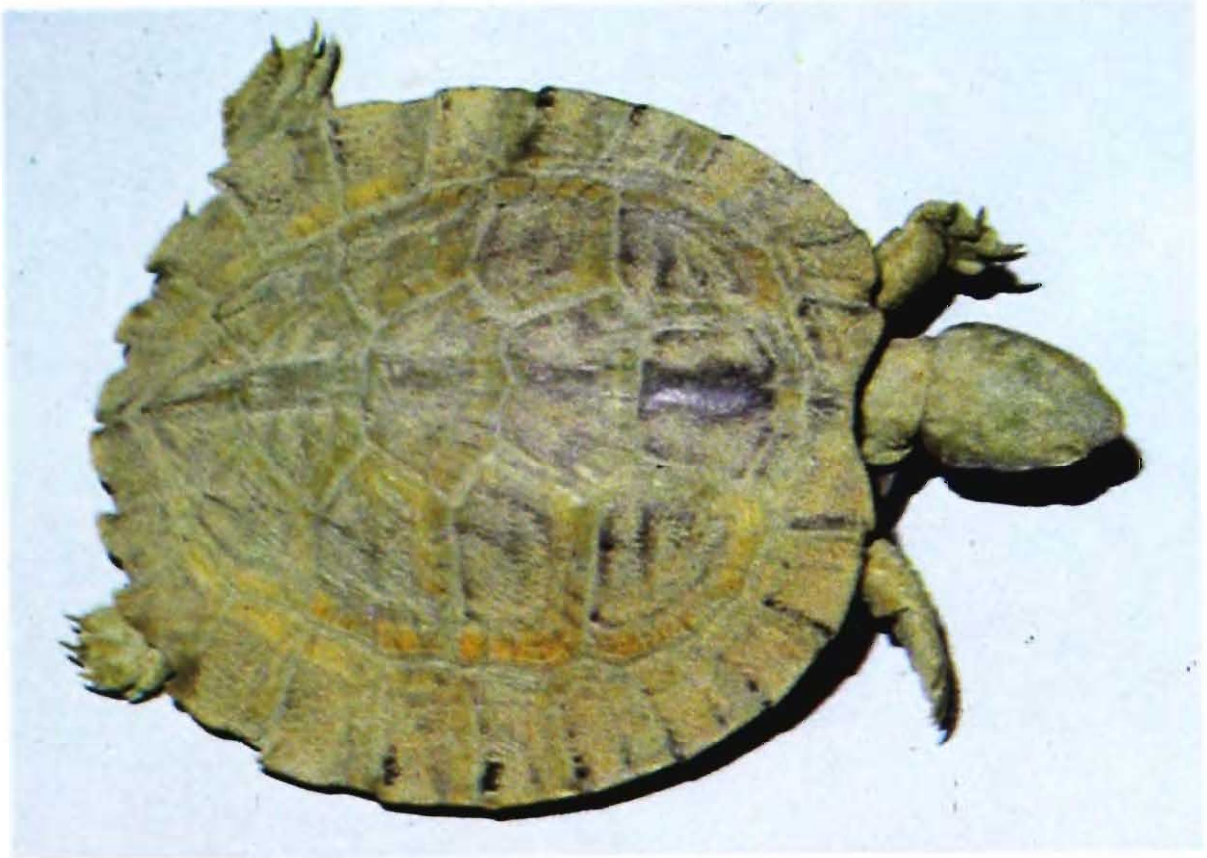
This is a small tortoise reaching a maximum length of 17 cm. in length. The head is moderately small, snout shorter than the orbit and truncate, skin of the posterior part of head is divided into large shields. Skull with a bony temporal arch. Alveolar surfaces of jaws narrow and upper is with a prominent median hook. The carapace (Fig. 49) is strongly tricarinate, greatly flattened on the vertebral region; anterior and posterior margins are serrated. Neural plates of the carapace hexagonal and with a narrow posterior margin. Nuchal shield is quite long and narrow; first vertebral shield is broadest on the posterior margin in the adults and is narrower than second; second, third, and fourth vertebral shields much broader than long, almost as broad as the costal shields. Plastron (Fig. 50) smaller than the opening of the shell, truncate anteriorly, notched posteriorly; united to the carapace by ligamentous tissue; with a short but absolutely distinct bridge, its width one-third the length of the plastron, the hypoplastral bone contributes more to the formation of the bridge than the hyoplastral bone; with an indistinct hinge between the hyo—and hypoplastral bones; only the front plastral lobe is movable; entoplastron intersected by the humero-pectoral suture; the longest median suture is between the abdominal shields, the shortest is between the gular shields; the suture between the pectoral and the abdominal shields corresponds with the hinge between the hyo—and hypoplastral bones. Axillary shield may be present or absent. Limbs are with half webbed digits, fore arm is completely covered with large, imbricate, horny shields; hind limbs club-shaped, its lower part and the sole of the foot with imbricate, pointed, horny shields. Tail is moderately long, its base and the adjacent skin of the thighs with pointed tubercles. Dorsum uniformly light brown, lateral most portion of the costal shields is dark brown. Ventrums yellowish-brown, with a dark spot on each plastral shield. Head brownish with dark vermiculations; temporal region with dark edged light spots.

Distribution: Hainan, India (Assam), Laos, Vietnam.

Habits and habitat: The species is docile, quite active, omnivorous, at ease in water as well as on land, and juveniles prefer to live in hill streams. It lays one to three eggs in a single clutch measuring 51-56 mm. in length and 25-27 mm. in width (Plate 44).

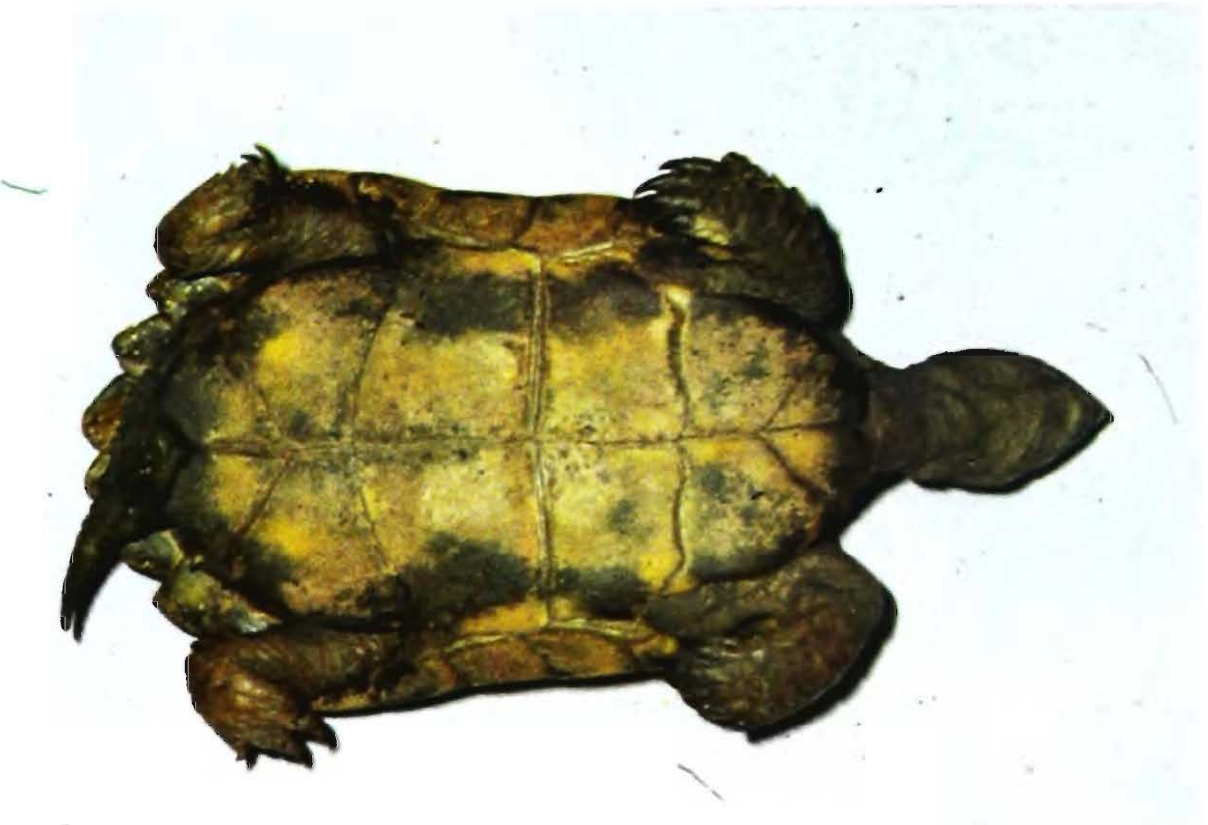
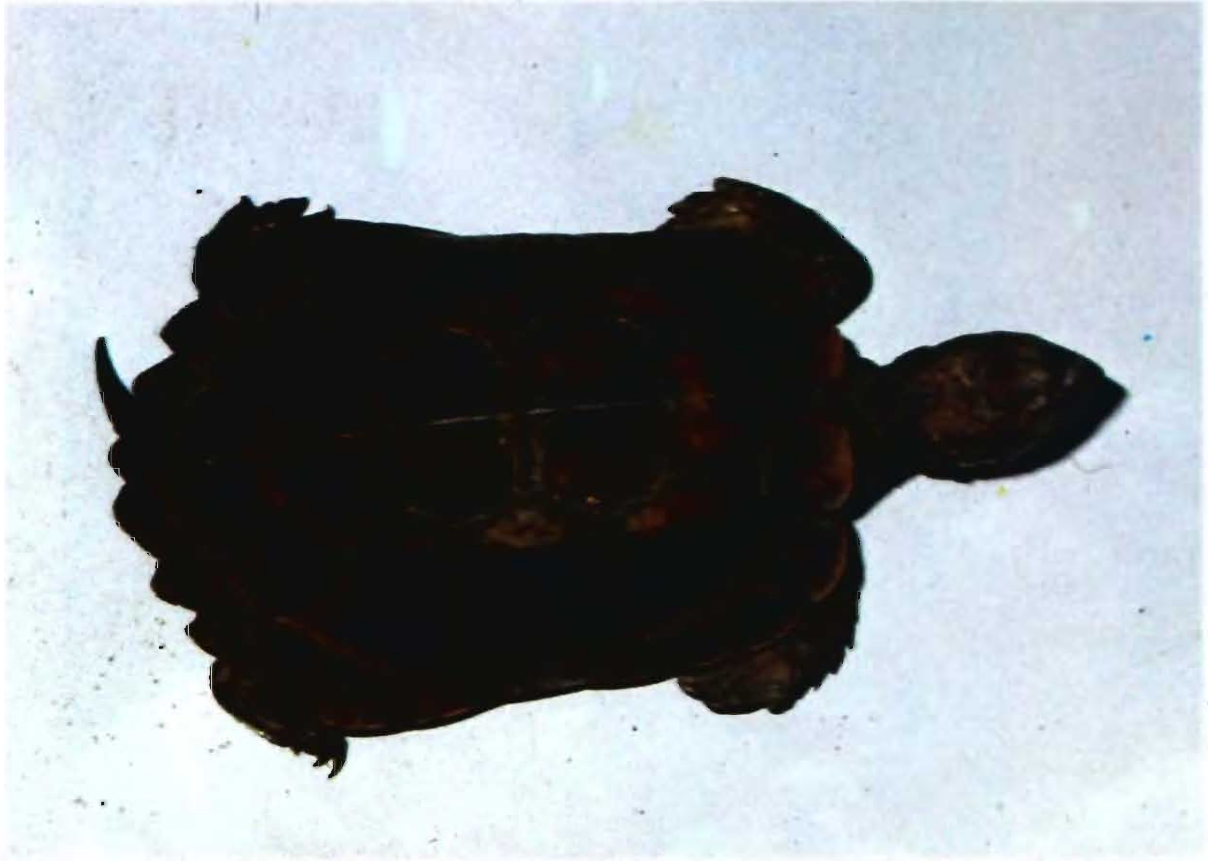
Status : Insufficiently known.

PLATE 18

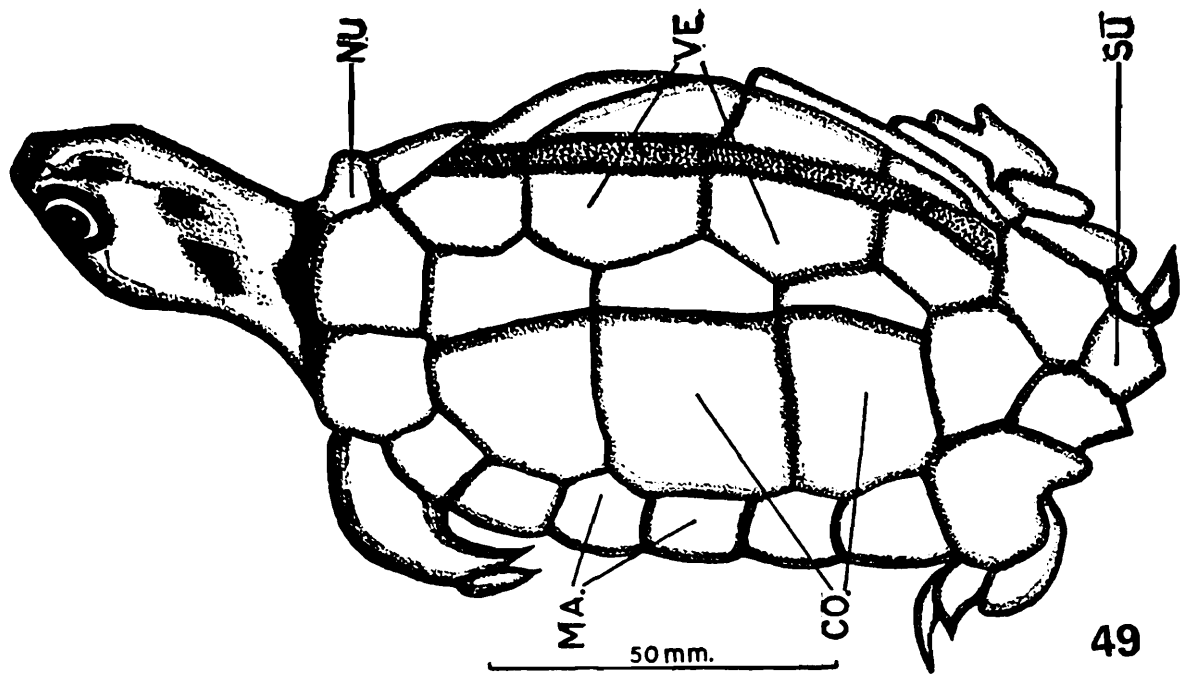


Garo and Khasi Hill Tortoise—*Cyclemys dentata* (Gray) Dorsal view, Ventral view.

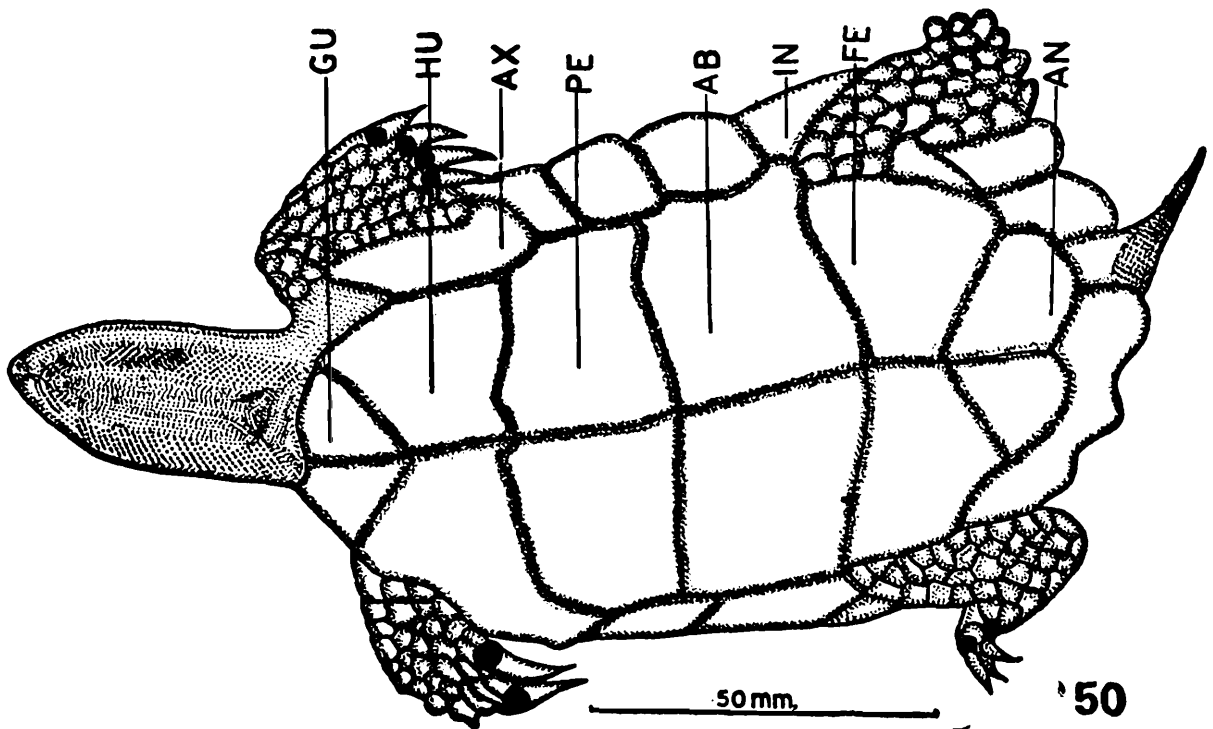
PLATE 19



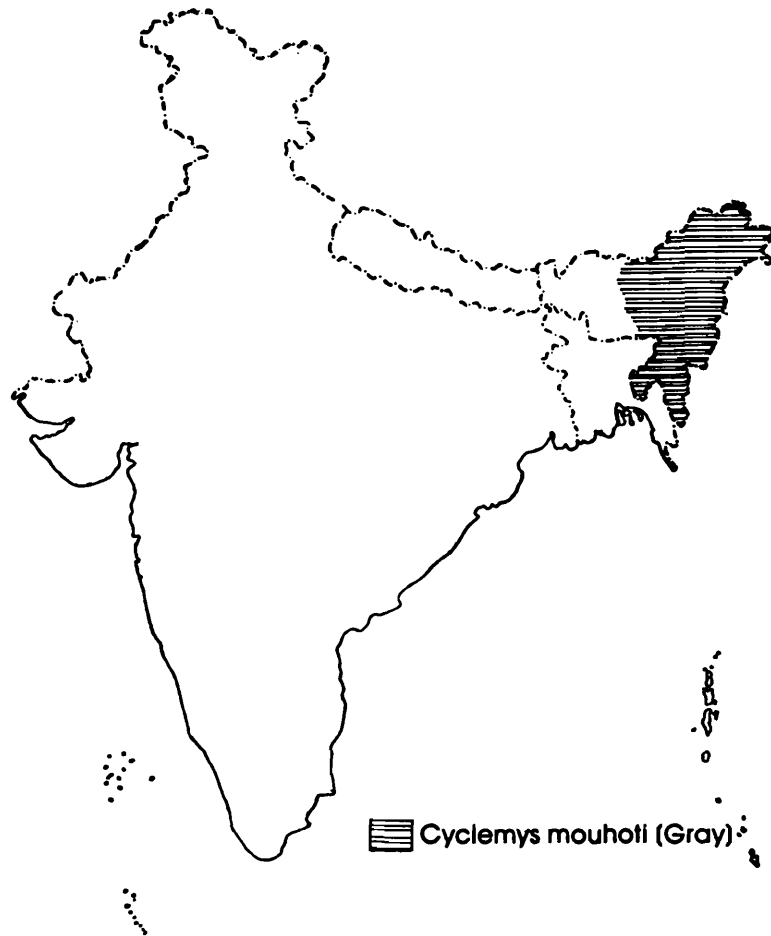
Assam Freshwater Tortoise—*Cyclemys mouhetii* (Gray) Dorsal view, Ventral view.



49. Carapace of *Cyclenys mouhoti* (Gray)



50. Plastron of *Cyclenys mouhoti* (Gray)



Map showing the distribution of *Cyclemys mouhoti* (Gray)

Conservation: Conservation measures have not so far been implemented adequately for the protection of this species. As a protective measure the species must be included in Appendix I of the Indian Wild Life Act.

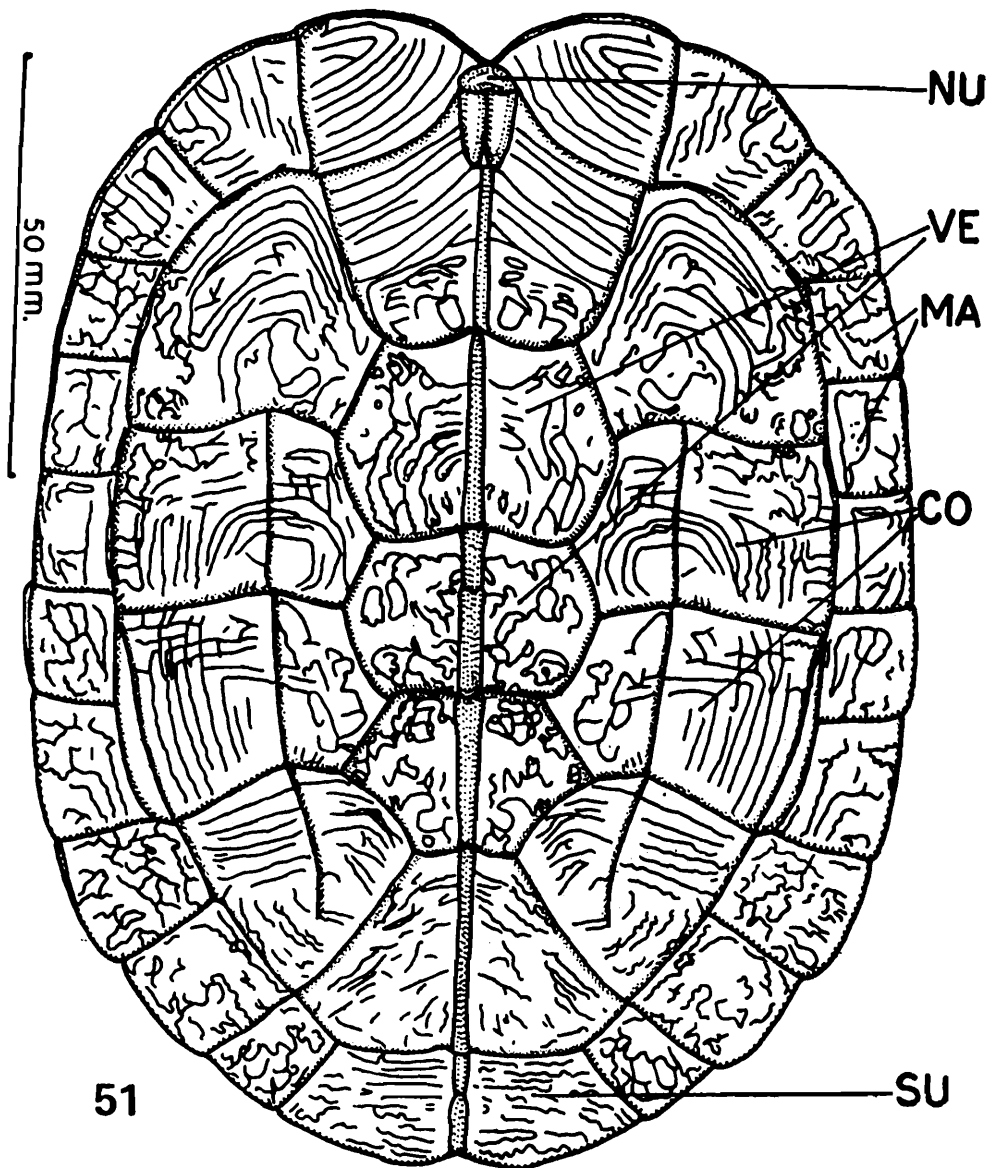
Genus 11. *Heosemys* Stejneger 1902

KAVALAI FOREST TURTLE

17. *Heosemys silvatica* (Henderson 1912)

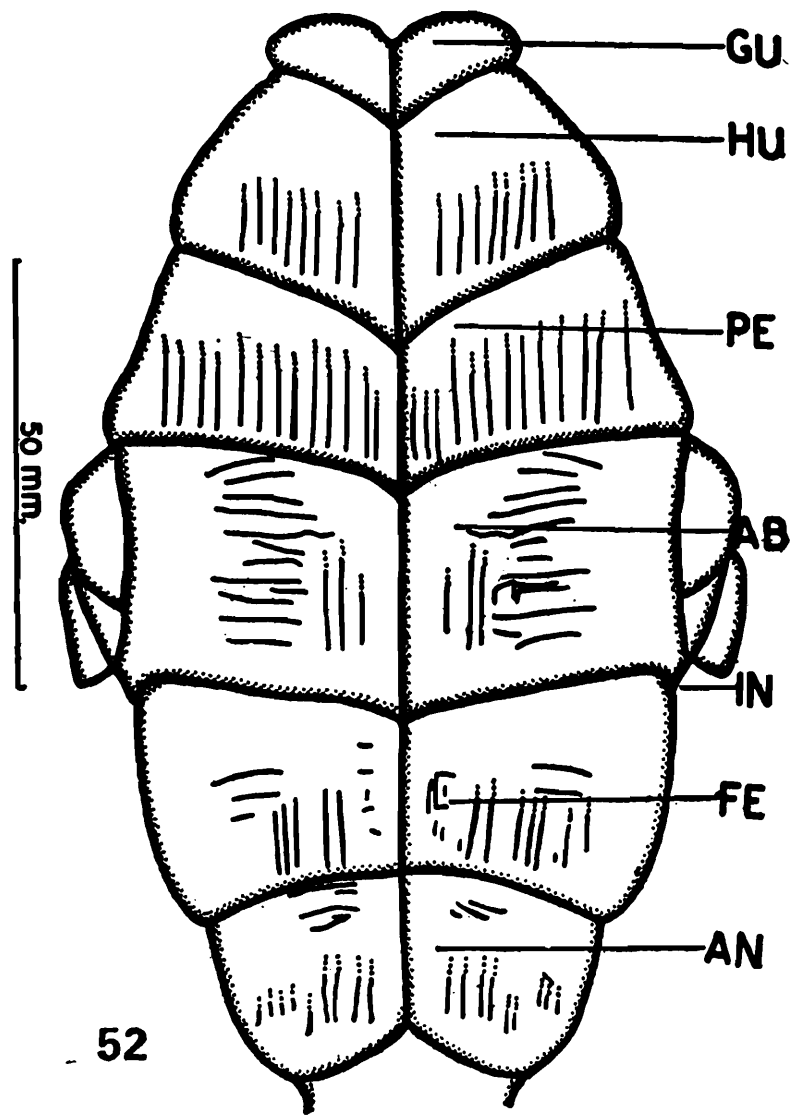
(Plate 20; figs. 51, 52)

This is a very small, secretive, freshwater-terrestrial turtle not reaching more than 12 cm. in length. Henderson (1912) originally described this species under genus *Geoemyda*. Until more material of this species is examined its true affinities are subject to doubt. The head is comparatively large, snout tube-like, truncated anteriorly and is as long as the orbit, upper



51. Carapace of *Heosemys silvatica* (Henderson)

jaw hooked; mandibular symphysis are very long, longer than the greatest diameter of the orbit. Skin of the posterior portion of head is having moderately large shields. Skull characters are not known fully. Carapace (Fig. 51) is much depressed and is provided with a strong vertebral keel. Two feebly developed keels are present on both the lateral aspects of carapace. The posterior margin of the shell is slightly reverted. Nuchal shield is small; first vertebral shield is broader in front than behind, larger than the second, third, and fourth vertebrals. Second, third and fourth vertebral shields are much broader than long and as broad as the costals. Plastron (Fig. 52) is almost as large as the shell opening and consists of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields. It angulates laterally, openly emerginate anteriorly and posteriorly and the width of the bridge is less than the length of the hind lobe. The longest medium suture is between the abdominal shields and the shortest suture exists between the gular. The axillary and inguinal shields of plastron are very small. Fore limbs are with enlarged, squarish, pointed, horny scales,

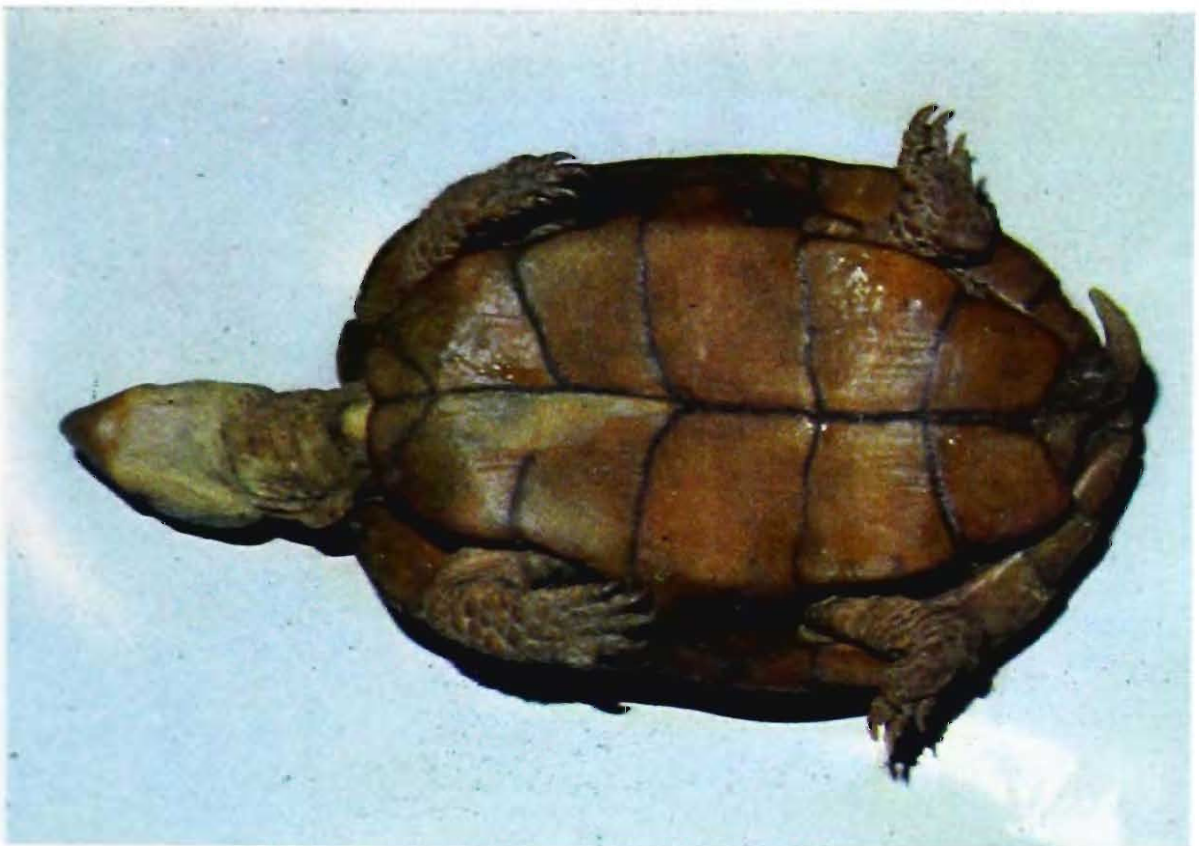
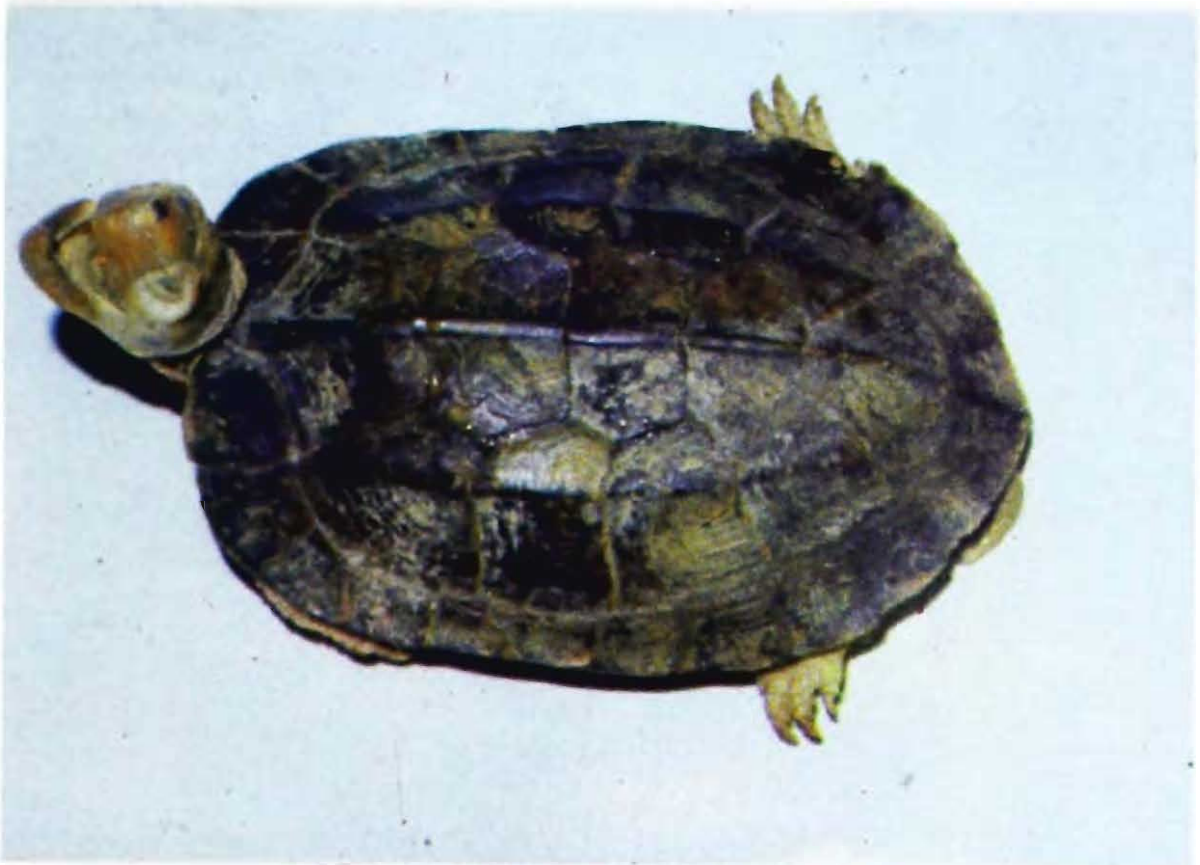


52. Plastron of *Heosemys silvatica* (Henderson)

mainly on the front. The hind limbs are club-shaped, the anterior margins and the region of heels are having enlarged horny scales. Fingers are webbed at the base. Toes are also provided with a rudimentary web-system. Tail is very short. The measurements include as length of shell 120 mm. breadth 83 mm. and depth 45 mm. The carapace is dark brown or bronzy. Plastron is yellow with two distinct deep yellow spots on the bridge. Upper portion of the forehead and jaws are bright yellow, hinder part of head and neck are brown, limbs and tail are black and top of snout is provided with a red spot.

Distribution: Endemic to Kerala (India). The species is based on two specimens collected in 1911 near Kavalai, about 33 km. from Chalakudi forests near Cochin in Kerala State of India. Recently in October-November 1982 three more turtles have been collected by Dr. P. T. Cherian of the Zoological Survey of India and by the Officers of Madras Snake Park Trust. Many living turtles were kept in the Crocodile Bank maintained by Madras Snake Park Trust on Mahabalipuram road at Madras.

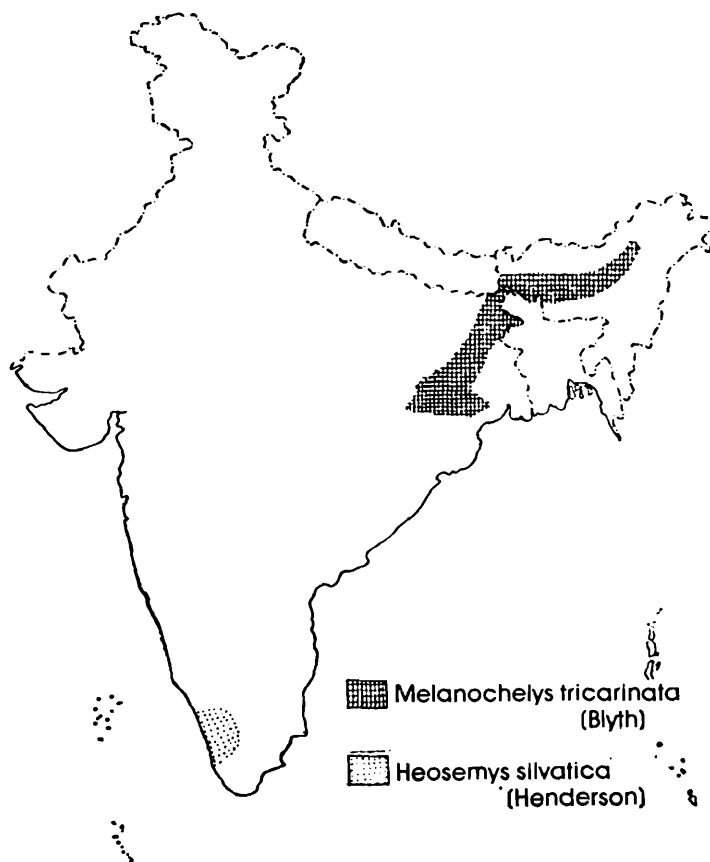
PLATE 20



Kavalai Forest Turtle—*Heosemys silvatica* (Henderson) Dorsal view, Ventral view.

Habits and habitat: According to the information provided by Dr. P. T. Cherian, local tribals and on the basis of original description, this turtle prefers to live in dense upland rain forest up to 500 metres altitude. Turtles live in small burrows on the muddy-rocky hill slopes covered with dense forest litter. The brownish colouration of the turtle is most suitable and renders it ability to camouflage in the brownish dry leaves. The species is said to be living entirely on vegetable material. Nothing is known about its breeding habits.

Status: The species is threatened mainly by loss of its rain forest habitat. It is reported by many local tribals that the liver of this turtle is a certain cure and preventive measure for bleeding piles and as such this turtle is killed immediately for the purpose, if traced anywhere in these forests.



Map showing the distribution of *Melanochelys tricarinata* (Blyth), and *Heosemys silvatica* (Henderson)

Conservation: Though rare, this species still exist in the rain forest area of Kerala. The protection of its habitat will naturally help in the conservation of this small, rare and curious turtle.

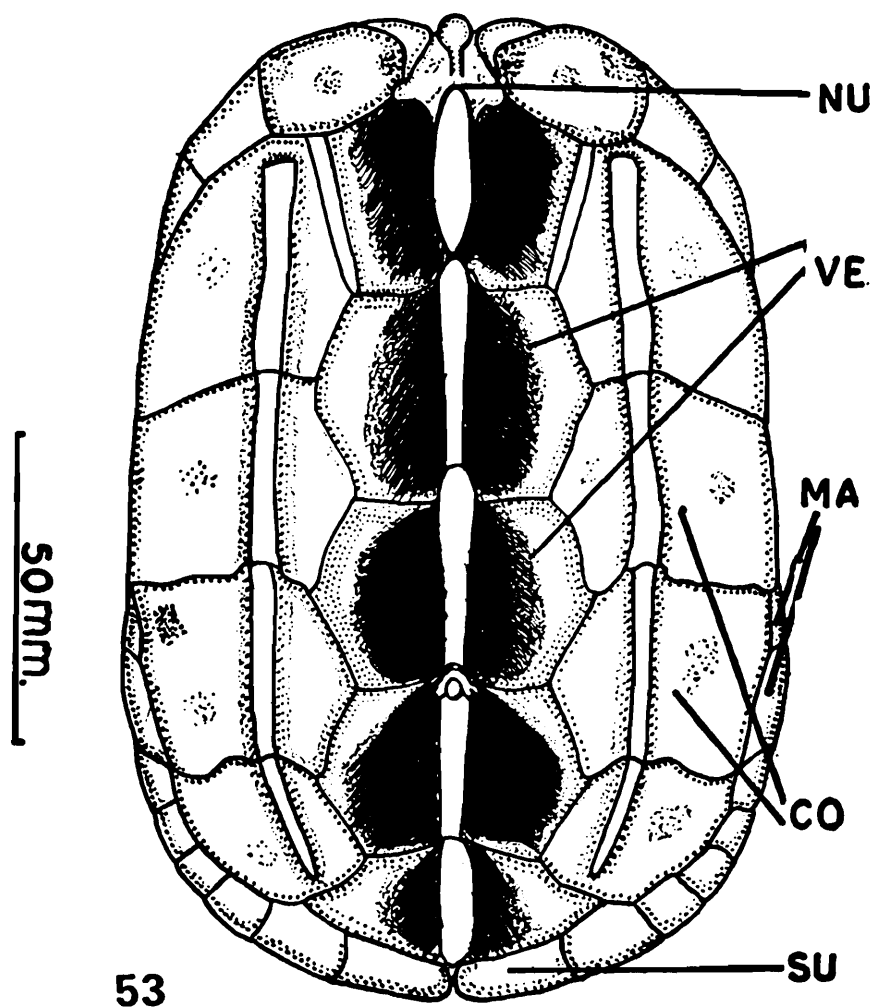
Genus 12. *Melanochelys* Gray 1869

THREE KEELED TORTOISE

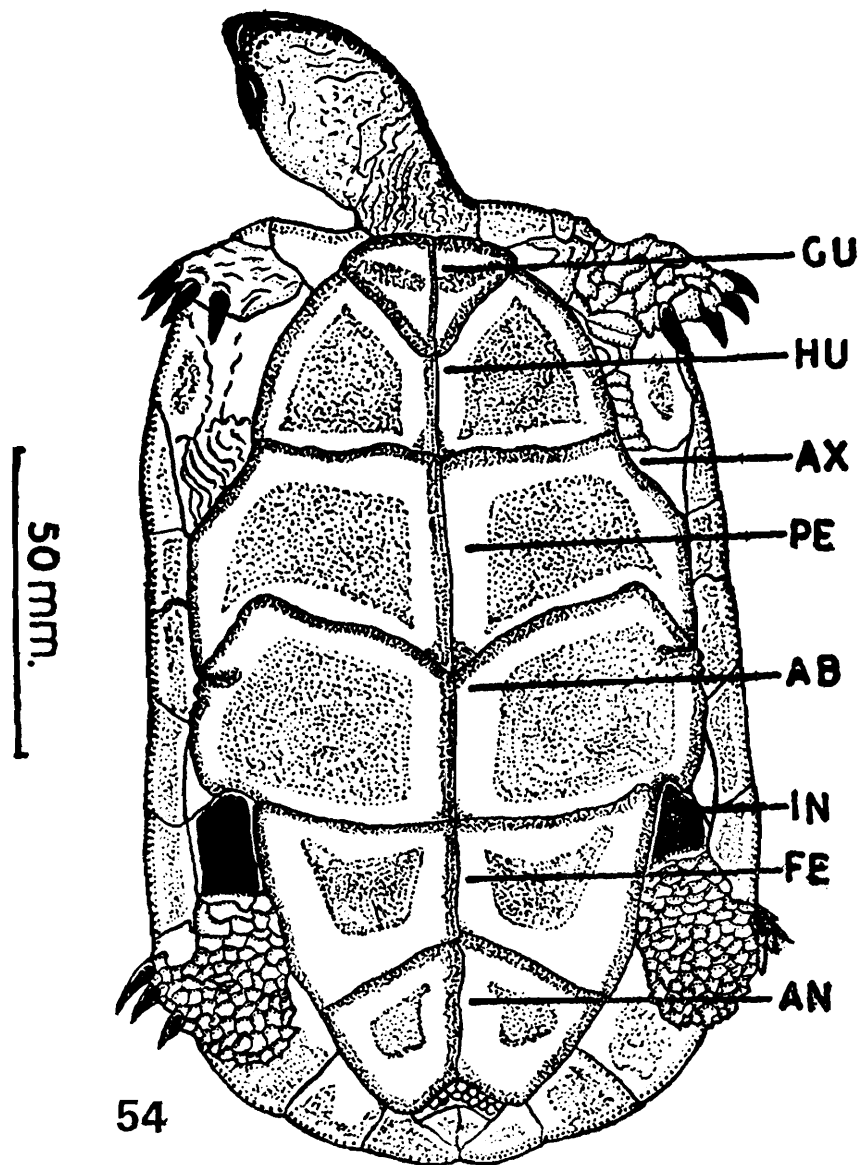
18. *Melanochelys tricarinata* (Blyth 1856)

(Plates 21 & 44; figs. 53, 54)

This is a moderately small species reaching a length of 17 cm. The head is moderately small, snout shorter than the orbit, truncate, upper jaw feebly notched at the middle. Skin of the posterior portion of head is divided into large shields. Skull is with a slender, thin and incomplete bony temporal arch; alveolar surfaces of jaws are narrow, without median ridge; choanae on a level with the anterior portion of the orbits; squamosal bone is present. The carapace (Fig. 53) is much elongated, arched and with steep sides in fully grown up males; with three obtuse keels; posterior border smooth or feebly serrated. Second neural plate is generally octagonal, other succeeding neural plates are narrow on the posterior border.

53. Carapace of *Melanochelys tricarinata* (Blyth)

Nuchal shield is not very large; first vertebral shield is broadest on the anterior margin; second, third, and fourth vertebrae broader than long, narrower than the costal shields. Plastron is intimately attached to the carapace by a suture, with short axillary and inguinal buttresses which reach to the outer margins of the costal plates. Entoplastron intersected by the



54. Plastron of *Melanochelys tricarinata* (Blyth)

humeropectoral suture. Plastron (Fig. 54) usually as long as the carapace, feebly angulated laterally in the juveniles, truncate anteriorly; hind plastral lobe is narrower than the shell opening, longer than the width of the bridge, notched posteriorly; the longest median suture is between the abdominal or the pectoral shields, the shortest between the humeral or the femoral, axillary shield usually present, inguinal shield is usually missing. Limbs are with long claws, fingers half webbed, toes with rudimentary webs only. Front part of arms with enlarged, squarish somewhat pointed scales; hind limbs flattened and quite large in the grown up males, the anterior margins and keels with enlarged horny scales. Tail is short. Dorsum is dark-plum

coloured with light brown keels having dark brown outlines. Ventrums yellowish-brown. Head and limbs dark plum or blackish above; a broad red stripe on each side of the head, starting from the nostril and passing above the eye and the tympanum; a similar band below the angle of the mouth, along the inferior margin of the lower jaw. Limbs with or without yellow spots.

Distribution: The species is available from Chotanagpur (Bihar), Jalpaiguri district (West Bengal), and the Dafla Hills and Bisnath Plain in northern Assam.

Habits and habitat: The species inhabits the hilly terrestrial areas. It is mainly herbivorous and generally 3 to 6 oval eggs are laid in a single clutch (Plate 44). Egg laying takes place throughout the year.

Status: Indeterminate, probably vulnerable. The main threats to the species include large scale exploitation of eggs and adults for food by the local tribals. The habitat destruction is the another major threat to the survival of this species.

Conservation: As a protective measure the Director, Zoological Survey of India has already proposed for the inclusion of this species in Appendix I of the Indian Wildlife Act, 1972.

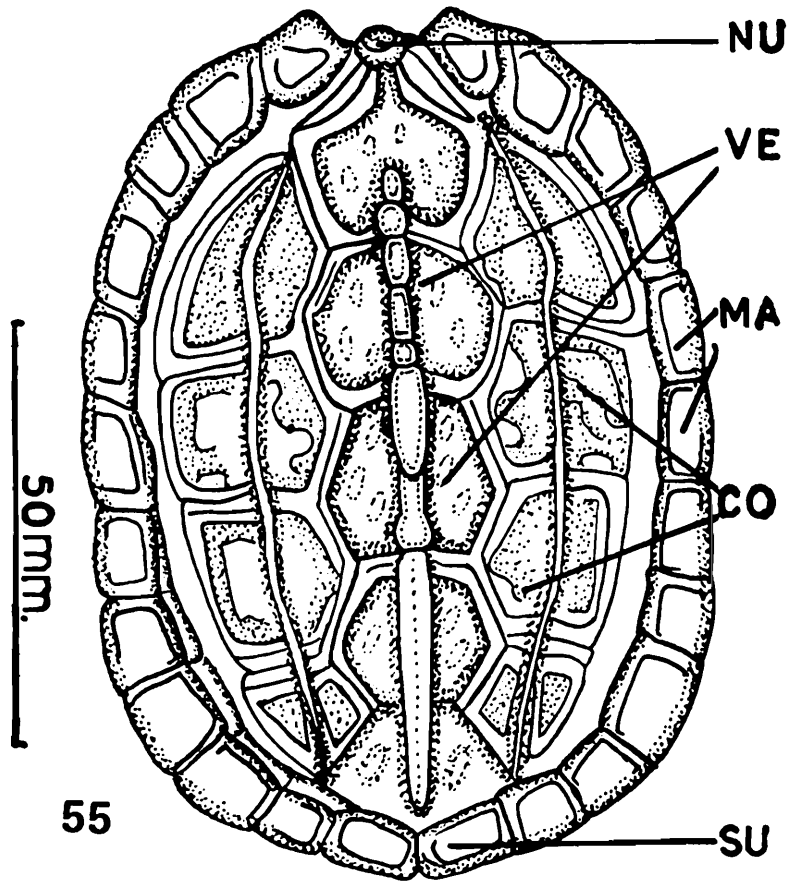
INDIAN SNAIL-EATING TURTLE

19. *Melanochelys trijuga trijuga* (Schweigger 1812)

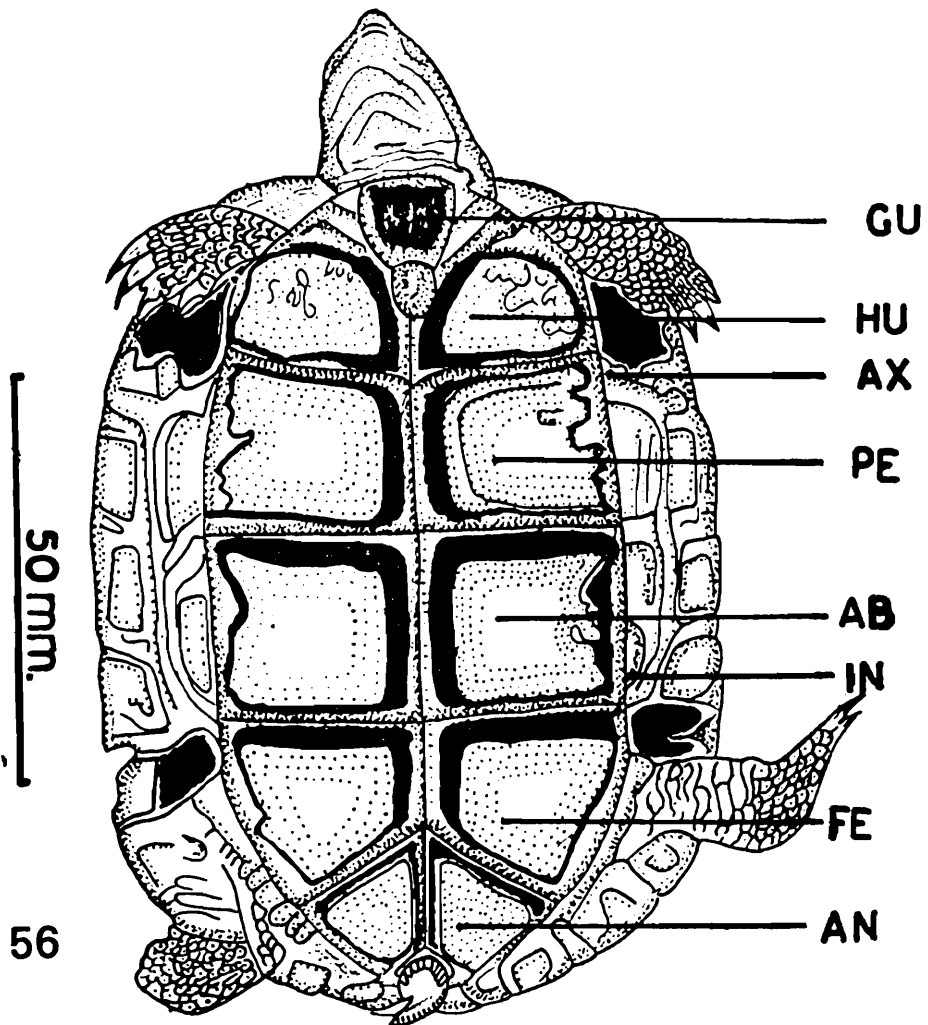
(Plate 22 ; figs. 55, 56)

Four well defined and perfectly established subspecies of *Melanochelys trijuga* are available in India (distribution shown in the accompanying map). These races are mainly recognised on the basis of head and shell colouration.

Size of this sub-species is moderate, reaching up to a length of 23 cm. or slightly more. The head is moderately small, snout shorter than the orbit, slightly projecting beyond the lower jaw; upper jaw notched at the middle. Skin of the posterior portion of head smooth but divided into large shields. Skull is with a bony temporal arch, which is sometimes incomplete posteriorly; alveolar surfaces of jaws are narrow, without median ridge; choanae on a level with the anterior portion of the orbits; squamosal bone is present. The carapace (Fig. 55) is moderately depressed, tricarinate, the lateral margins slightly reverted, the posterior margin feebly serrated in the young. Nuchal is moderately small; vertebral shields are quite



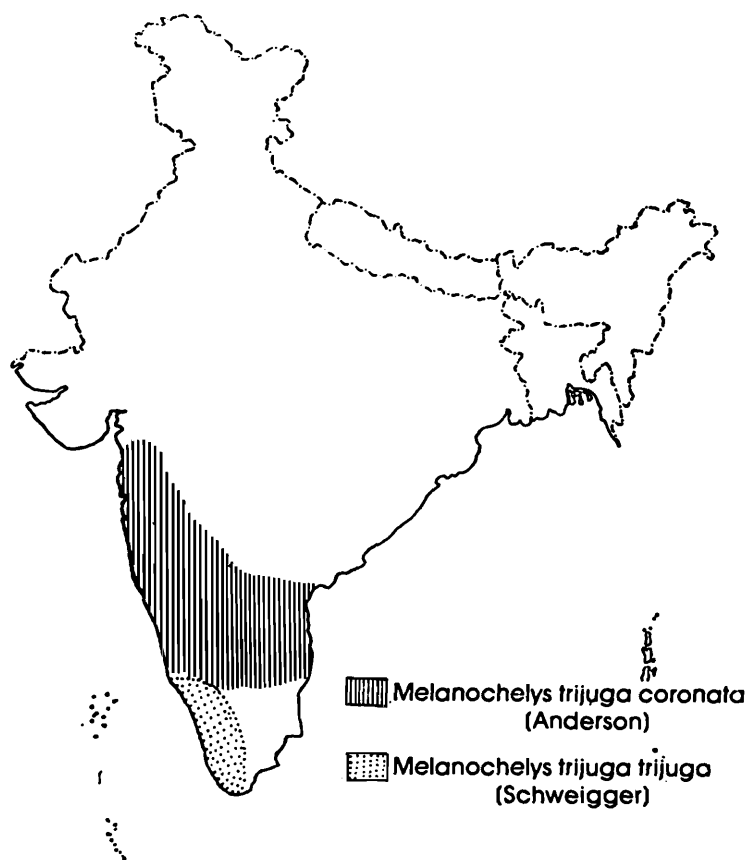
55. Carapace of *Melanochelys trijuga trijuga* (Schweigger)



56. Plastron of *Melanochelys trijuga trijuga* (Schweigger)

variable both in shape and proportions, as long as broad or longer than broad in the adult, slightly narrower than the costals. Plastron (Fig. 56) is intimately attached to the carapace by a suture, with short axillary and inguinal buttresses which reach to the outer margins of the costal plates. Entoplastron intersected by the humero-pectoral suture. Plastron is almost as long as the carapace, truncate and openly emerginating anteriorly; hind plastral lobe is narrower than the shell opening, generally shorter than the width of the plastral bridge, deeply notched posteriorly; the longest median suture is between the abdominal shields or the pectoral shields, the shortest median suture is between the humeral shields. Axillary and inguinal shields are present. Limbs are flattened and with completely webbed digits; front of arm and hinder part of leg with enlarged horny scales. Tail very short in comparison to the body. Dorsum light brown in the juveniles and dark brown to blackish in the adults. The plastron has a yellow margin which reduces in width by the advancement of age. Lateral keels are yellow in the young. Head is greyish or olivaceous with yellow or pink reticulations which are more prominent on the sides; these markings become obscured with the advancement of age.

Distribution: The subspecies is available in Goa, Karnataka, Kerala, Maharashtra and Tamil Nadu. It inhabits mainly the central portion of Indian peninsula.



Map showing the distribution of *Melanochelys trijuga coronata* (Anderson) and *Melanochelys trijuga trijuga* (Schweigger)

Habits and habitat: This subspecies is mainly aquatic and completely vegetarian in habits. Nothing is known about the breeding habits.

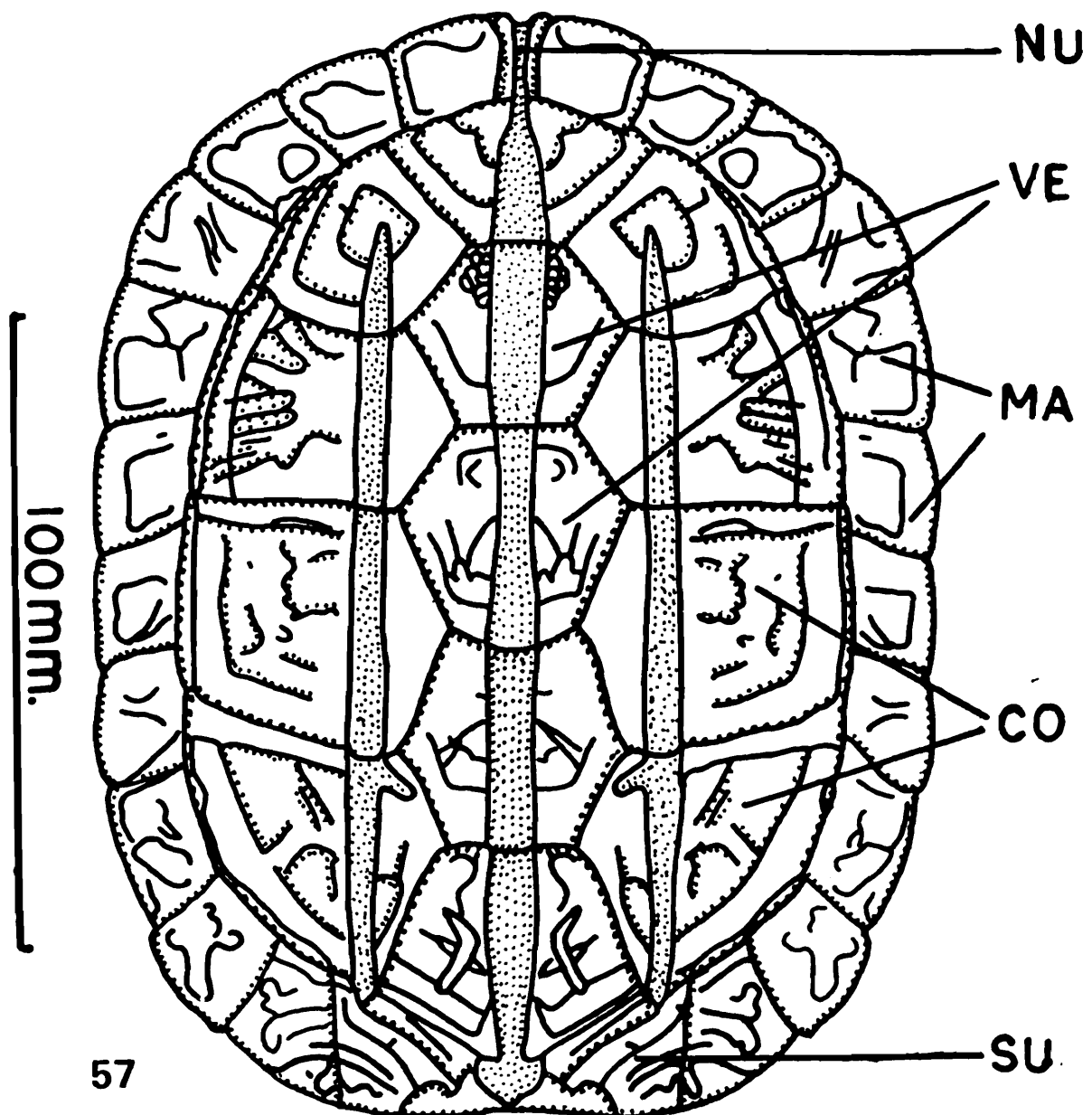
Status: Indeterminate, possibly vulnerable. The main threat to the subspecies is due to large scale exploitation of eggs and adults for food. The habitat destruction also has an impact on the decline of this turtle.

Conservation: Suitable conservation measures have not so far been implemented for the protection of this turtle. This subspecies must be included in Appendix I of the Indian Wildlife Act.

20. *Melanochelys trijuga coronata* (Anderson 1878)

(Plate 23; figs. 57, 58)

This is a small turtle in which the length never exceeds 18 cm. Taxonomic characters are the same as available in *M. trijuga trijuga* except that it

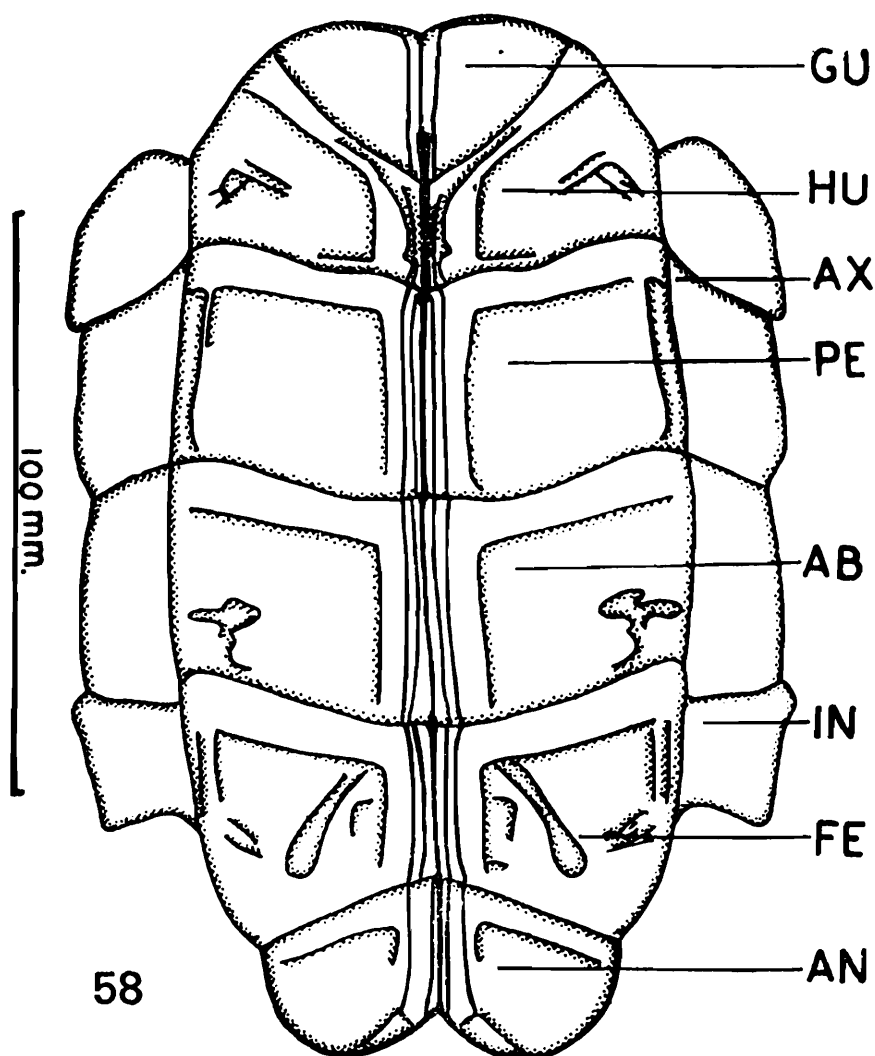


57. Carapace of *Melanochelys trijuga coronata* (Anderson)

differs in colouration. Complete dorsum and ventrum is dark brown or almost black without markings or spots. Top of the head and front of the snout black, temporal region is yellow and the rest of the head is olivaceous.

Distribution: The subspecies is confined to Kerala and is available near Cochin, Calicut and other adjoining areas.

Habits and habitat: Mainly aquatic and herbivorous. Nothing is known about its breeding habits.

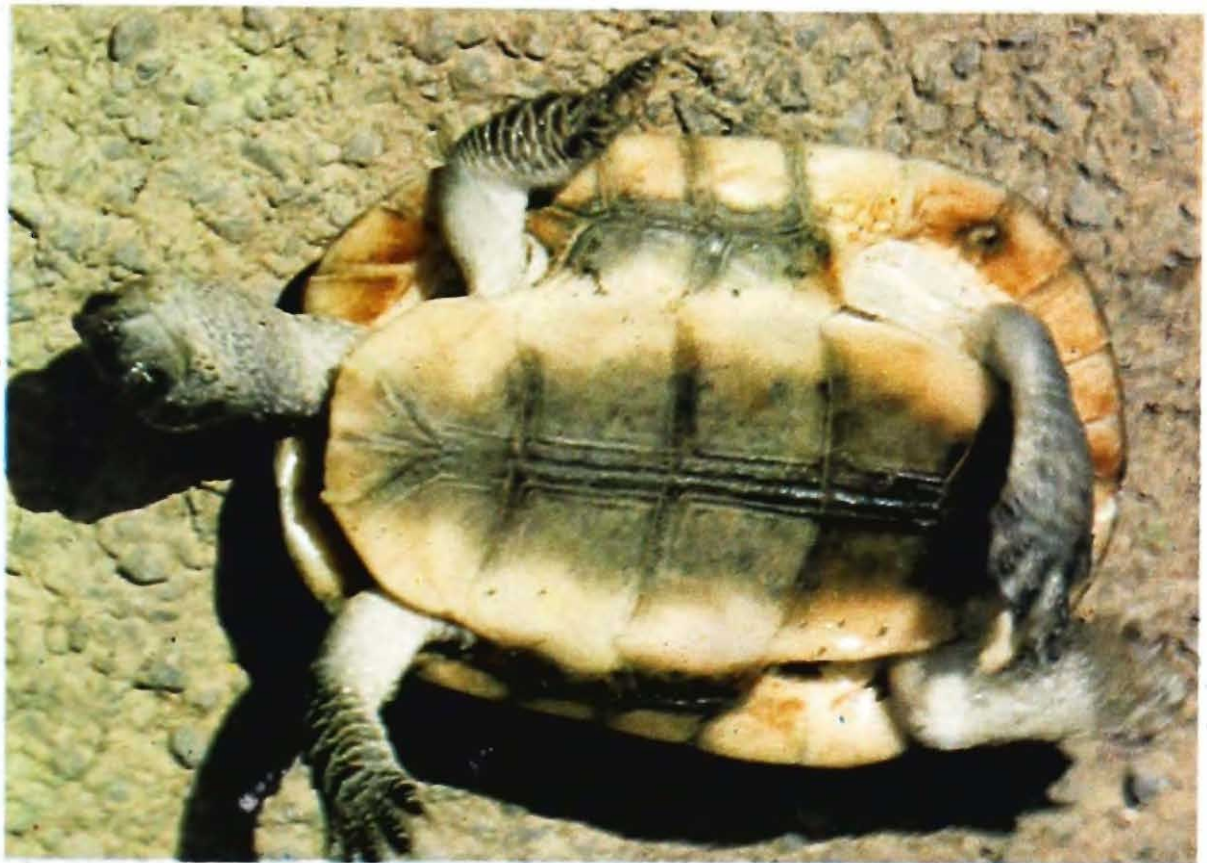


58. Plastron of *Melanochelys trijuga coronata* (Anderson)

Status: Indeterminate, possibly has become vulnerable on account of habitat destruction and large scale exploitation of eggs and adult individuals for food by the local tribals.

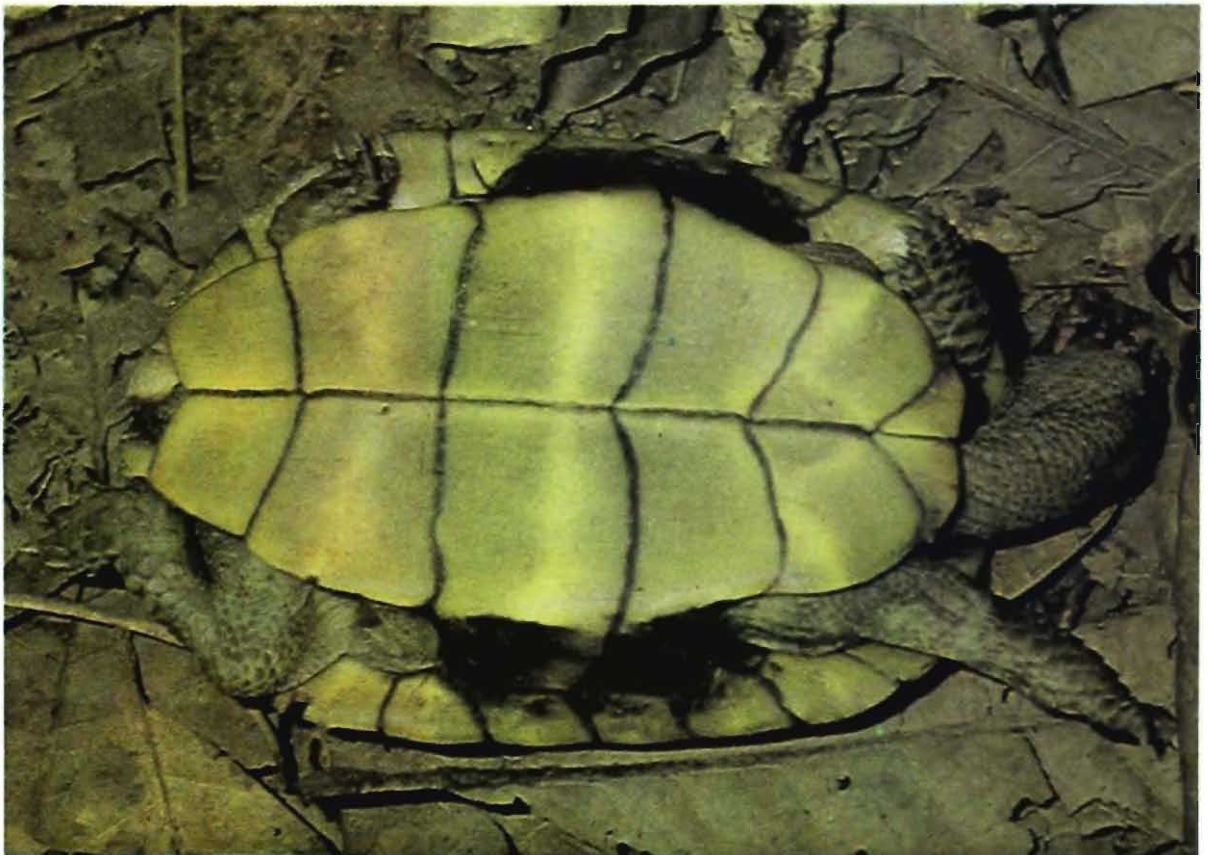
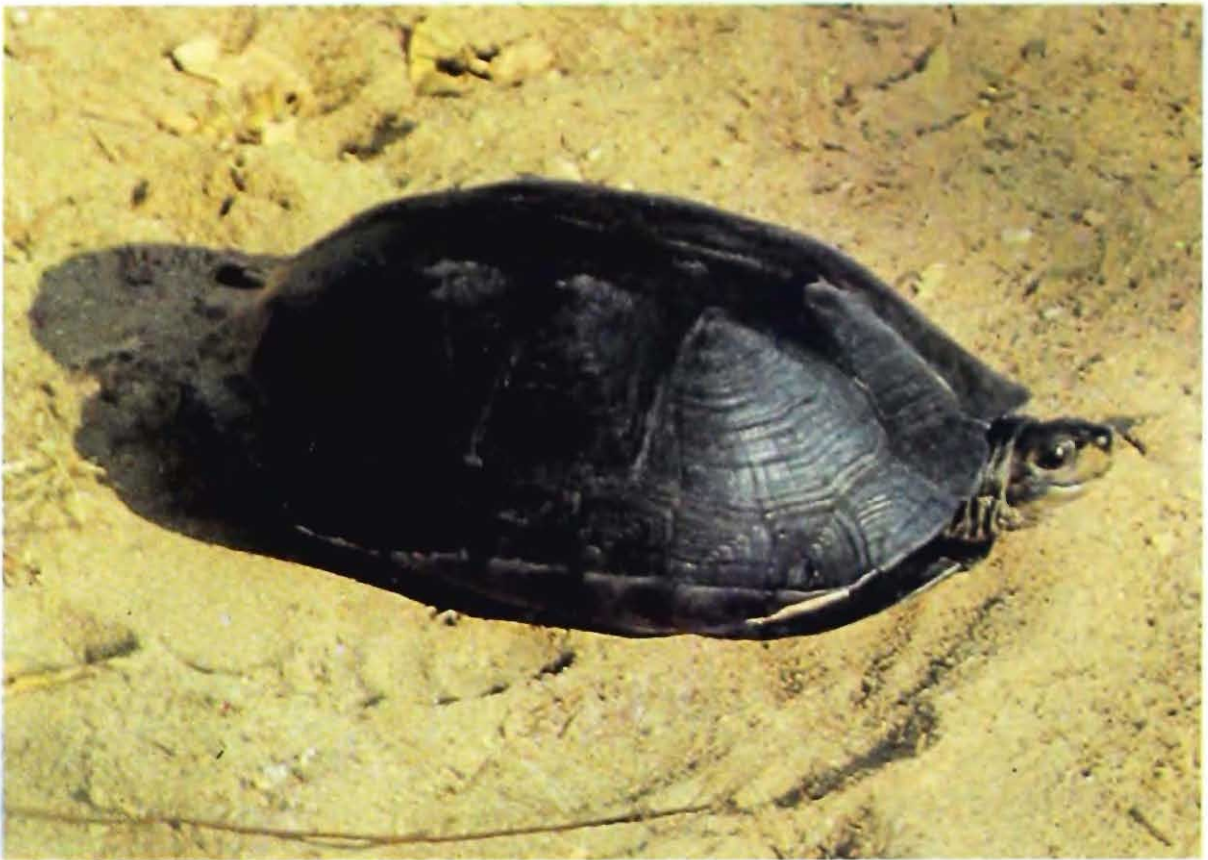
Conservation: Suitable conservation measures have not so far been implemented. This subspecies must be included in Appendix I of the Indian Wildlife Act.

PLATE 21



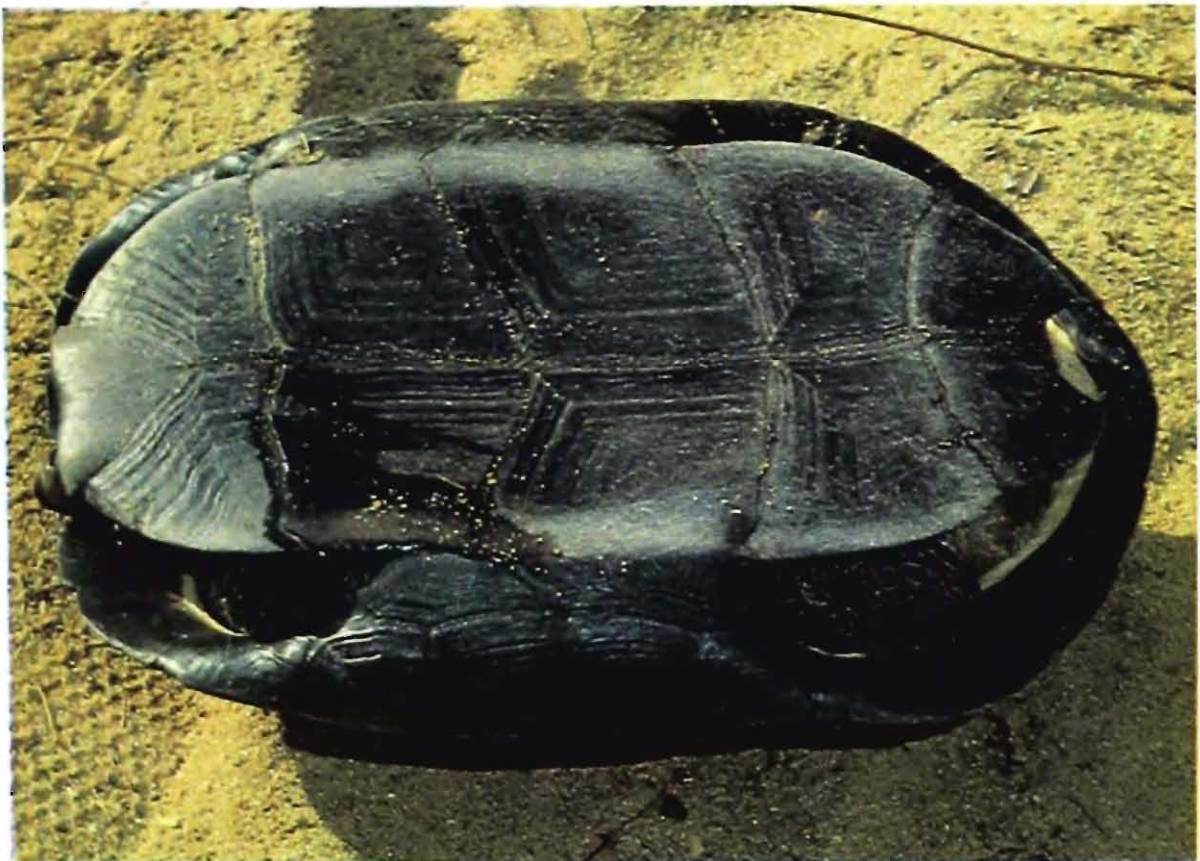
Three keeled Tortoise—*Melanochelys tricarinata* (Blyth) Dorsal view, Ventral view.

PLATE 22



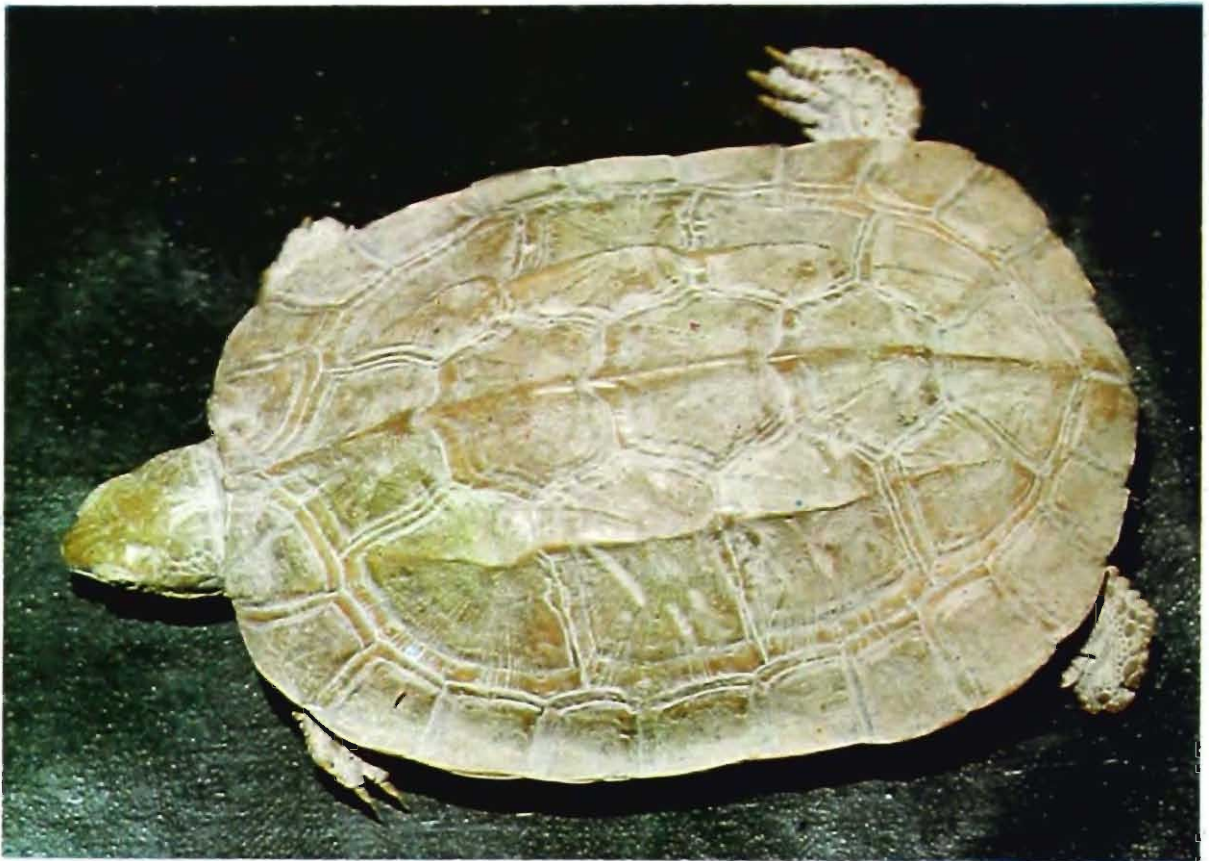
Indian Snail-eating Turtle—*Melanochelys trijuga trijuga* (Schweigger) Dorsal view, Ventral view.

PLATE 23



Melanochelys trijuga coronata (Anderson) Dorsal view Ventral view.

PLATE 24

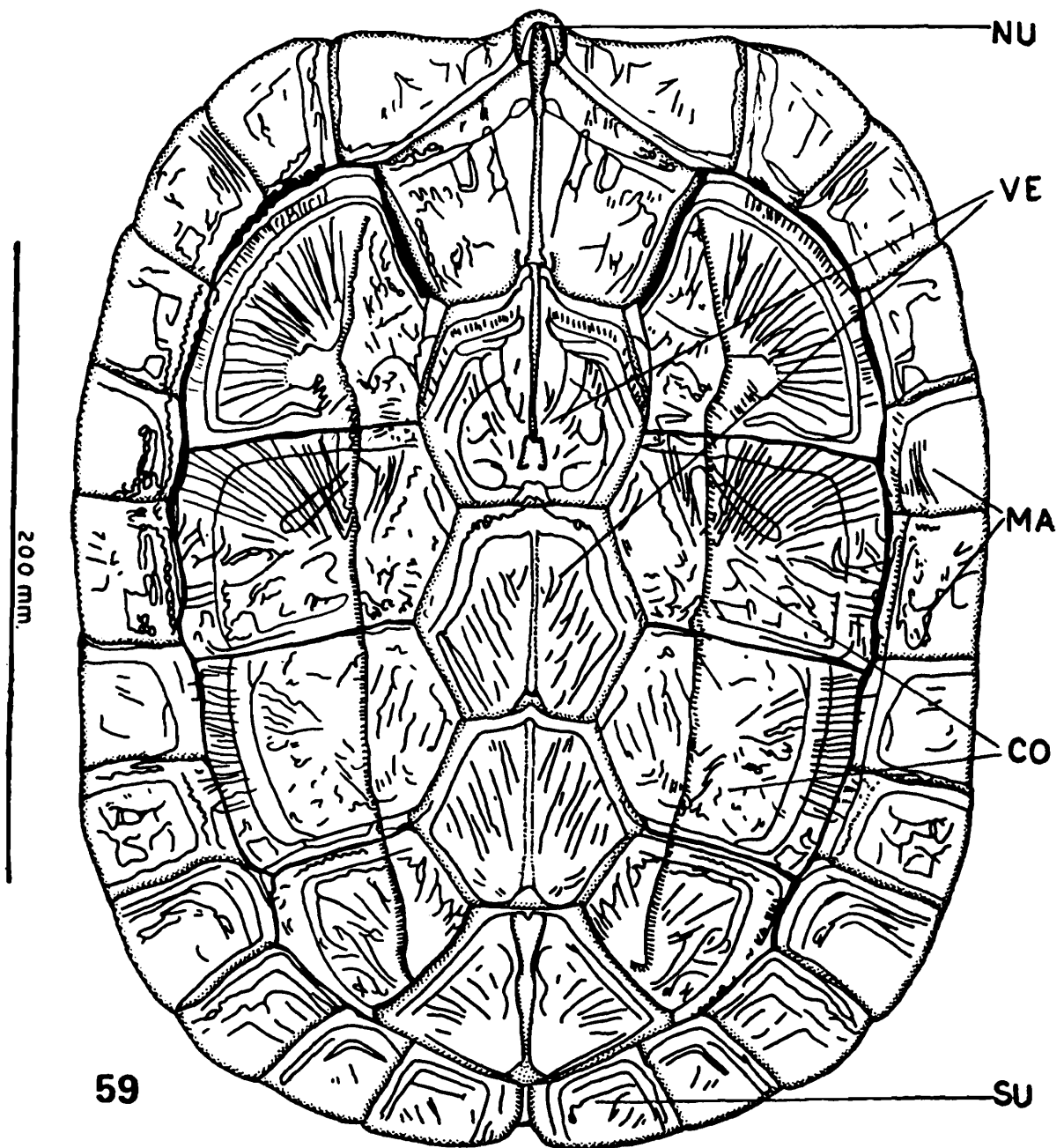


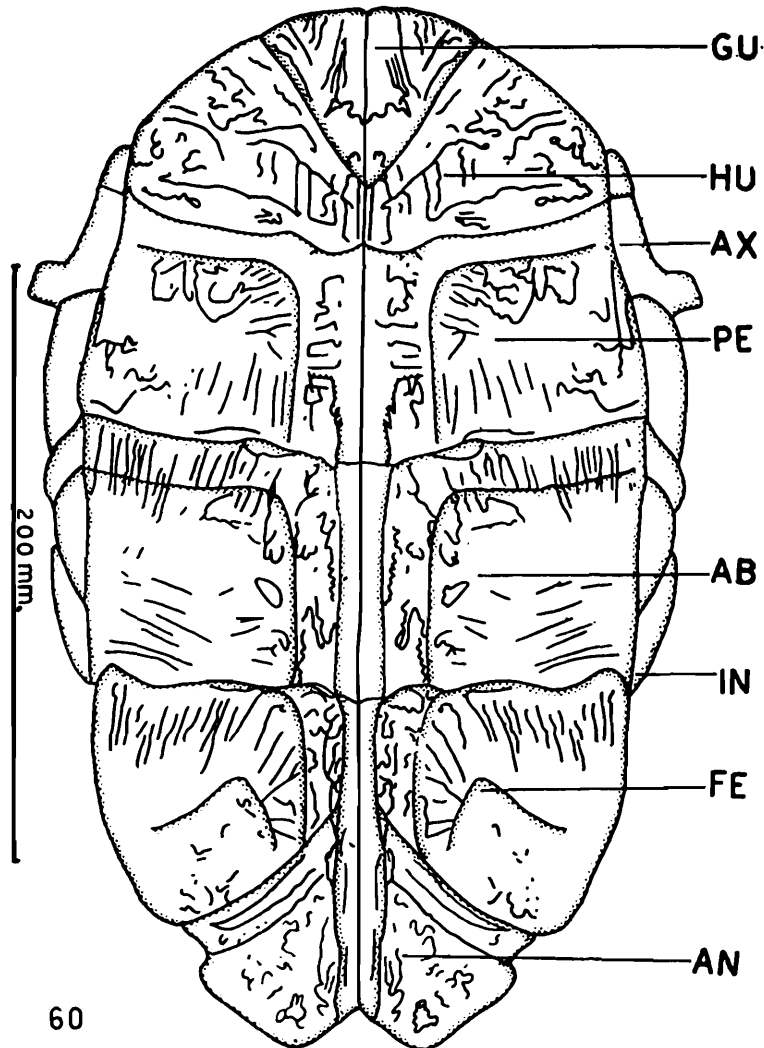
Melanochelys trijuga indopeninsularis (Annandale) Dorsal view, Ventral view.

21. *Melanochelys trijuga indopeninsularis* (Annandale 1913)

(Plate 24; figs. 59, 60)

This is a comparatively larger subspecies of turtle in which the shell reaches up to a length of 34 cm. Taxonomic characters are the same as available in *M. trijuga trijuga* except that it differs in colouration. Dorsum dark brown in the juveniles but deep black in the adults. Vertebral keels and plastral margins are yellow. Head grey or brownish, young with yellow reticulation but adults are devoid of such markings.

59. Carapace of *Melanochelys trijuga indopeninsularis* (Annandale)



60. Plastron of *Melanochelys trijuga indopeninsularis* (Annandale)

Distribution: Chotanagpur (Bihar) and Jalpaiguri District (West Bengal).

Habits and habitat: Mainly aquatic but at ease on the land also. It is herbivorous and food comprises the grass, vegetables and fruits. Nothing is known about the breeding habits of this subspecies.

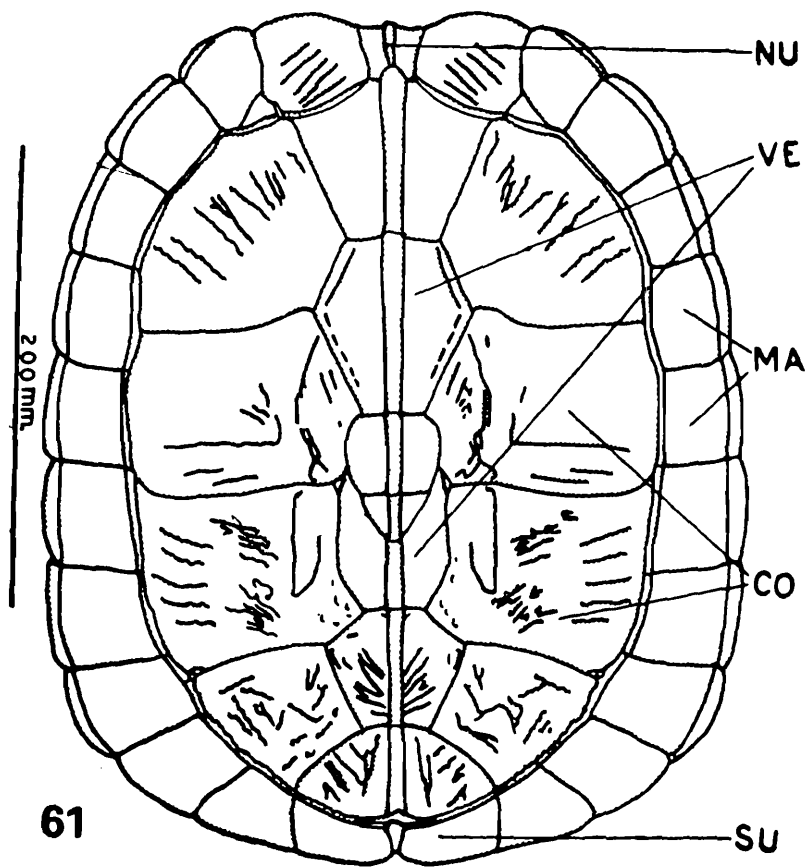
Status: Indeterminate, possibly has become vulnerable on account of habitat destruction and large scale exploitation of eggs and adult individuals for food by the local tribals.

Conservation: Suitable conservation measures have not yet been followed. This subspecies must be included in Appendix I of the Indian Wildlife Act.

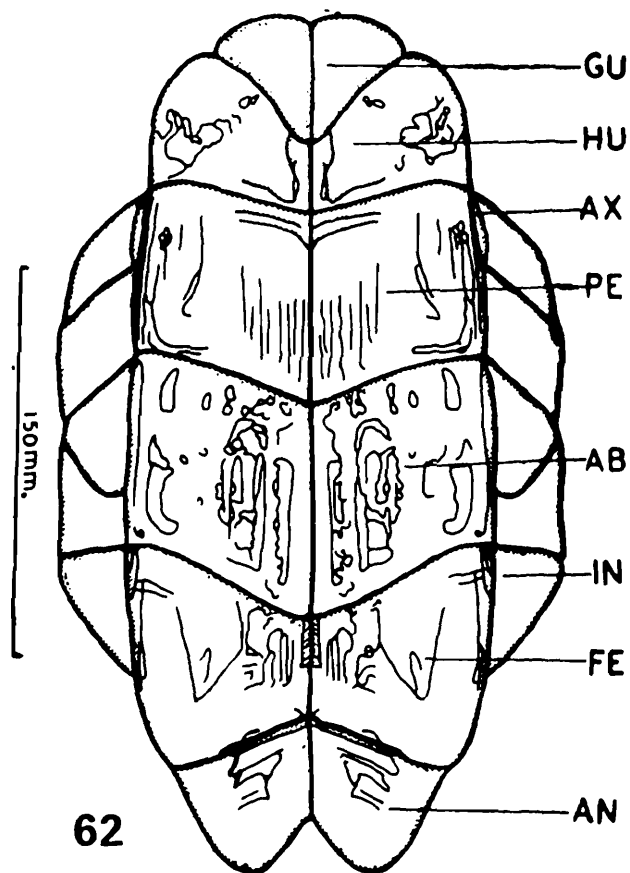
22. *Melanochelys trijuga thermalis* (Lesson 1830)

(Plate 25; figs. 61, 62)

This is a moderately large turtle in which length of the shell reaches up to 22 cm. Taxonomic characters are the same as available in the typical

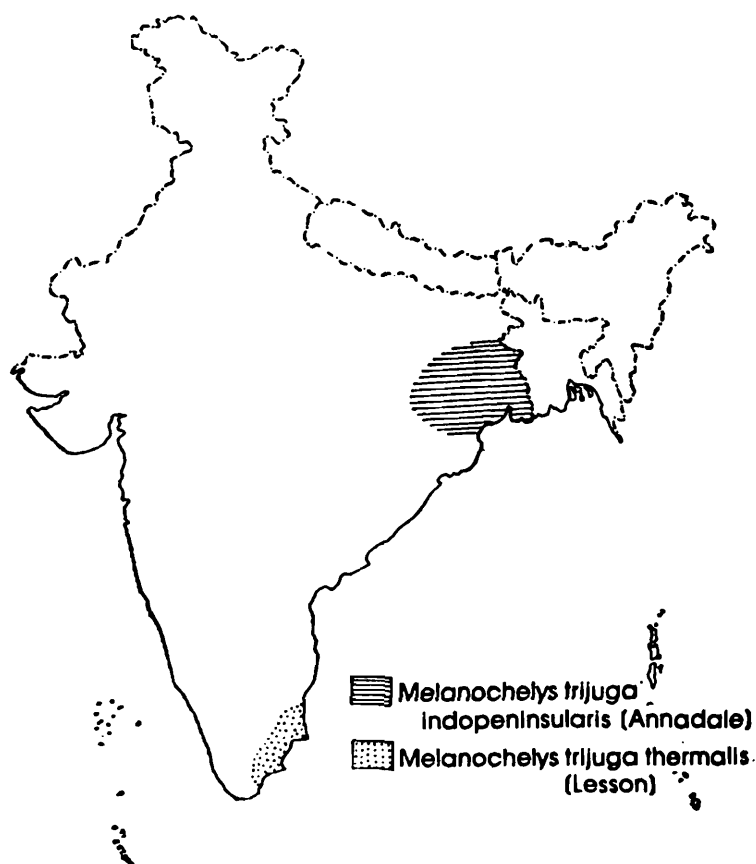


61. Carapace of *Melanochelys trijuga thermalis* (Lesson)



62. Plastron of *Melanochelys trijuga thermalis* (Lesson)

form except that it differs in colouration. Black all over, darkness is comparatively less at the sides of the plastron and along the dorsal keels but the keels are yellowish. Head dark black with orange or reddish spots and reticulations in the young individuals. In the aged adults the head remains absolutely black.



Map showing the distribution of *Melanochelys trijuga indopeninsularis* (Annandale) and *Melanochelys trijuga thermalis* (Lesson)

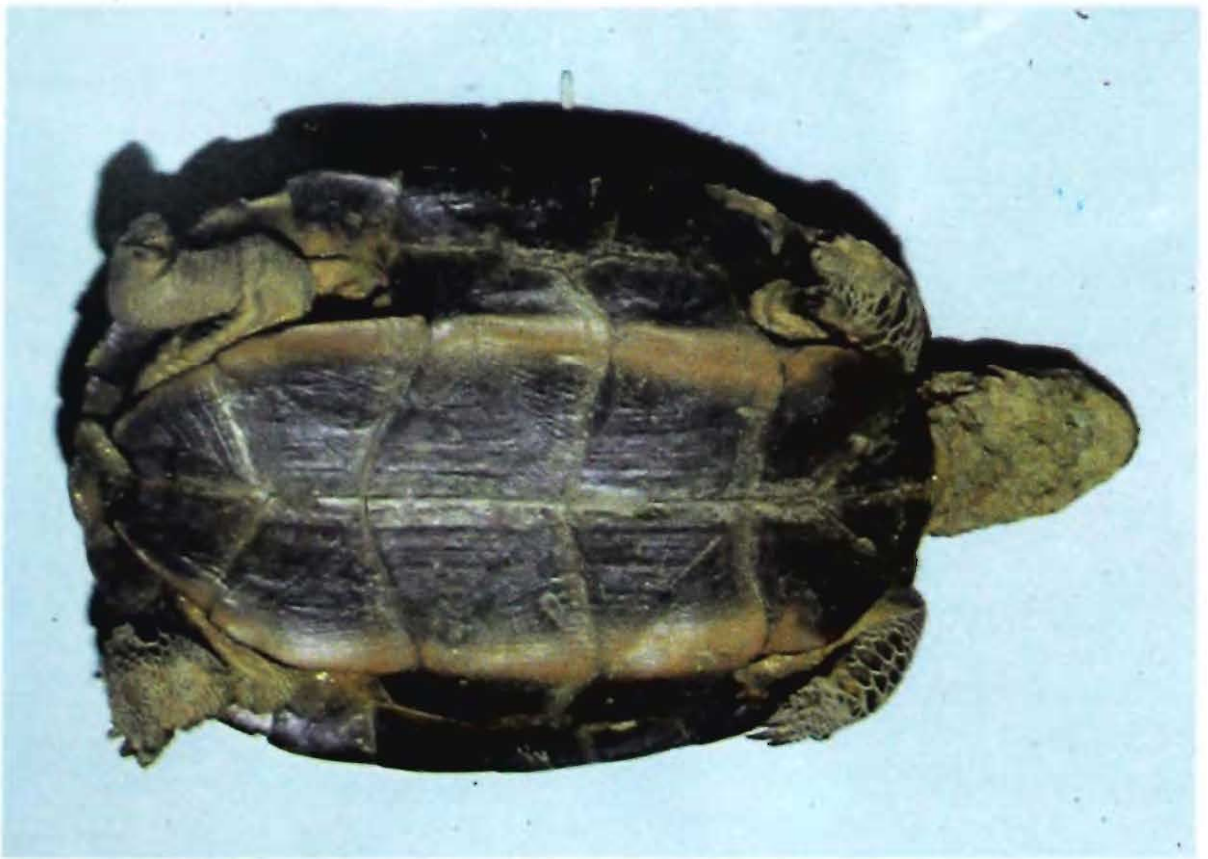
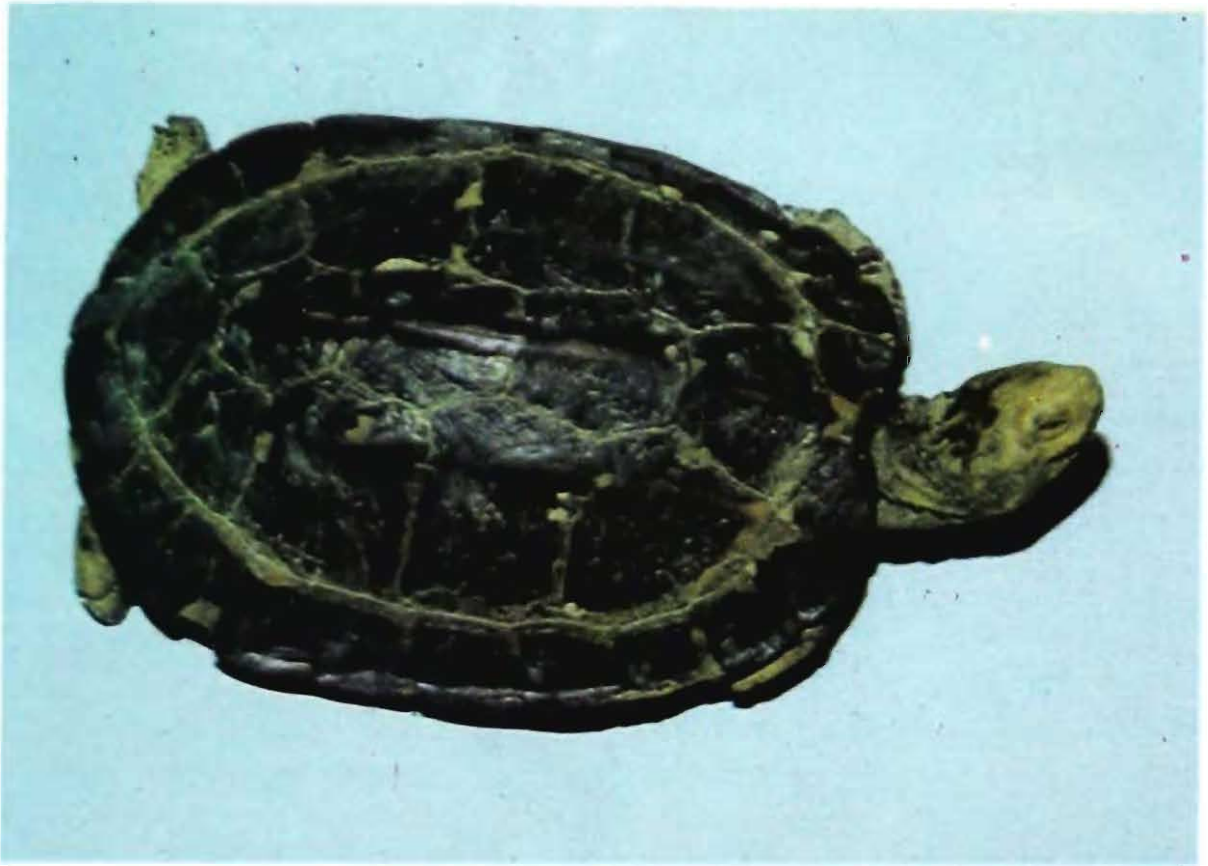
Distribution: Ramnad District (Tamil Nadu, India), Maldive Islands and Sri Lanka.

Habits and habitat: These turtles prefer to live in ponds and occasionally bask on stones and logs projecting from the water. They are equally comfortable on land also and sometimes are found far away from water. The sub-species is absolutely herbivorous. It digs a small nest-pit about 7 or 8 cm. deep and deposits there about three to five eggs in a single clutch. The eggs range from 43-45 mm. in length and 24-27 mm. in width. Breeding takes place throughout the year and a single female lays from three to five times during that period.

Status: Indeterminate, possibly has become vulnerable on account of habitat destruction and large scale exploitation of eggs and adults for food.

Conservation: Suitable conservation measures have not yet been followed. This subspecies must be included in Appendix I of the Indian Wildlife Act.

PLATE 25



Melanochelys. trijuga thermalis (Lesson) Dorsal view, Ventral view.

Family IV. TESTUDINIDAE Gray 1825

This family comprises the true land tortoises, whose neck is completely retractile within the solid shell. The carapace is covered with horny epidermal shields, frequently with distinct growth rings and is generally dome shaped. The marginal shields of the carapace are connected to the somewhat flat or slightly concave plastron by a broad bridge. Nuchal shield of the carapace is without suitably developed costiform processes. The plastron is usually flat in females and concave in males, composed of nine bones. Ear chamber is completely blocked behind by the quadrate; (Plate 26) temporal region not roofed over; a bony temporal arch is present. The digits are short and completely devoid of webs; with not more than two phalanges; metacarpals not or but slightly longer than broad; the hind feet are club-footed; the skin of the anterior side of the fore-limb is covered with strong horny scales. The skin on the top of the head is divided into shields. The tail is relatively short. Eggs are spherical in shape. Scent glands are absent in Testudinidae. The members of this family existed and flourished in India during the Pliocene Period in the Siwalik Hills. At present the family is widely distributed in tropical, subtropical and temperate zones of the world except Australia. This study which is on Indian species comprises a single genus *Geochelone*, and its 4 species.

Genus 13. *Geochelone* Fitzinger 1835

Neural shields are hexagonal, tetragonal and octagonal with a narrow posterior margin; costal shields narrow and wider. Two suprapygals are present, the anterior one overlapping the smaller posterior one. Plastron intimately united to carapace by distinct suture. Posterior lobe of plastron always rigid. Axillary and inguinal buttresses are quite short and do not completely reach up to the costal shields. Gular shields of the plastron are paired. Alveolar surface of upper jaw generally with a prominent median ridge. Choanae on a level with the anterior half of the orbits; prootic bone usually exposed dorsally. Supranasal scales are always absent. The nuchal shield may be present or absent. Limbs are cylindrical, the hinder one clubshaped, covered with enlarged and very hard scales; each thigh is with three distinct spur like outgrowths, digits very short, not at all webbed. Tail is quite short, not longer in the young than in the adult.

Key to the species of the Genus Geochelone

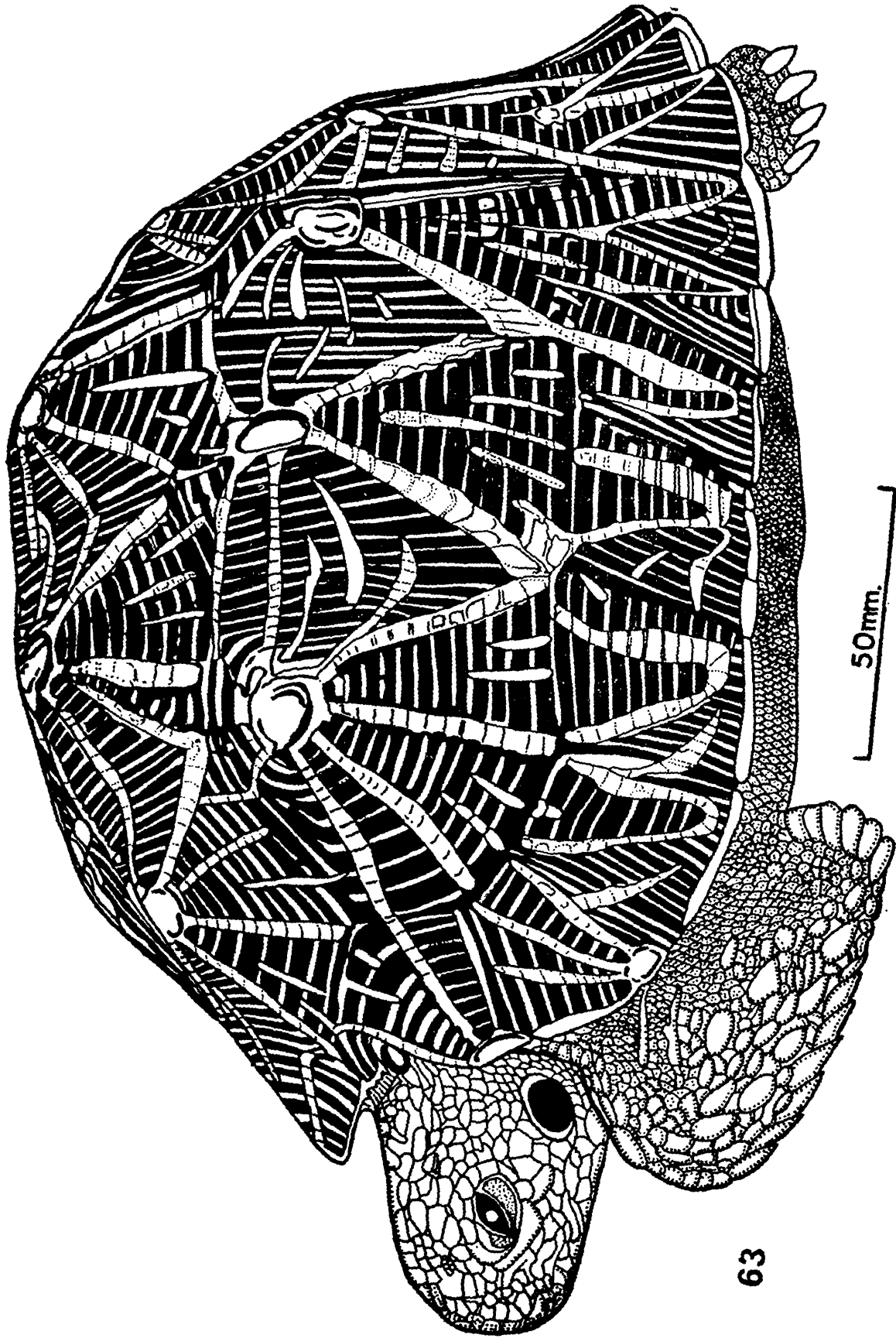
- I. Only single supracaudal shield is present.**
- A. Vertebral and costal shields forming most prominent humps in adult individuals; nuchal shield is not present; plastron is with dark radiating lines; top of head is covered with irregular shields *G. elegans*
- B. Vertebral and costal shields do not form humps.
- a. Nuchal shield is present; suture between the pectoral shields equal to or longer than that between humeral shields; top of head is with a pair of prefrontal, a large frontal (often subdivided) and with many smaller shields *G. elongata*
- b. Nuchal shield is always absent, suture between the pectoral shields is shorter than that between the humeral shields; top of head is with a pair of prefrontal, a large frontal (which is never subdivided) and with many smaller shields *G. travancorica*
- II. Two supracaudal shields are present ; pectoral shields of plastron are widely separated** *G. emys*

STAR TORTOISE OR INDIAN STARRED TORTOISE

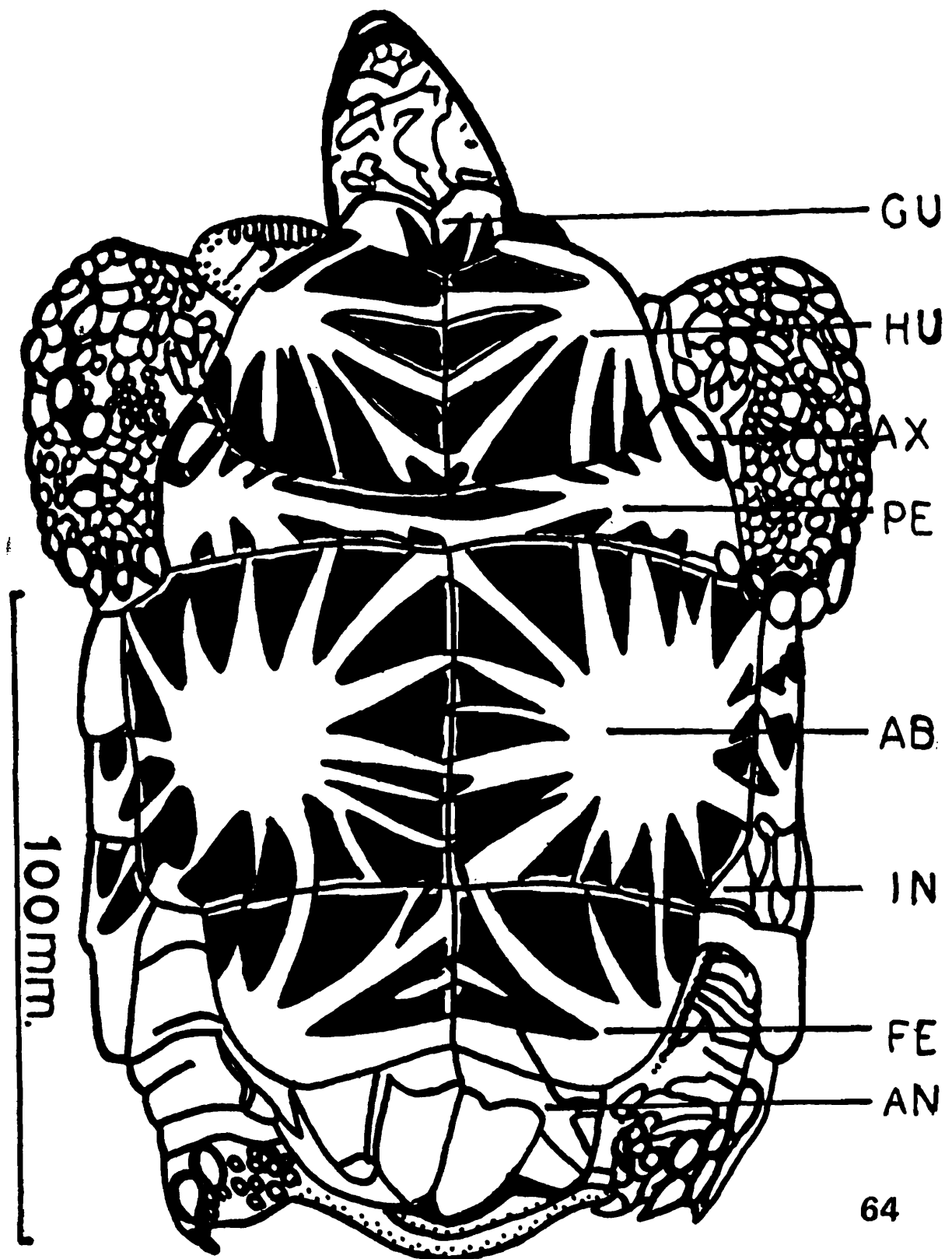
23. *Geochelone elegans* (Schoepff 1795)

(Plates 27 & 45; figs. 63, 64)

It is a small tortoise in which the length of largest female reaches up to 25 cm. males never exceed more than 16 cm. in length. The head is of moderate size, its anterior portion is bulged and somewhat convex. The upper jaw is slightly tricuspid. The skin at top of head is divided into small irregular shields. Carapace (Fig. 63) is elongated, highly domed, the vertebral and costal shields form well marked conical humps in the adults, the apex of each hump correspond with the areola; lateral aspects of carapace are almost vertical; anterior and posterior margins reverted, the posterior one is strongly serrated. Nuchal shield is not present. Vertebral shields are 5 in number; first vertebral is longer than broad; second to fourth vertebrae are broader than long. Costals are 4 in number and are equal or less broad than vertebrae. Supra-caudal shield undivided and incurved. Marginals are 22, excluding the supracaudal shield.



63. Lateral view of the entire aspect of *Geochelone elegans* (Schoepff)



64. Plastron of *Geochelone elegans* (Schoepff)

Plastron (Fig. 64) is large, truncate or openly notched anteriorly, deeply notched posteriorly and is made up of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields; the suture between the abdominal shields is largest and the shortest suture is between

PLATE 26

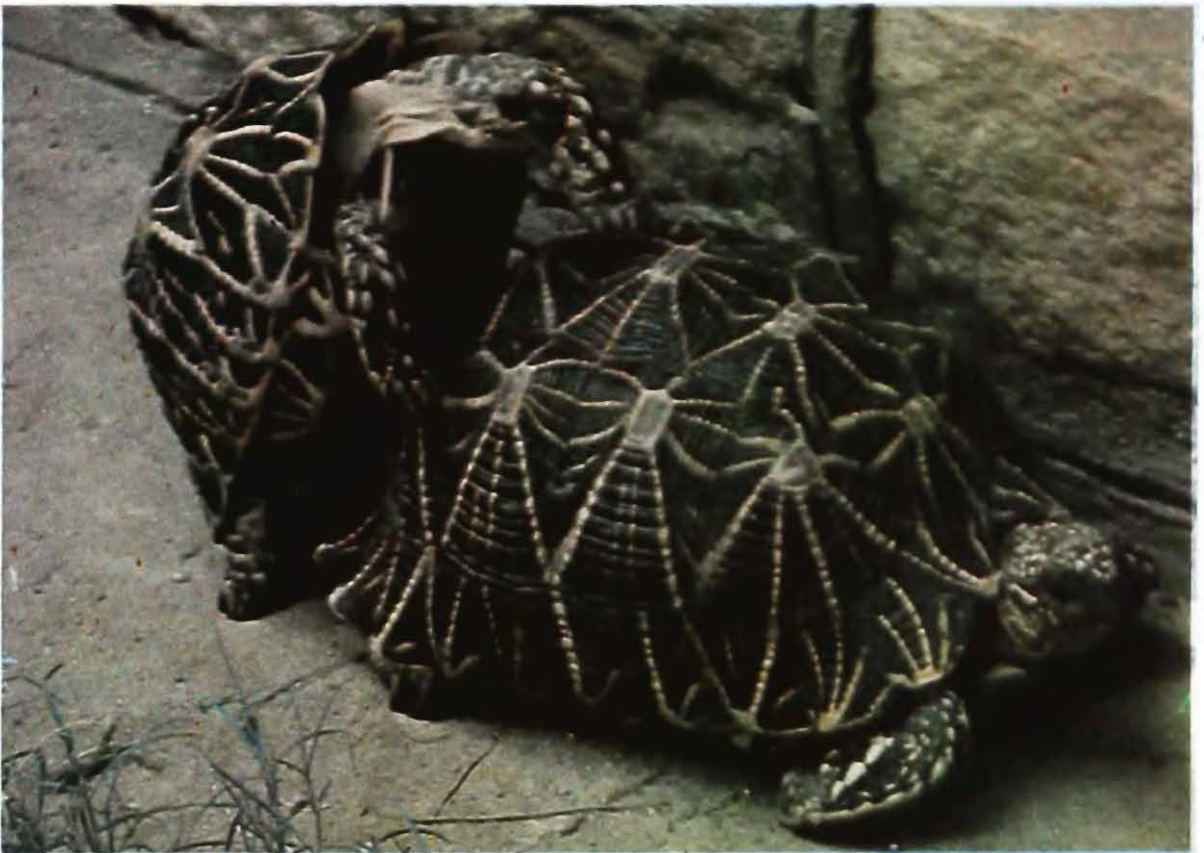
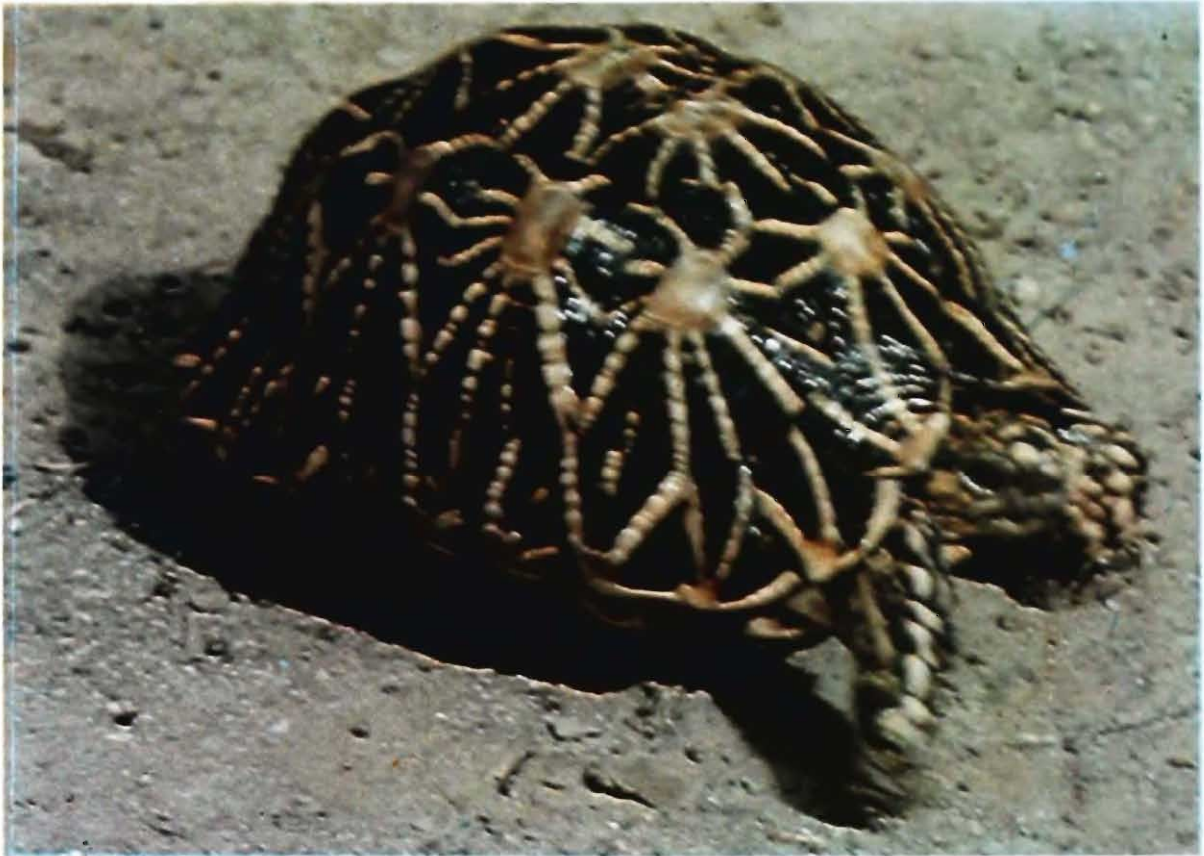


1cm.



Skull—Family Testudinidae— Lateral view, Dorsal View, Ventral view.

PLATE 27



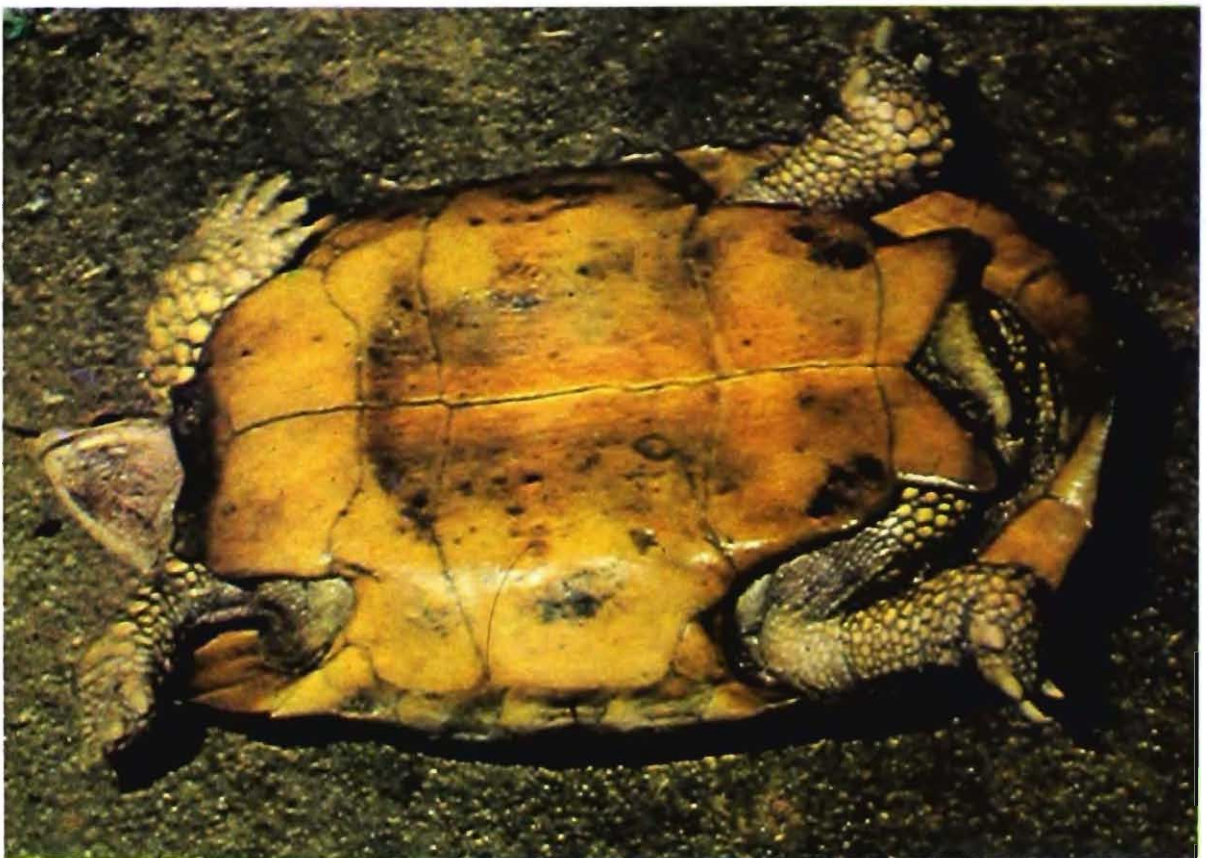
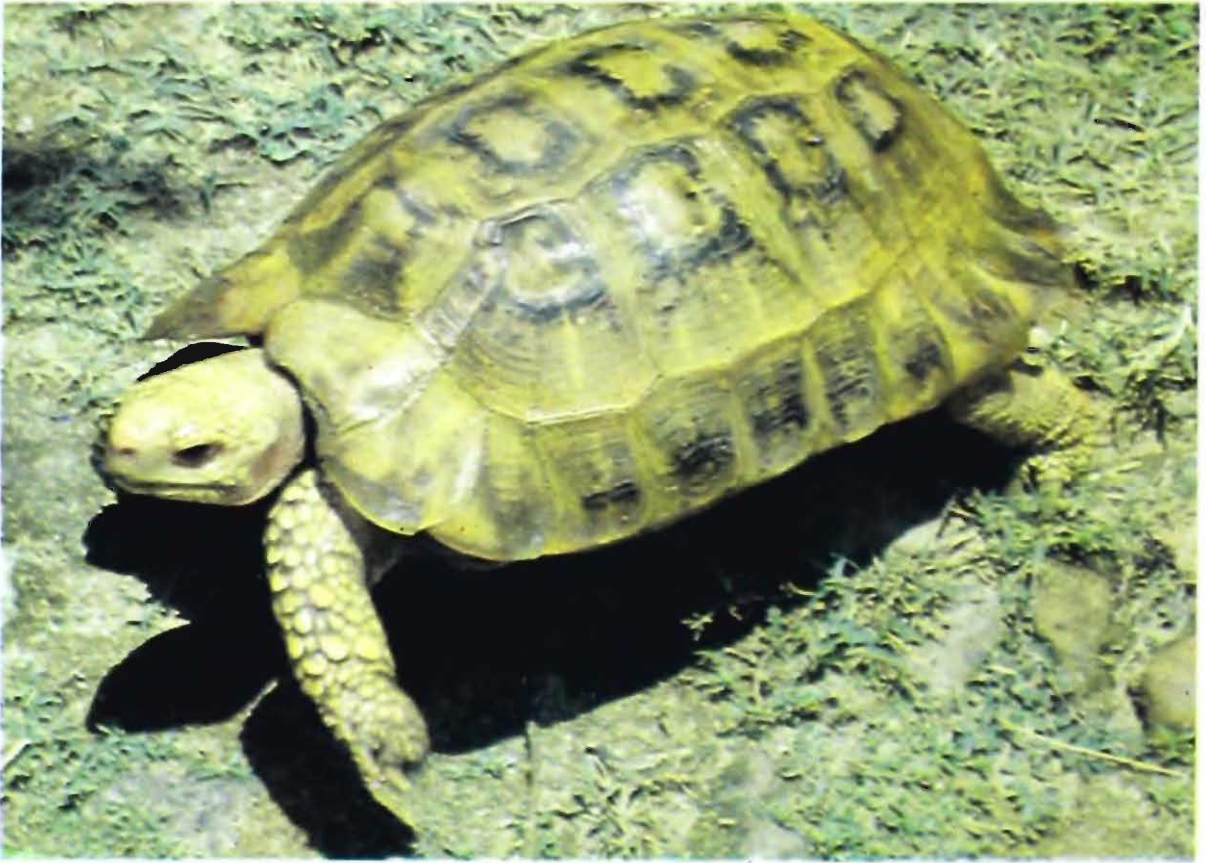
Star Tortoise—*Geochelone elegans* (Schoepff) Dorsal view, Copulating view.

PLATE 28



Yellow Tortoise—*Geochelone elongata* (Blyth) Dorsal view. Ventral view.

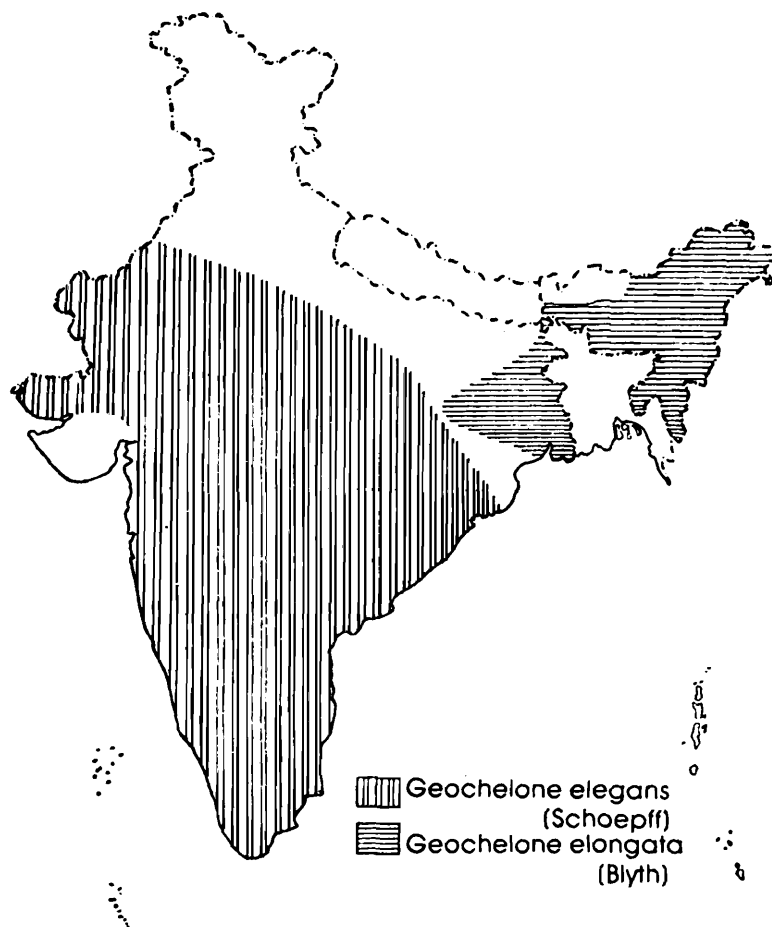
PLATE 29



Travancore Tortoise—*Geochelone travancorica* (Boulenger) Dorsal view, Ventral view.

the pectoral or the anal shields, in the adult and fully grown individuals; axillary and inguinal shields are small. Forelimbs are with five claws; outer side of the arm of forelimb and heel are provided with large imbricate, sharply pointed, bony scales; a patch of such comparatively more larger scales are present on the back of the thigh. Tail is moderately long and terminating into a spur-like scute. Shell is black above, each vertebral and costal shield is with a yellow areols from which radiate as many as eight streaks, ultimately producing a radiated (starred) pattern which is continuous over the marginals to the plastron. Head and limbs are yellow, more or less spotted with dark brown or black. Juveniles are almost entirely yellow or orange, with black marks along the sutures.

Distribution: Peninsular India and offshore islands like Karadura and Rameswaram, Sri Lanka, extending west as far as Sind (Pakistan).



Map showing the distribution of *Geochelone elegans* (Schoepff) and *G. elongata* (Blyth)

Habits and habitat: The species inhabits rocky, grassy arid areas with plenty of other vegetation. The star tortoise is quite active during the morning and evening hours of the day and feeds on grass, flowers, vegetables, fruits and all other available vegetable material. Courtship and

copulation takes place throughout the rainy season from June to October. About 3 to 6 hard-shelled eggs are laid in a single clutch and measure from 45-46 mm. in length and 35-37 mm. in breadth. Some of the same clutch are almost spherical (Plate 45). The eggs are laid at least three times in a year and are deposited in a self-dug nest pit roughly about 15 cm. deep and 10 cm. in diameter. Before starting the digging operation, the egg laying female moistens the soil of the nest site by using her urine for this purpose. The mother tortoise employs her hind limbs for scraping and digging the soil. After the egg deposition is over the nest is covered with the same urine-soaked muddy soil and the whole area is compacted by the female. The complete operation of egg laying is completed within four hours.

Status: Indeterminate, suspected to be threatened by habitat loss.

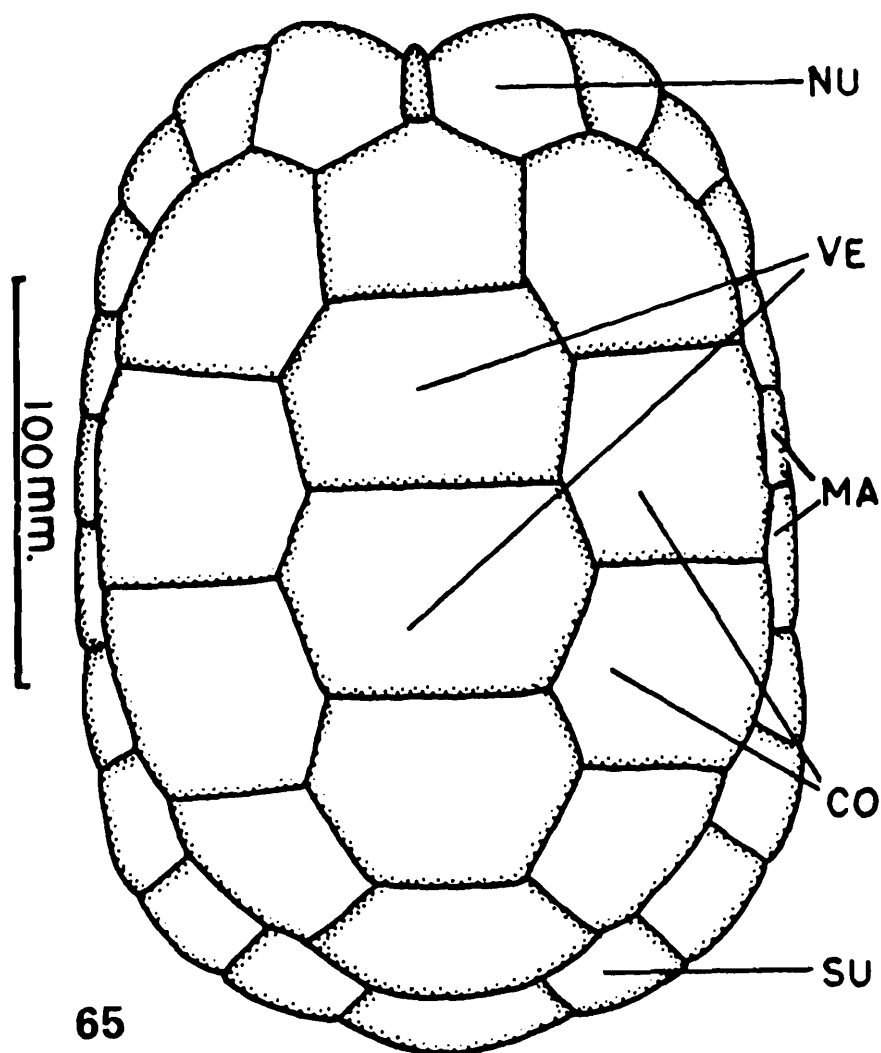
Conservation: Listed in Appendix II of CITES which implies that commercial trade is allowed providing a permit from the country of export is obtained, this can provide a method of monitoring trade levels. The main demand of this tortoise is from the Federal Republic of Germany and Switzerland. Since 1975 about 200 specimens of Star tortoises have been exported there from India and Sri Lanka.

YELLOW TORTOISE, RED-NOSED TORTOISE
OR
YELLOW-HEADED TORTOISE

24. *Geochelone elongata* (Blyth 1853)

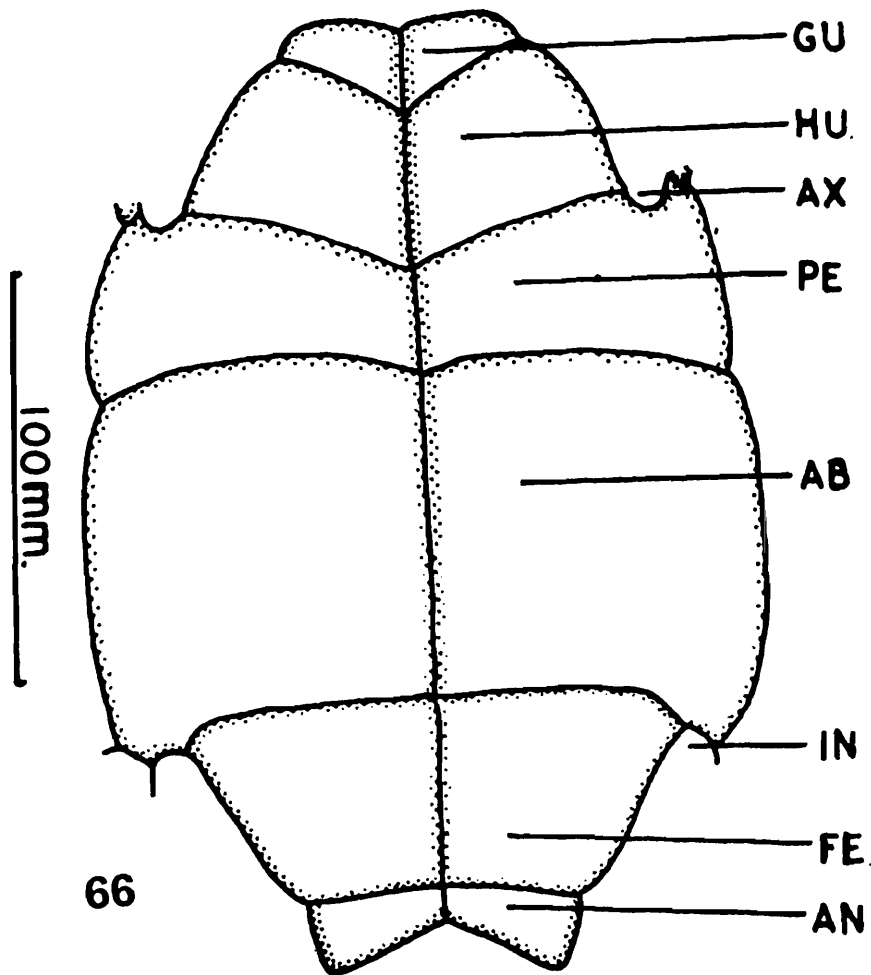
(Plates 28 & 45; figs. 65, 66)

This is a small species of tortoise reaching slightly over 27 cm. in length. The head is of moderate size. The upper jaw is tricuspid and horny margins of jaws feebly denticulated. The skin at the top of head is with a pair of prefrontal shields and a large frontal often subdivided and always present the rest of the head is covered with smaller shields. Carapace (Fig. 65) is elongated, narrow, flattened on the vertebral portion in adults. Marginals are generally serrated and flared on the posterior aspect of the carapace. Nuchal shield is present and somewhat elongated. Vertebral shields are 5 in number; first vertebral shield is as broad as long; second to fourth vertebrals are broader than long. Costal shields are 4 in number and are as broad as adjoining vertebrals. Supracaudal shield undivided and in-



65. Carapace of *Geochelone elongata* (Blyth)

curved. Marginals are 22 excluding the supracaudal shield. Plastron (Fig. 66) is large; truncate anteriorly, deeply notched posteriorly and is made up of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields; the longest median suture is between the abdominal shields, the shortest is between the anal shields which may be entirely separated by the anal notch; suture between the pectoral shields is as long as or longer than that between the humeral in the adult; axillary shield is generally smaller than inguinal. Fore limbs with large, imbricate, pointed scales, heels with large flat scales; a patch of enlarged flattened scales on the hinder portion of thigh. Tail longer and curved in the male than in the female and terminating in a horny tubercle. General dorsal colouration is yellow or greenish-yellow, with variable amounts of black markings. Large dark spots are present on marginals. Head is whitish-yellow but during the breeding season a reddish tinge is developed on the front side of head in males. In juveniles the carapace is pure yellow with few black spots.



66. Plastron of *Geochelone elongata* (Blyth)

Distribution: Burma, India, Kampuchea, Laos, Malaysia, Thailand and Vietnam.

Habits and habitat: This species inhabits the low rocky-hilly areas. This tortoise has great tolerance for heat, being found on open hill sides in Thailand when the ground was unbearably hot. The species is herbivorous and mainly depends on a fruit diet. Generally two to four large oval eggs are laid in a single clutch (Plate 45).

Status: Indeterminate, suspected to be threatened on account of habitat destruction and over exploitation of adults for flesh and due to international trade. In Thailand the population of this species has declined to a considerable level during the last 15 years on account of human predation and urbanisation.

Conservation: Listed in Appendix II of the CITES which implies that commercial trade is allowed providing a permit from the country of export is obtained. The main exporting country of this species is Thailand

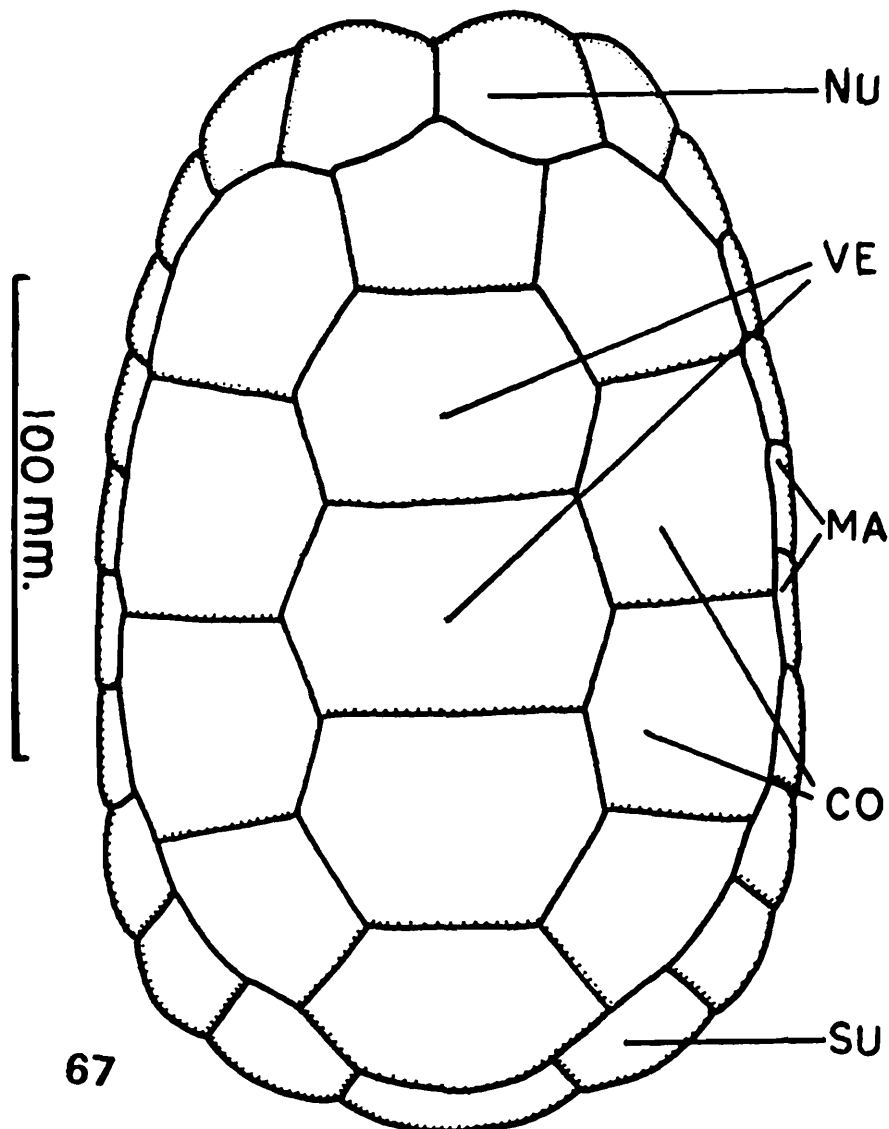
which sent about 3800 specimens to the U.S.A., the Federal Republic of Germany, Switzerland and the United Kingdom since 1975. In India there is a strict ban on its export since 1979. It will be most useful if the exact status of this species is assessed throughout its range.

TRAVANCORE TORTOISE

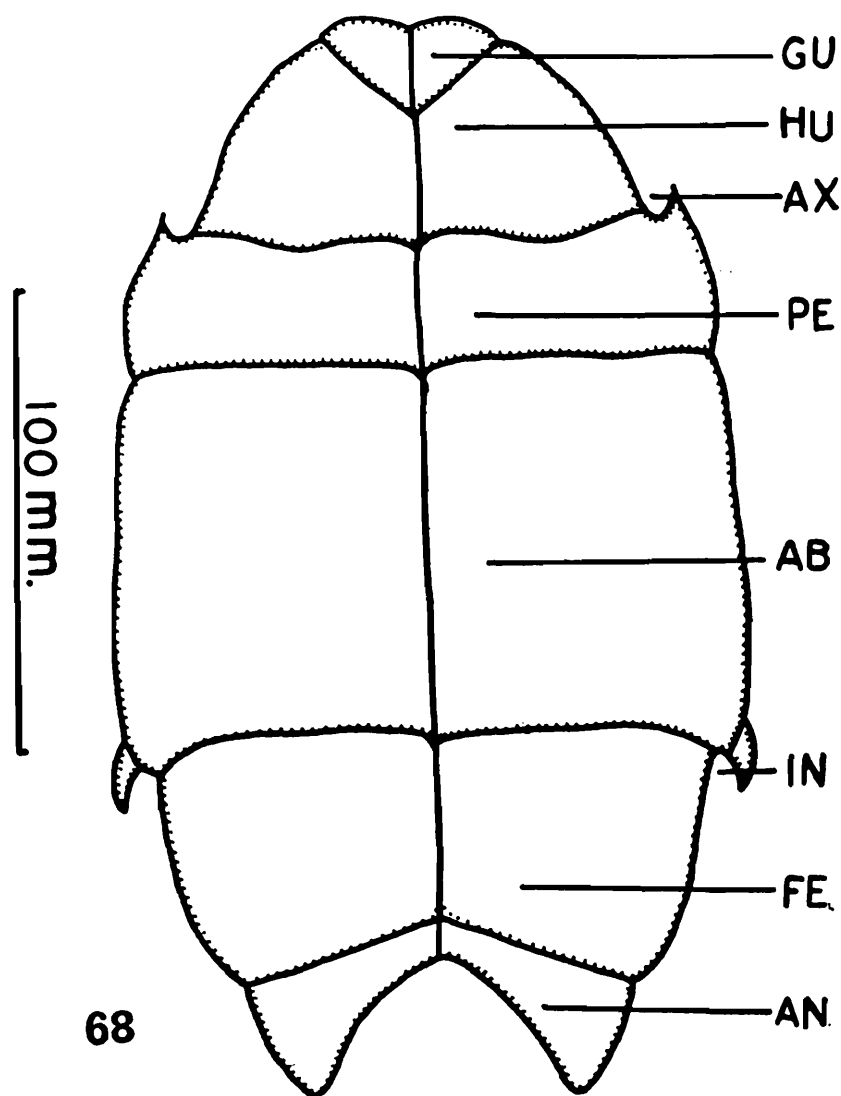
25. *Geochelone travancorica* (Boulenger 1907)

(Plates 29 & 46; figs. 67, 68)

This is a moderately large terrestrial hill tortoise reaching up to 30 cm. in length and weighs up to 3.75 kg. The head is of moderate size and its upper jaw is tricuspid; horny margins of jaws feebly denticulated. The



67. Carapace of *Geochelone travancorica* (Boulenger)

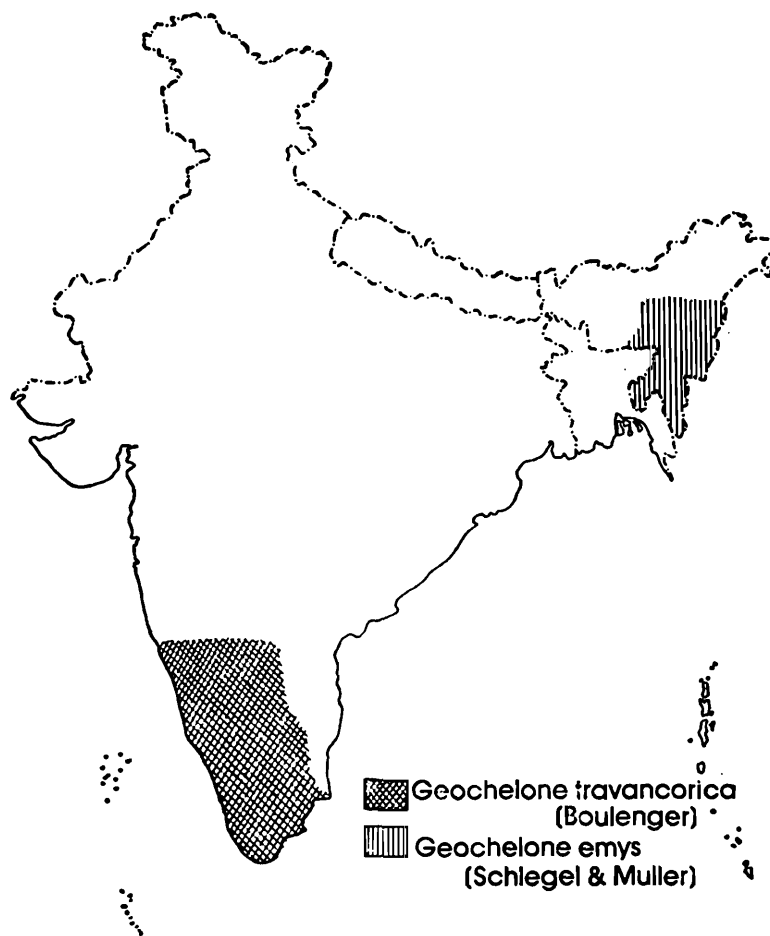


68. Plastron of *Geochelone travancorica* (Boulenger)

top of the head is covered with large, moderate and small shields; frontal shields paired. Carapace (Fig. 67) is rigid, oval, more or less dome-shaped with a slightly flared margin; nuchal shield is not present; vertebrals are 5 in number, first vertebral as broad as long and rest are broader than long. Costals are 4 in number and are less broad than vertebrals. Marginals are 23, including a single narrow supracaudal shield; two anteriormost peripheral marginals are largest and subtriangular; lateral marginals are quite thin and narrow. Plastron (Fig. 68) is large, truncate anteriorly, deeply notched posteriorly and is made up of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields; the suture between the abdominal shields is largest and the shortest suture is between the anal shields; in many specimens anal shields are absolutely separated by the deep anal notch, suture between the pectoral shields is shorter than that between the humeral shields; axillary shields is smaller than the inguinal shield. Outer side of the fore limb is provided with distinctly large, imbricate, pointed scales. Tail is moderately long and terminates into a

horny tubercle. It is longer and curved in the male than in the female. General colouration of the shield is quite variable from light brown, greenish-yellow or pale yellow. Shields are generally with a large dark blotch and edged with a lighter band, or yellow with dark band around. In most of the specimens the plastron is having black spots on the abdominal shields. The colouration of head is somewhat light greenish with a tinge of yellow. Limbs are with numerous irregular light black spots.

Distribution: Travancore Hills, Cochin forests and western slopes of the southern extremity of Western Ghats in Kerala and hilly areas of Mercara (Coorg) in Karnataka.



Map showing the distribution of *Geochelone travancorica* (Boulenger) and *Geochelone emys* (Schlegel & Mueller).

Habits and habitat: This moderately large tortoise prefers a hilly, rain forest terrain up to an altitude of 1000 metres or so. Nothing is known about its biology except that breeding season extends from November-January and six small to medium, oval eggs are laid in a single clutch (Plate 46). Food comprises mostly vegetable material. This tortoise has got a strong liking for mushrooms and in captivity relishes fruits (mango jackfruit and banana), boiled rice, baked bread and leaves of grass.

Status: The species is nominally protected by legislation and is suspected to be threatened by habitat loss and human consumption. In recent past the species was available in fairly good numbers all over the range. Its flesh is relished by the local people in Kerala and the animal is hunted immediately, the moment it is sighted by any tribal or any labourer working in a cardamom plantation. The tribals and other native track these tortoises by tracing their paths by observing the stubs of small mushrooms which they consume and relish.

Conservation: Listed in Appendix II of CITES which implies that commercial trade is allowed providing a permit from the country of export is obtained, this can provide a method of monitoring trade levels. Commercial export of this species is also banned, along with other reptiles since 1979. After assessing the exact status in the remaining rain forest habitat, a detailed study of biology and ecology might help in formulating suitable management plans to conserve this species along with its unique diminishing rainforest biotope.

Captive breeding: Nothing is known. Auffenberg (1964) has given an interesting account of its courtship and breeding colour change in captive male specimens.

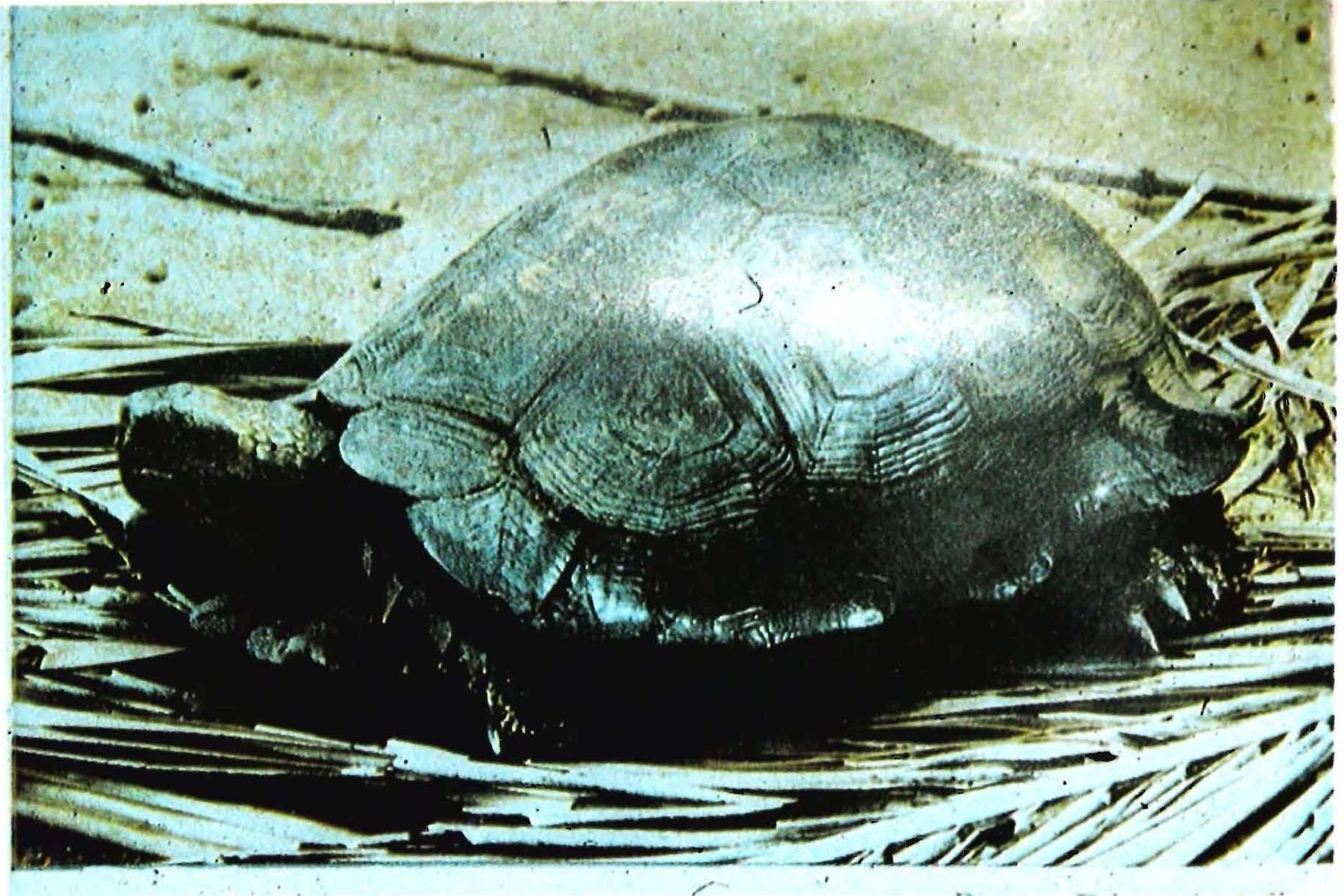
**YELLOW AND BLACK GIANT TORTOISE, ASSAM
LAND TORTOISE, BURMESE BROWN TORTOISE,
OR SIX-FOOTED TORTOISE**

26. *Geochelone emys* (Schlegel & Mueller 1844)

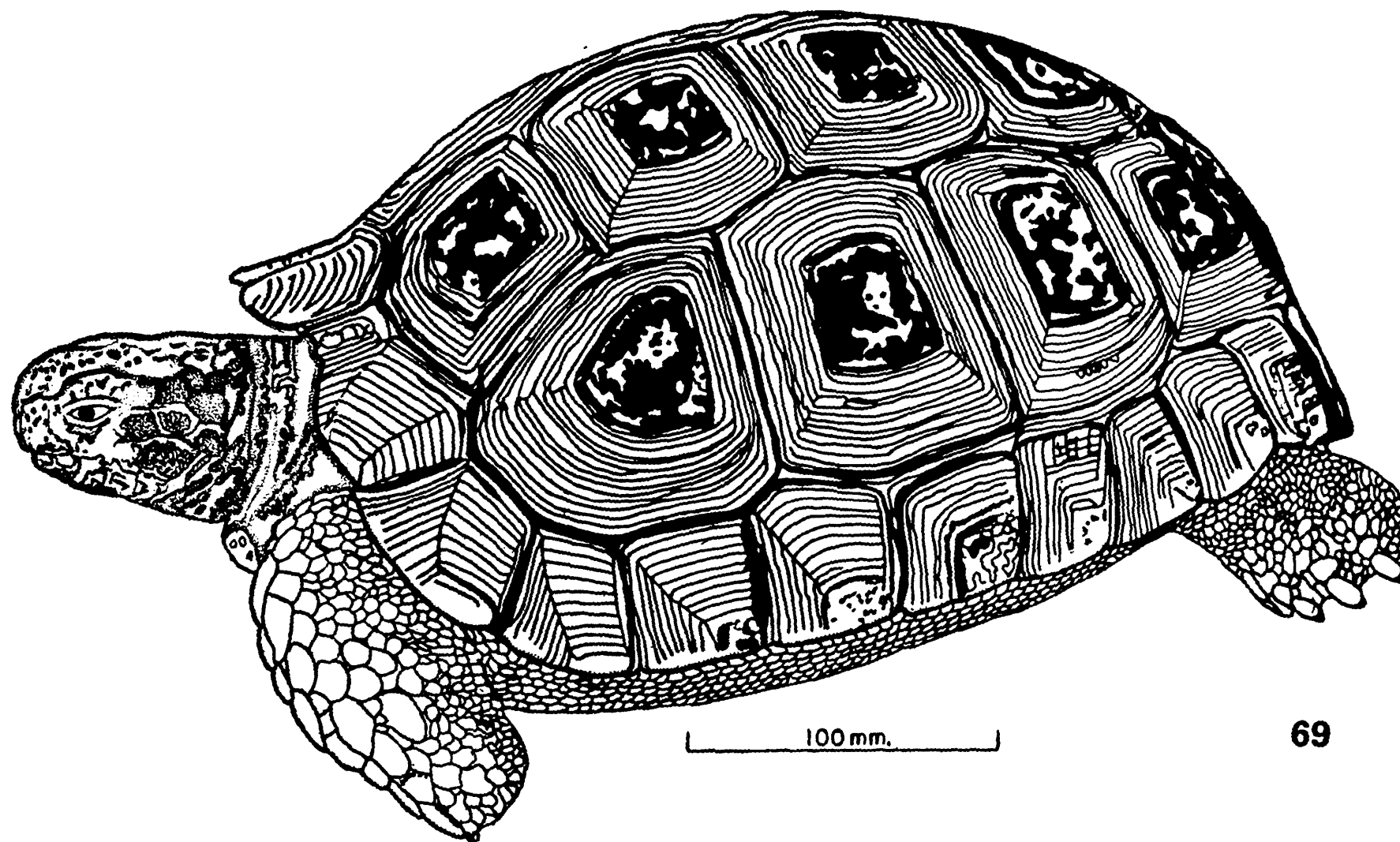
(Plate 30; figs. 69-71)

This is a large terrestrial species, largest of the Asiatic tortoises, reaching slightly over 47 cm. in length and weighs 31 kg. or even more. The head is comparatively massive and its upper jaw is feebly hooked. The top of the head is covered with large symmetrical shields like frontal and two pairs of shields anterior to it signify the most constant character. Carapace (Fig. 70) convex or dome-shaped, depressed on the vertebral region in juveniles but slightly elevated in adults; anterior and posterior margins are flared and serrated; nuchal shield is small to moderate; vertebrals are 5 in number and are broader than long. Costals are 4 in number and little less or as broad as vertebrals. Marginals are 25 (including one nuchal and a pair of supra caudals which are quite thin and narrow), those on sides are

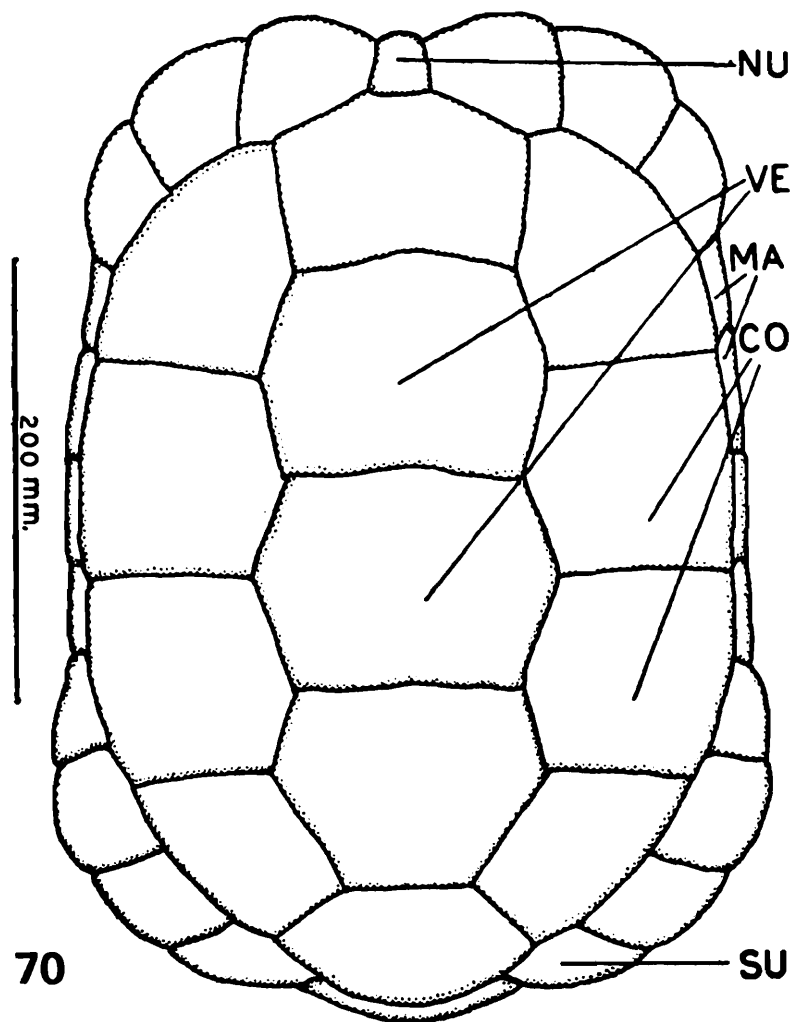
PLATE 30



Yellow and black giant Tortoise—*Geochelone emys* (Schlegel & Muller).



69. Lateral view of the entire aspect of *Geochelone emys* (Schlegel & Mueller)

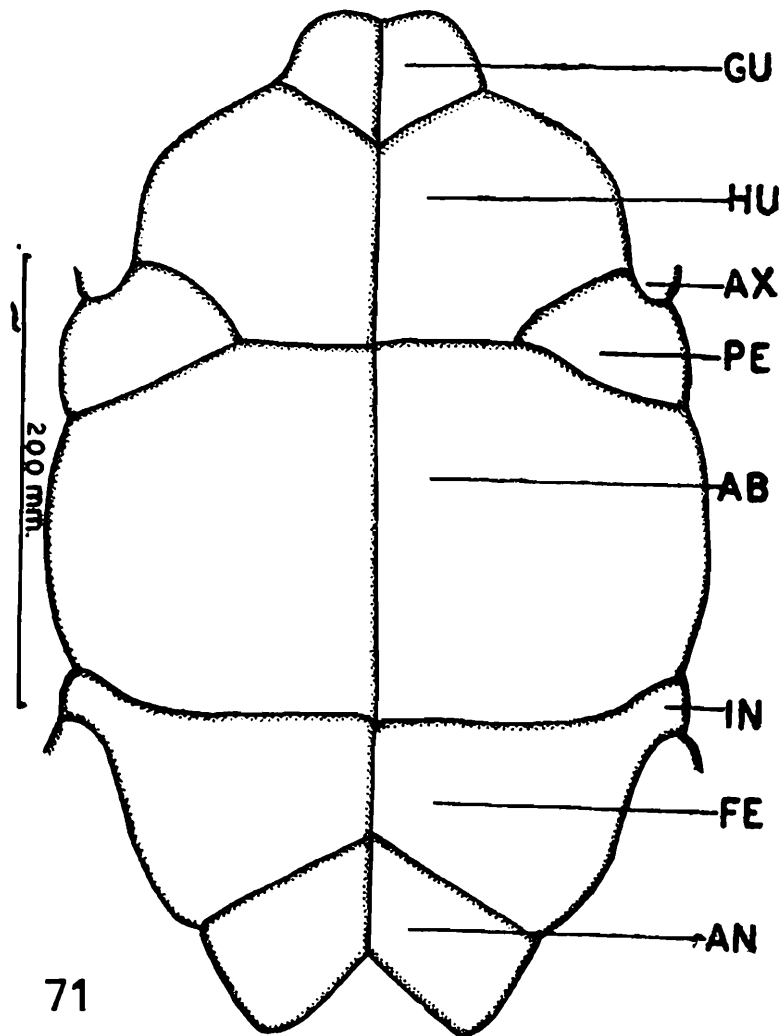


70. Carapace of *Geochelone emys* (Schlegel & Mueller)

quite narrow. Plastron (Fig. 71) is large, sometimes larger than carapace owing to the extended gular shields, slightly notched anteriorly and deeply notched posteriorly, it is made up of paired gular, humeral, axillary, pectoral, abdominal, inguinal, femoral and anal shields; the suture between the abdominal shields is much larger than that between any of the other plastral shields; pectoral shields are usually widely separated from one another; inguinal shields large, often divided into two, axillary shield smaller. Fore-limbs with five claws, their front is having pointed, bony, imbricate scales, forming four or five longitudinal series. Hind limbs are four clawed, with large, pointed scales on the sole and heel; adults have a greatly enlarged conical scute on the back of the thigh and this is why it is known as six-footed tortoise. Tail is moderate and terminates in a grooved spur-like tubercle. The measurements are : length of shell 470, breadth 340 and depth 195 mm. Shell dark brown or blackish. Head and limbs are blackish.

Distribution: Cachar and Naga Hills of Nagaland in India, Bangladesh (eastern hilly areas), Burma (hilly areas), Thailand (peninsular part), Malaysia

(abundant in hilly areas of Western Malaysia but the population has declined elsewhere), Sumatra, Borneo (Sabah and Sarawak).



71. Plastron of *Geochelone emys* (Schlegel & Mueller)

Habits and habitat: This slow, docile and considerably large tortoise prefers to live in hilly forested areas where plenty of water for its drinking is available. It lives mainly on the vegetable material available in forests but the diet is supplemented by a variety of invertebrates and small amphibians. Not much is known about its breeding habits except that it lays 5-8 eggs (50 × 43 mm. in length and breadth) in a clutch.

Status: Ruthless overexploitation of adults for protein-rich flesh and eggs is going on over much of its range. The species has become extremely rare and is considered threatened in Bangladesh, India and Thailand. In Malaysia also the population has considerably declined during the last 20 years on account of human predation and urbanisation.

Conservation: Listed in Appendix II of the CITES which implies that commercial trade is allowed providing a permit from the country of export is obtained. The main exporting country of this species is Thailand which sent about 2000 specimens to U.S.A., the Federal Republic of Germany and Switzerland since 1975. In India there is a strict ban on its export since 1979. It will be most beneficial if the exact status of this species is assessed throughout its range. Further detailed studies in ecology and biology of this tortoise will lead so as to formulate suitable management plans for its conservation.

Captive breeding: It is being tried in Malaysia. About 15 specimens are kept in Kuala Lumpur Zoological Garden.

Family V. TRIONYCHIDAE, Bell 1828

This family comprises the soft-shelled fresh-water or mud turtles in which head and neck is completely retractile. Their neck which is exceedingly long and flexible bends in a sigmoid curve in a vertical plane; ear is hidden; last cervical vertebrae articulate with the first dorsal by a double facet on the centrum and by the zygapophysis; pterygoid bones are separated from each other and basisphenoid reaches up to palatine bones; jaws are absolutely hidden under fleshy lips; snout ends in a proboscis and much elongated. Pelvis not anchylosed to the carapace and plastron. Carapace and plastron covered by a continuous layer of soft skin; without epidermal shields; the sides of the hinder portion of carapace are quite flexible; epi-plastron is separated from hypoplastron by a Λ -shaped entoplastron; plastron united to carapace by ligamentous tissue; marginal bones of the carapace are missing or form an incomplete series, not attached to the ribs. Limbs are fully webbed, with only three claws on each foot; phalanges elongate, fourth digit with four or more phalanges, only the three inner digits are clawed, forelimbs are semi-paddle shaped.

Key to the Genera of the family TRIONYCHIDAE

- I. Plastron with soft, semicircular flaps, which permit the retracted hind feet to be completely concealed. Marginal bones are present. Front part of the plastron is also flexible and quite suitable for the closure of the anterior shell opening. Plastron with seven callosities in the adult. Carapace without a definite pattern, yellow spots may be present or absent. Snout comparatively short **Lissemys**

II. Plastron without flexible skin-flaps and without cutaneous femoral valves. Marginal bones are not present. Plastron with four callosities only in the adult. Carapace with a definite pattern in juvenile specimens. Snout rather long.

- A. Orbit nearer the temporal than the nasal fossa; postorbital arch narrower than the diameter of the orbit; proboscis as long as the eye-opening **Trionyx**
- B. Orbit nearer the nasal than the temporal fossa; postorbital arch twice as broad as the diameter of the orbit; proboscis as long as the eye-opening **Chitra**

Genus 14. Lissemys Smith 1931

Nuchal bone is butterfly-shaped; dorsal shield is with a prenuchal, marginal and series of posterior marginal bony plates; seven or eight neural plates forming a continuous series; eight pairs of costal plates, the last two pairs forming a median suture. Plastron is with a cutaneous femoral valve, under which the hind-limb may be concealed; seven plastral callosities are present in the adult; hypoplastron co-ossified with hypoplastron. Skull convex above; postorbital arch narrower than the orbital diameter; posterior margin of pterygoid is with a median ascending process which forms a suture with the opisthotic. Tail is very short. A single species with two subspecies inhabiting India.

Key to the Subspecies of Lissemys punctata

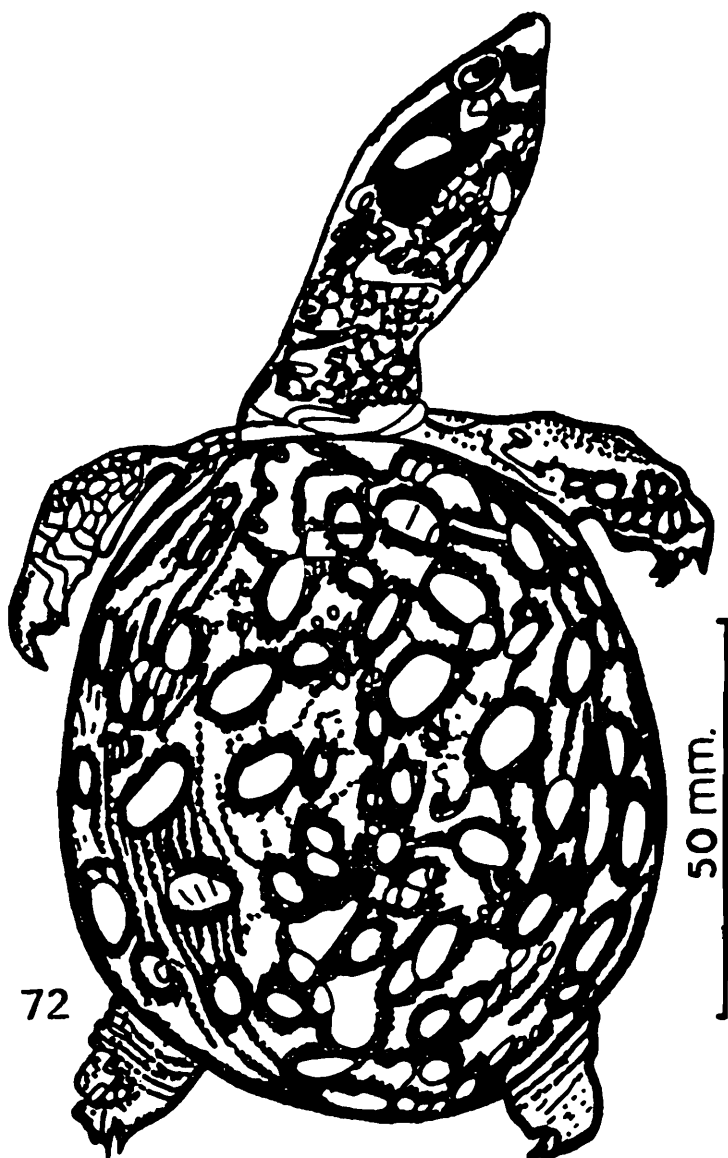
- First marginal bone much longer than the second in the adult; ectoplastral callosity is generally small in the adult; head and carapace with yellow spots *L. p. punctata*
- First marginal bone much larger than the second in adult; ectoplastral callosity is generally moderate in the adult; carapace is uniform brown or blackish; head with black longitudinal lines, these are most prominent in the juveniles *L. p. granosa*

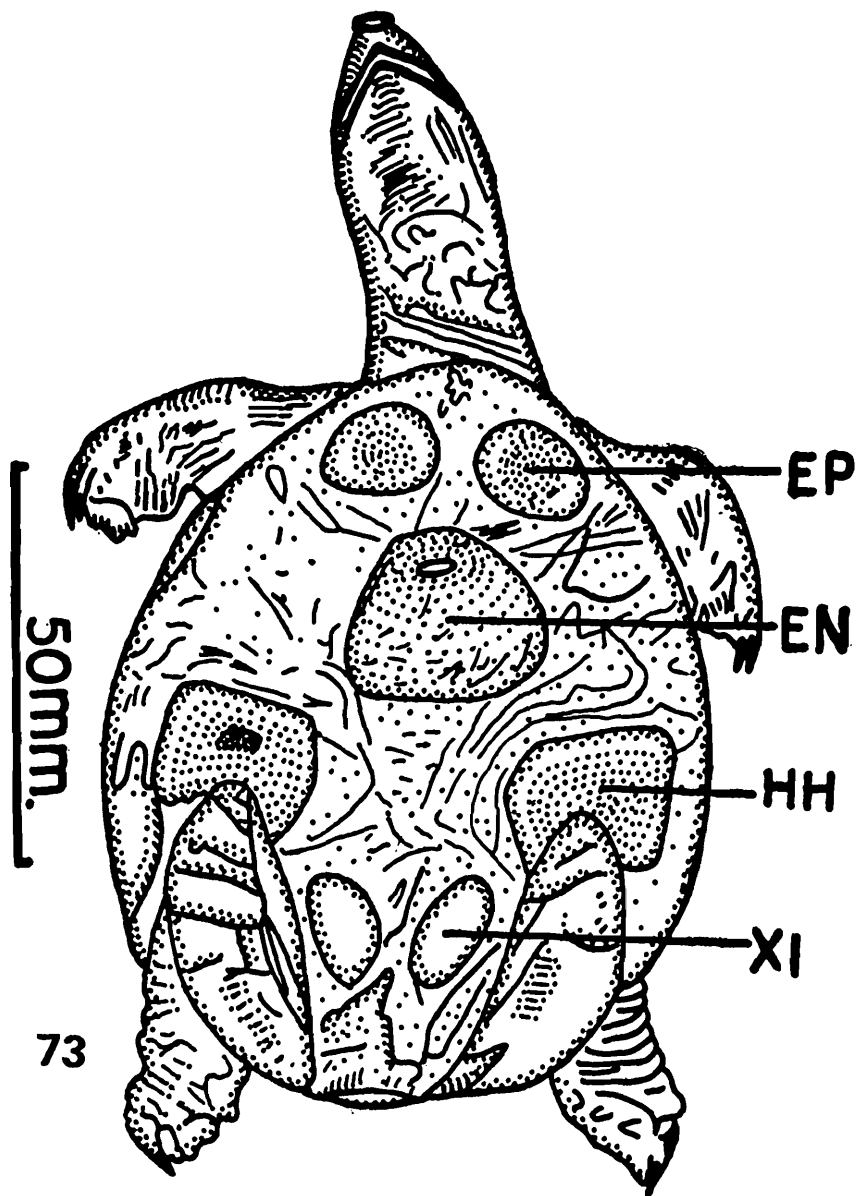
NORTH INDIAN FLAP-SHELLED TURTLE

27. *Lissemys punctata punctata* (Lacepede 1788)

(Plate 31; figs. 72, 73)

This is a small, flat turtle whose length hardly exceeds more than 24 cm. The head is moderately large, the snout is short and broad, its length is less than the length of the eye opening. The carapace (Fig. 72) and plastron (Fig. 73) covered by a continuous sheet of soft skin and their callosities are finely granulated. Skin of dorsal disc of juveniles longitudinally plaited. The lateral and the hinder portions of the carapace are most flexible. Neural bones are two in number and rest between the first pair of costal plates. First marginal bone in the adult is very large, much

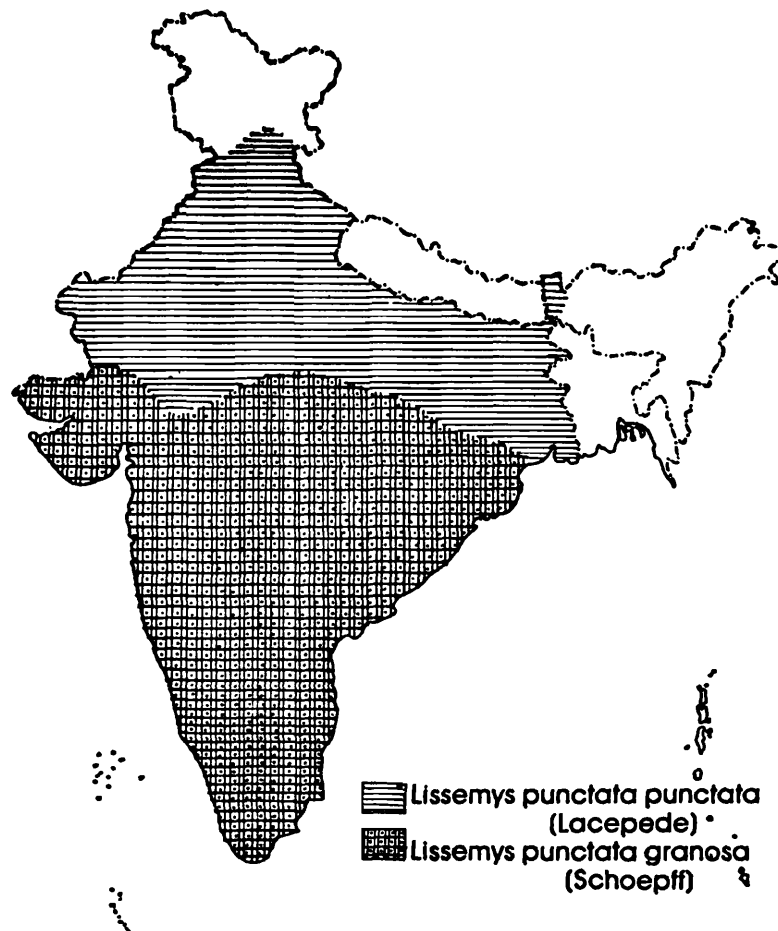
72. Carapace of *Lissemys punctata punctata* (Lacepede)



73. Plastron of *Lissemys punctata punctata* (Lacepede)

longer than the other marginal bones. Plastron is with soft, semicircular flaps, which accommodate the retracted hind feet to be totally concealed; front portion of the plastron is quite flexible and permits the closure of the anterior shell opening quite effectively. Plastron is with seven callosities in the adult, namely paired hyo-hypo., xiphi., and epiplastral, and a single entoplastral (quite small in adults). Limbs are fully webbed, with only three claws on each foot. Tail is very short. Olive-brown above. Carapace is grey-green, with numerous blackbordered yellow spots, irregularly arranged and with a light yellow marginal rim.

Distribution: Bangladesh, Burma (Akyab), India, Andaman Islands, and the Ganga river systems, Sikkim and Kutch, Nepal, Pakistan (Sind river system) and Sri Lanka.



Map showing the distribution of *Lissemys punctata punctata* (Lacepede) and *Lissemys punctata granosa* (Schoepff)

Habits and habitat: The subspecies prefers to live in shallow, muddy ditches, lakes and marshes. It is a carnivorous turtle and feeds mainly on frogs, fishes, shrimps and snails. Nothing is known about its breeding habits except that it lays 12 eggs in a single clutch.

Status: Suspected to be threatened on account of ruthless killing and overexploitation of adults and their eggs for protein-rich food. Habitat destruction is another principal factor of threat to the species. The nests of these turtles are frequently raided by predators like man, otters, mongooses, jackals and dogs. The construction of hydro-electric dams and barrages has greatly checked the movements of the turtles towards its breeding grounds.

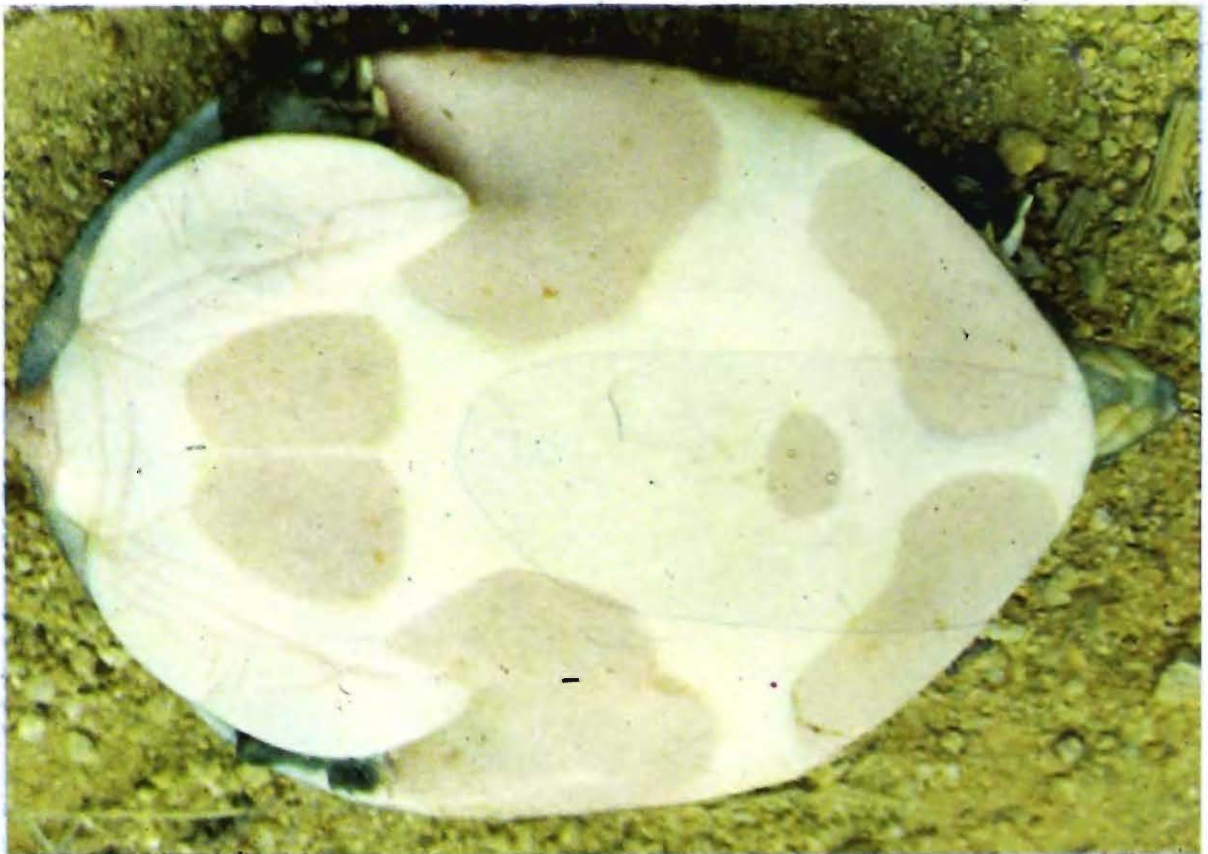
Conservation: Nominally protected by legislation and export of adults and their products is prohibited. This subspecies is already in the Appendix I of IUCN. Exact data on the population are not available but it has been drastically reduced. A detailed study on the status and ecology will lead so as to formulate suitable management plans to conserve this endangered subspecies.

PLATE 31



North Indian Flap-shelled Turtle—*Lissemys punctata punctata* (Lacepede) Dorsal view
Ventral view.

PLATE 32



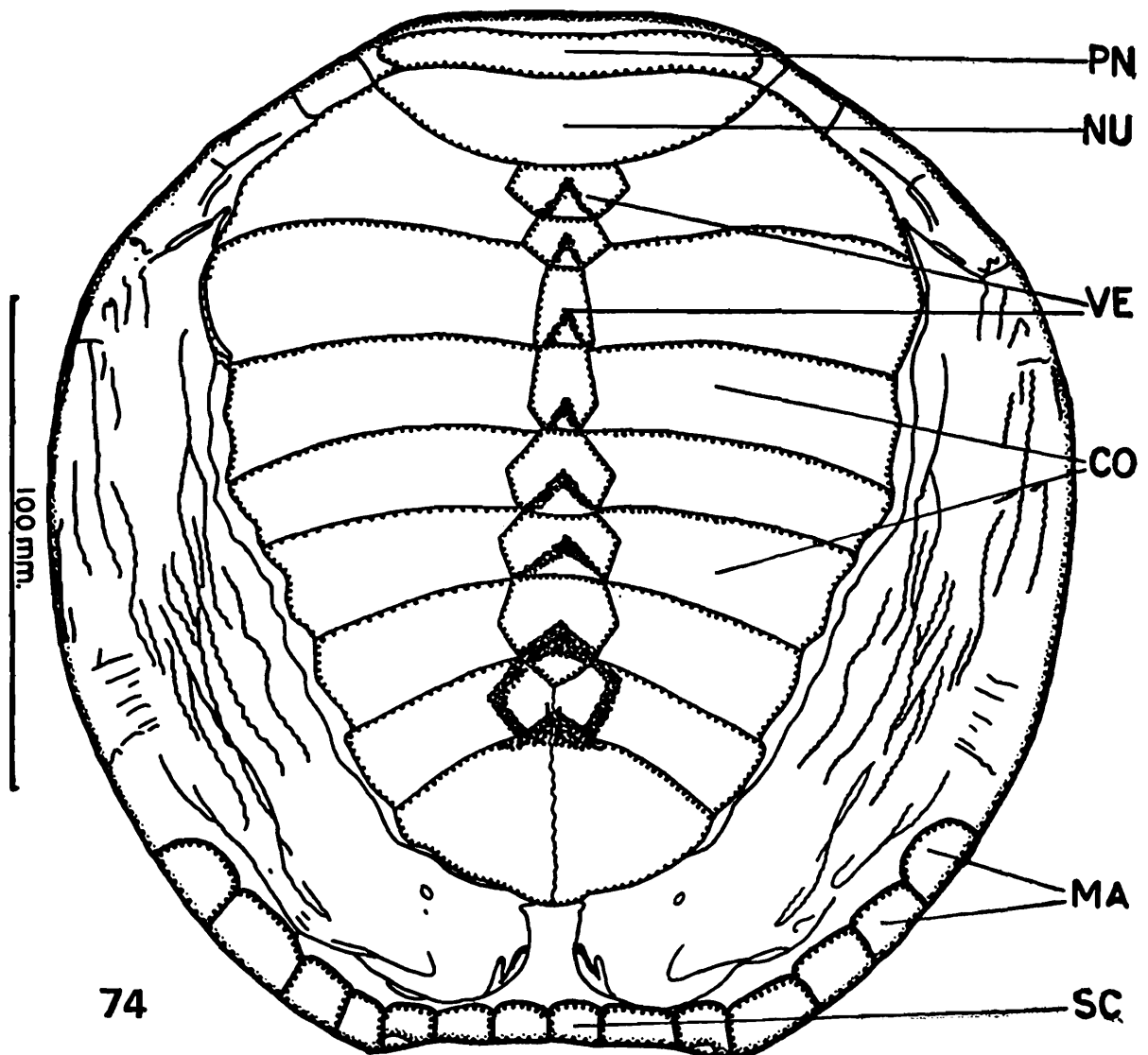
Southern Flap-shelled Turtle—*Lissemys punctata granosa* (Schoepff) Dorsal view, Ventral view.

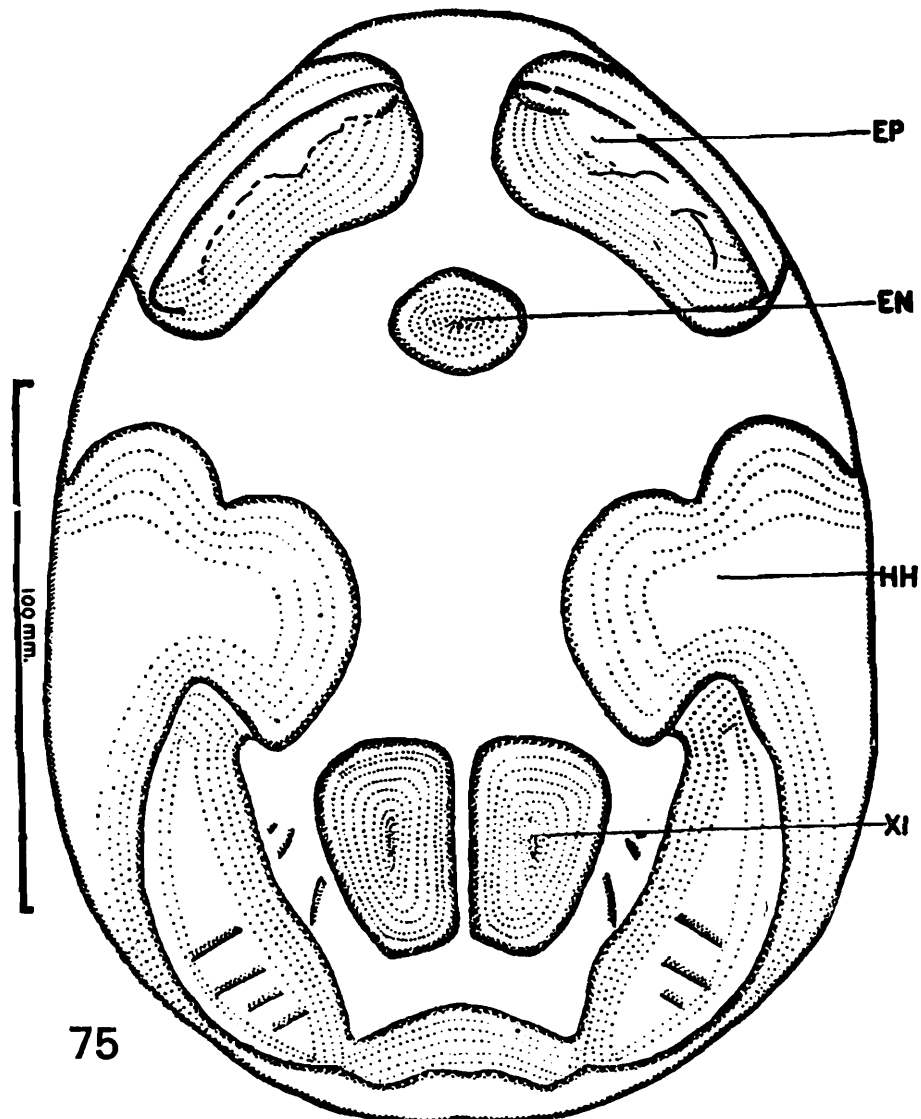
SOUTHERN FLAP-SHELLED TURTLE

28. *Lissemys punctata granosa* (Schoepff 1801)

(Plates 32 & 46; figs. 74, 75)

Other taxonomic characters and size etc. are same as available in the *Lissemys p. punctata* except that the first marginal bone is smaller than the second (Fig. 74), entoplastral callosity is very large in the adult individuals and in certain specimens it is in contact with the hyo-hypo-plastral callosities (Fig. 75). It differs in colouration also and the carapace is uniformly olive-brown, juveniles sometimes with light longitudinal markings on the greenish head.

74. Carapace of *Lissemys punctata granosa* (Schoepff)



75. Plastron of *Lissemys punctata granosa* (Schoepff)

Distribution: Peninsular India and Sri Lanka.

Habits and habitat: It prefers to live in ponds and tanks with muddy bottoms and embankments. It is strictly carnivorous and has got a great liking for fish but eats frogs, shrimps and snails also. It is a very pugnacious creature and bites immediately even on a gentle handling. It lays 10-12 spherical eggs in a single clutch; eggs measuring 30-33 mm. in diameter (Plate 46).

Status: Suspected to be threatened on account of large scale killing for eggs and adults, habitat destruction and urbanisation on the nesting sites.

Conservation: Nominally protected by legislation and any export of adults and their products is prohibited. This turtle is included in Appendix I of IUCN. Exact data on the population is not available, but it has been considerably reduced. A detailed study on the status and ecology will lead so as to formulate suitable management plans to conserve this endangered subspecies.

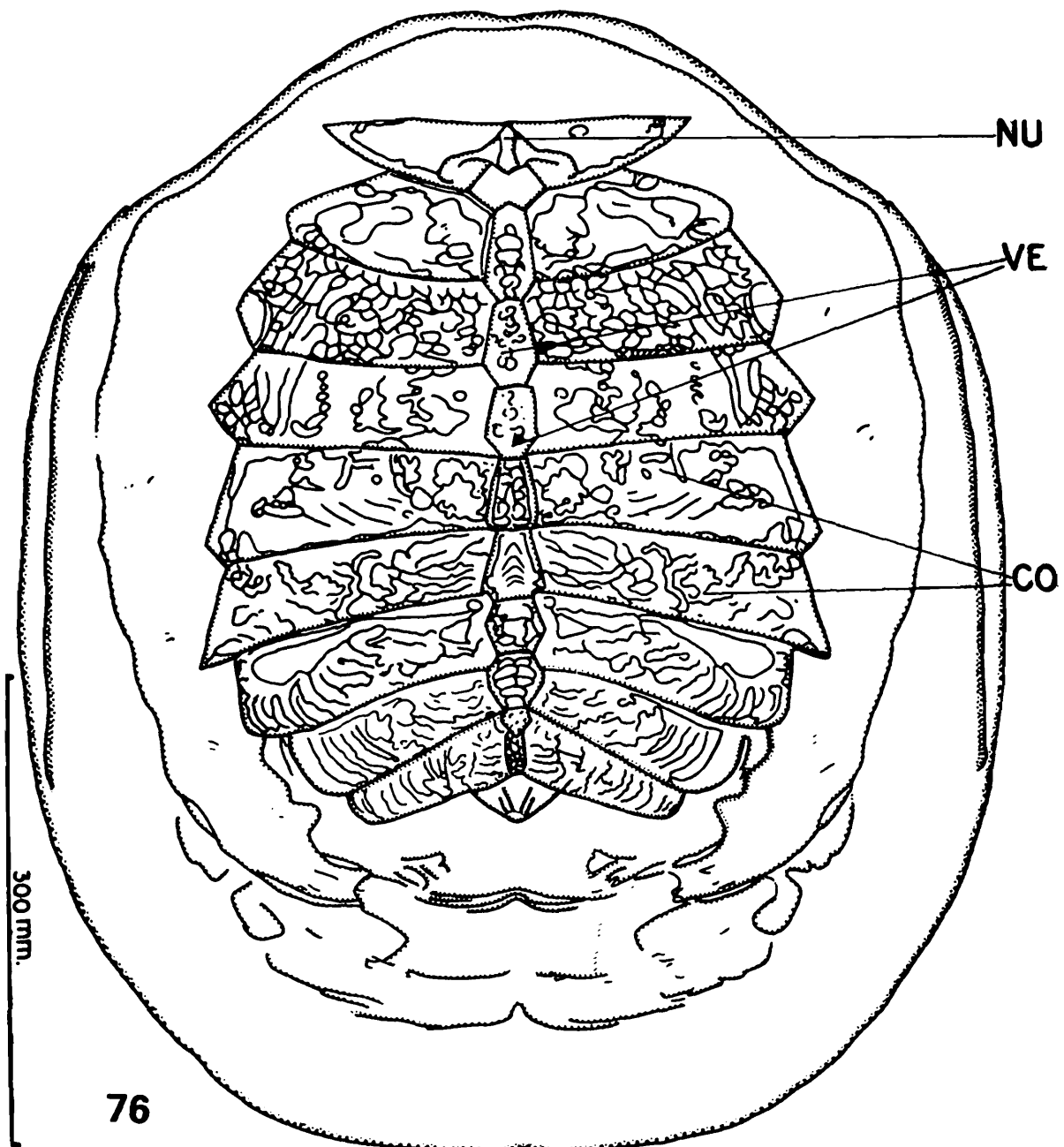
Genus 15. *Chitra* Gray 1844

NARROW-HEADED SOFT-SHELLED TURTLE

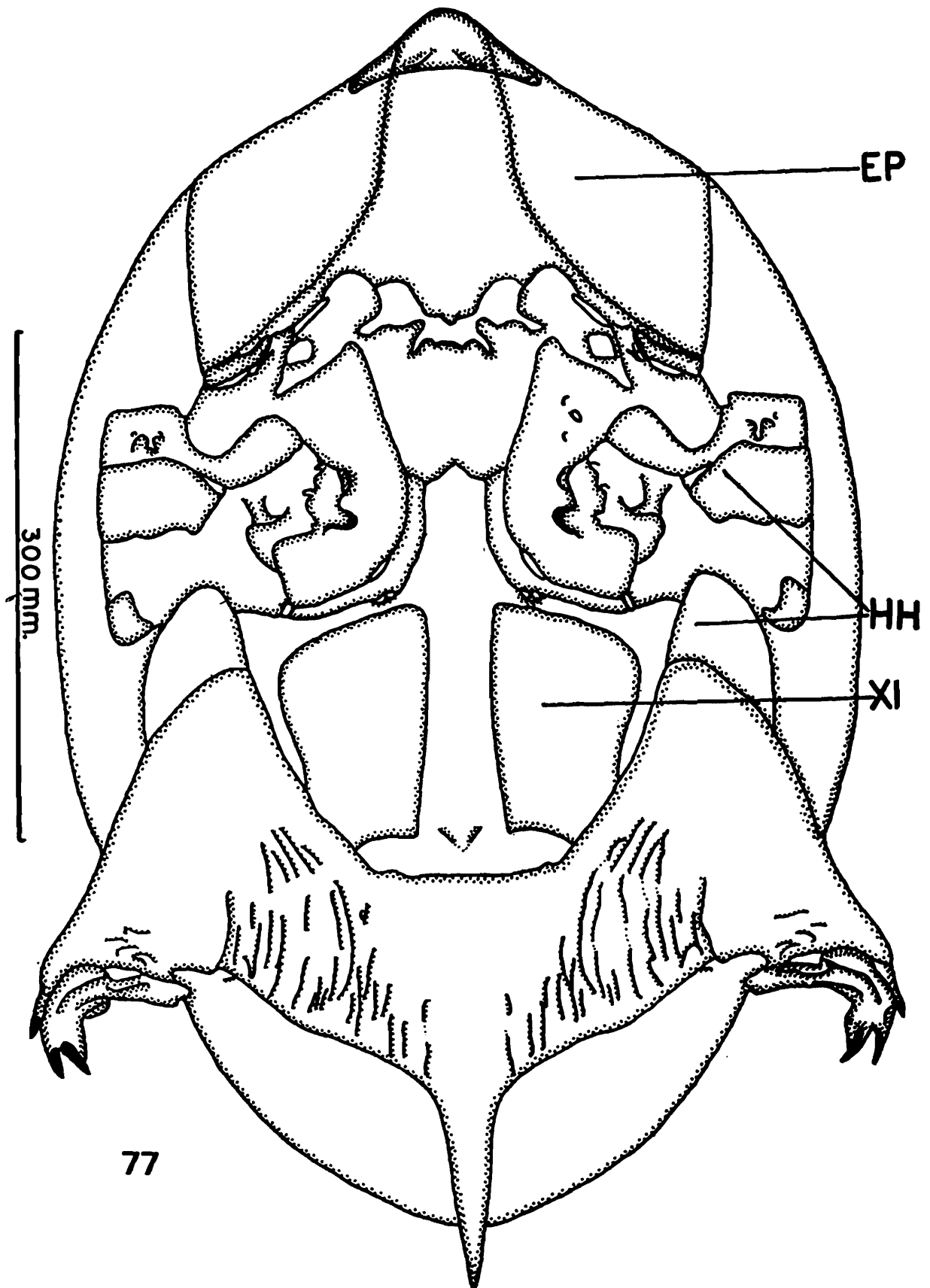
29. *Chitra indica* (Gray 1831)

(Plates 33, 34 & 47; figs. 76, 77)

This is a gigantic, flat soft-shelled species reaching to a length of 90 cm. or more. The head is quite small in comparison to the body, somewhat elongated; snout is rounded; proboscis about as long as the eye-opening. Skull (Plate 33) is very long and narrow, flat above, the orbits are close to its anterior extremity; post-orbital arch twice as broad as the diameter

76. Carapace of *Chitra indica* (Gray)

of the orbit; posterior margin of the pterygoid is free and devoid of any ascending process. The alveolar surfaces of jaws are slightly expanded, and the edges of jaws are extremely sharp. The eyes are displaced much forward. Carapace (Fig. 76) is remarkably pitted and vermiculated; a



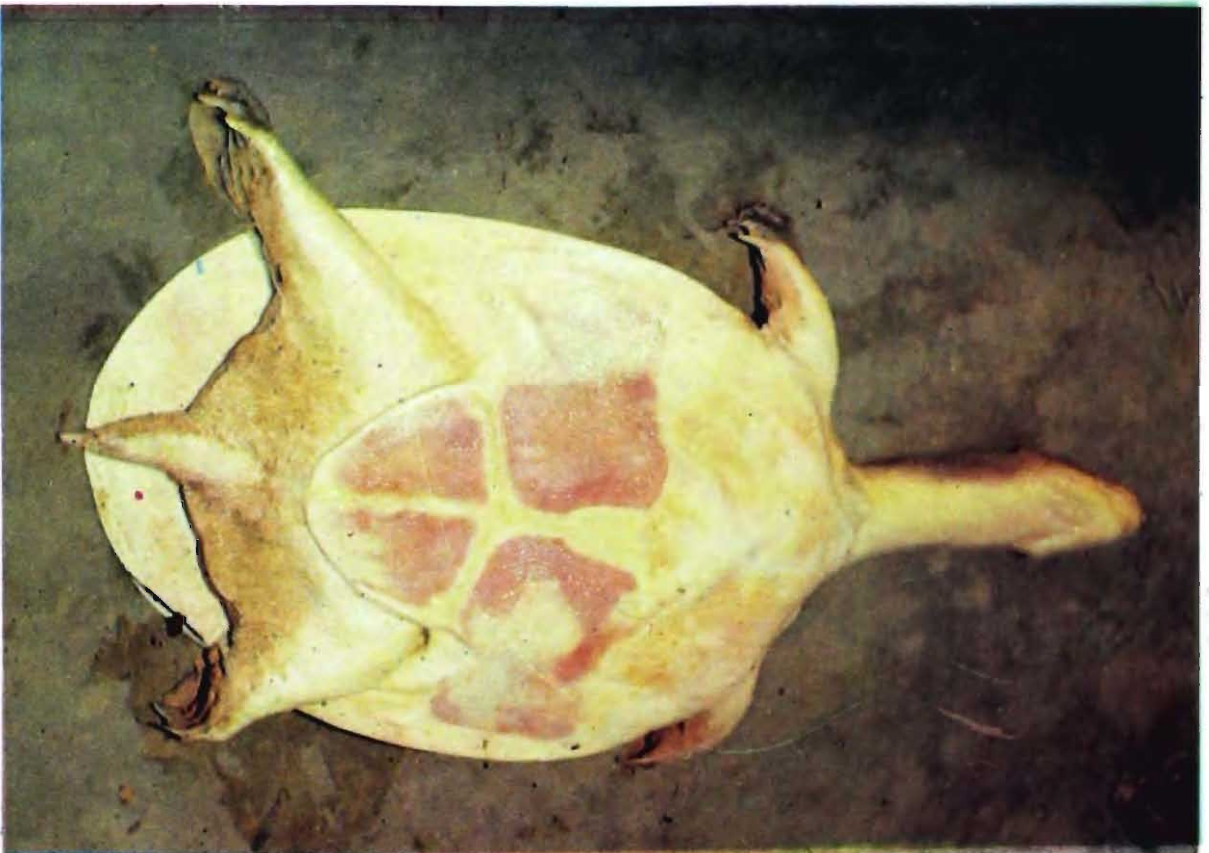
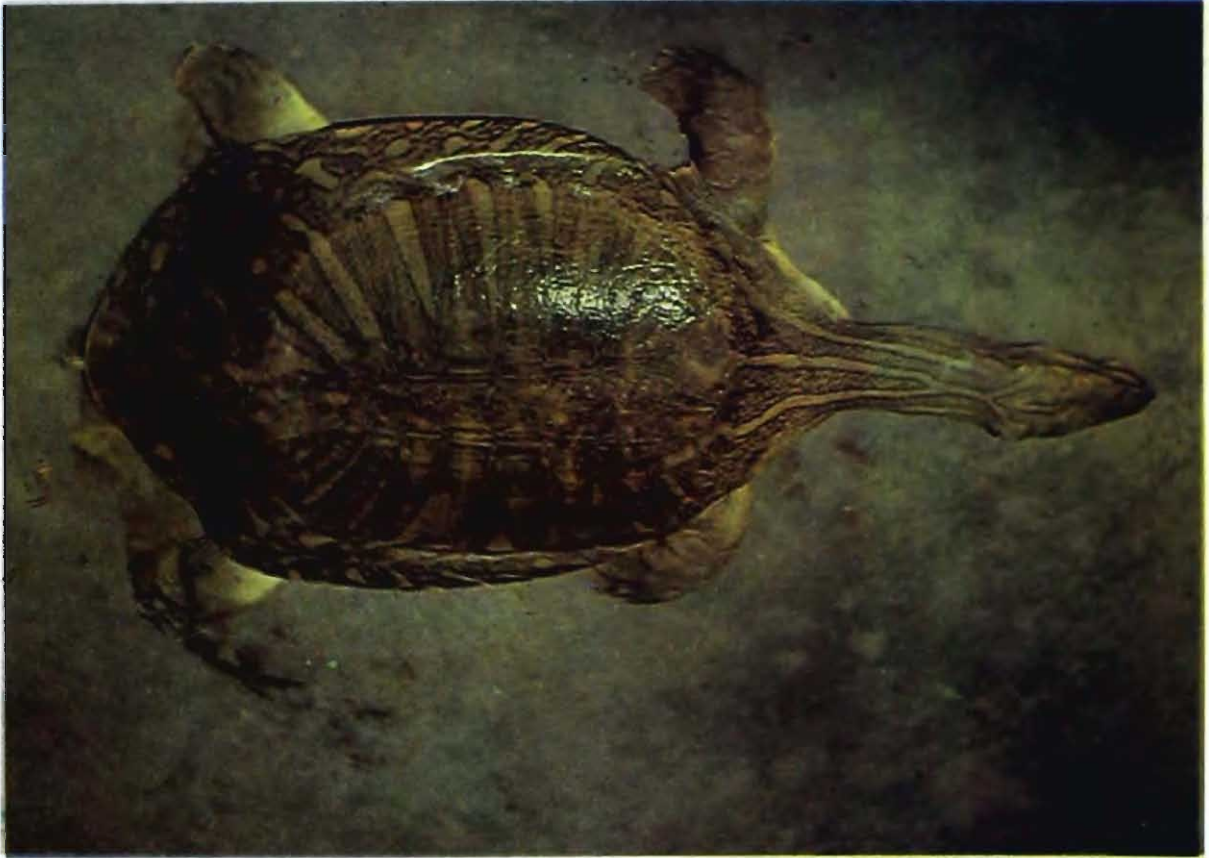
77. Plastron of *Chitra indica* (Gray)

PLATE 33



Skull—*Chitra indica* (Gray)— Lateral view, Dorsal view, Ventral view.

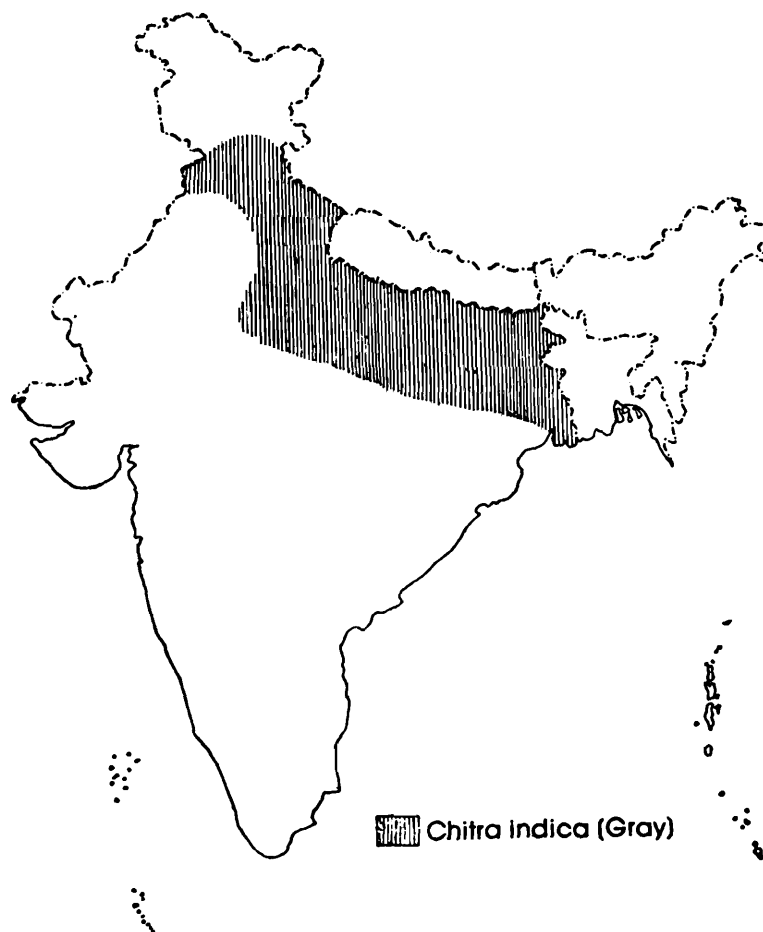
PLATE 34



Narrow-headed Soft-shelled Turtle—*Chitra indica* (Gray) Dorsal view, Ventral view.

single neural plate rests between the first pair of costals; outer extremity of nuchal plate overlapping the second dorsal rib; eight neural plates form a continuous series; eight pairs of costal plates are present, the last pair is in contact with the mid-line. Hyoplastron is distinct from hypoplastron; anterior limbs of epiplastra are long and slender, widely separated from one another; four well developed hyo-hypo and xiphi plastral callosities are present in the adults (Fig. 77). Dorsal colouration is olivaceous-yellow, with dark vermiculations or black dots in juveniles. In adults the black punctate markings are replaced by large angular markings of light yellow colour. Head and neck with light, black-edged longitudinal streaks and a \wedge — shaped mark in the mid-line commencing just in front of the disc. In fully grown up and aged adults these markings become less distinct.

Distribution: India (Uttar Pradesh, Bihar and West Bengal), Nepal, Pakistan, Malaysia and Thailand.



Map showing the distribution of *Chitra indica* (Gray)

Habits and habitat: This species is most agile and prefers to live in shallow rivers with sandy bottoms and banks. This is most dangerous carnivorous freshwater turtle and its food comprises mainly fish, gastropod molluscs and other small animals. On handling it suddenly shoots out

its long neck and bites most savagely. It is capable of inflicting most severe wounds. It lays 8-10 spherical eggs in a single clutch; eggs measuring 36-42 mm. in diameter (Plate 47).

Status: Indeterminate, suspected to be threatened on account of excessive killing of adults and overexploitation of eggs for food. Other factors of threat are same as given in the case of other Trionychids.

Conservation: Nominally protected by legislation. Exact population estimates are not available but it has been considerably depleted in the recent past. A detailed study on the status and ecology will lead so as to formulate suitable management plans to conserve this endangered species.

Genus 16. *Trionyx* Geoffroy 1809

Main generic characters are: Normally eight pairs of costal plates are present; outer extremity of nuchal plate overlying the second dorsal rib; normally eight neural plates; eight dorsal plates; the last one or two are in contact in the middle line. Hyoplastron is distinct from hypoplastron; not more than five plastral callosities are present in the adult. Skull is convex dorsally; postorbital arch narrower than the orbital diameter; posterior margin of pterygoid is free, without an ascending process. Limbs exposed, with three claws. Tail short. Proboscis about as long as the opening of the eye. Dorsal disc of the young are with small tubercles mostly arranged in longitudinal series. Out of 15 species available in the whole world, ten are Asiatic, one African and four American. In India three species are present.

Key to the species of Genus Trionyx

Alveolar surface of mandible raised at its inner margin, the edges meeting and forming a projection at the symphysis, the length of which is less than the diameter of the orbit in the adult; maxillary groove is well defined; head with black streaks; disc of young without ocelli *T. gangeticus*

Alveolar surface of mandible not raised at the inner margin, more or less flat at the symphysis, which is usually longer than the orbital diameter in the adult; maxillary groove well defined; head with black streaks, disc of young with 4 or more ocelli *T. leithi*

Alveolar surface of mandible not raised at the inner margin, grooved at the symphysis, which is distinctly longer than the diameter of the orbit in the adult; maxillary groove ill defined; head marbled with black and yellow; disc of young with 4 or more ocelli *T. hurum*

INDIAN SOFT-SHELLED TURTLE
OR
GANGA SOFT-SHELLED TURTLE

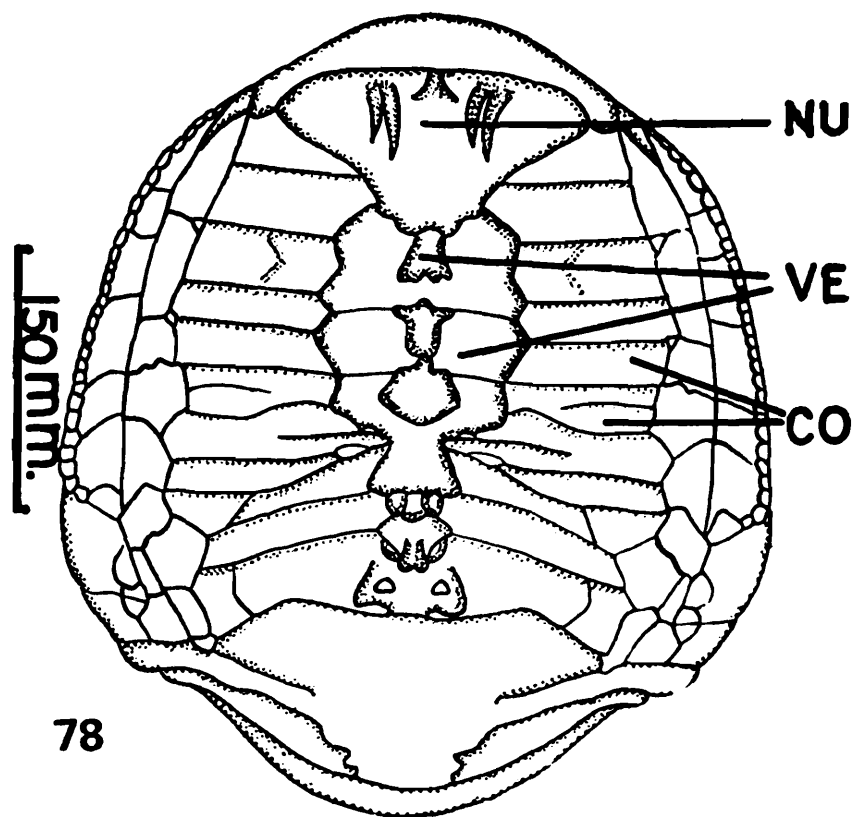
30. *Trionyx gangeticus* (Cuvier 1825)

(Plates 35, 36 & 47; figs. 78, 79)

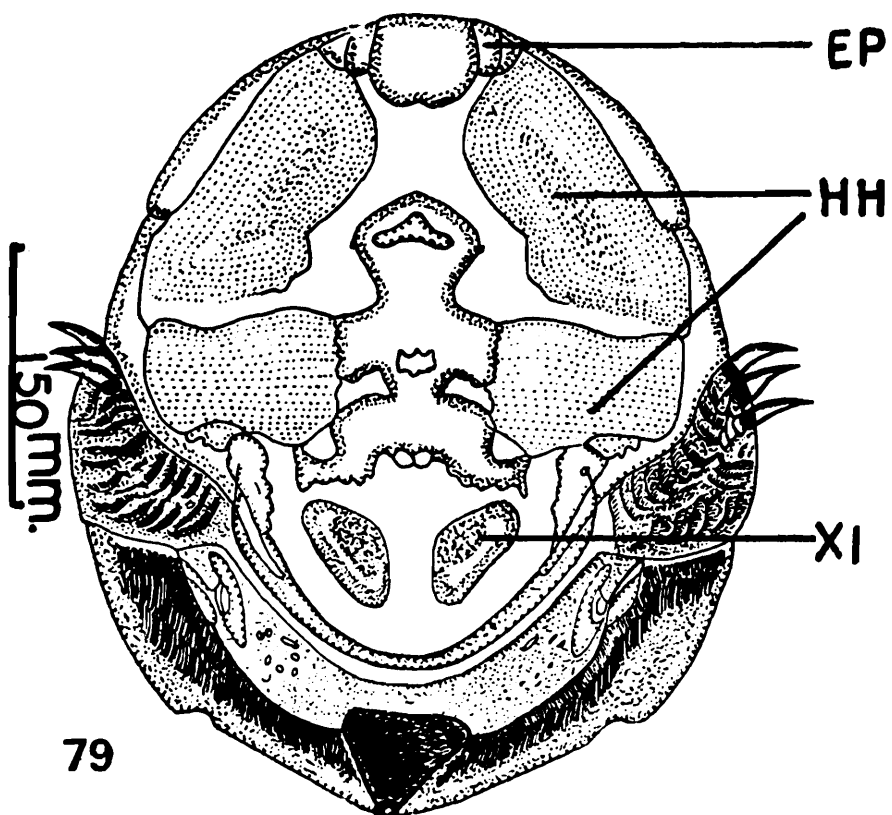
This is a very large, soft-shelled turtle with an oval shell and reaches up to 45 cm. in length. The head is comparatively large and broad with dorso-laterally situated eyes and quite thick and somewhat elongated proboscis. The snout is equal to the diameter of the orbit. In the skull, (Plate 35) postorbital arch is one-half to one-third the diameter of the orbit; alveolar surface of upper jaw is flat, with a well defined medial axillary groove between them; mandibles with raised inner edges, which meet at the symphysis to form a short, median projection; length of symphysis is less than the diameter of the orbit in the adult. Two neural plates rest between the first pair of well developed costal plates; last pair of costal plates is generally in contact in the mid-line; all the plates of the carapace (Fig. 78) are coarsely pitted and vermiculated; Nuchal shield is not present; anterior limbs of epiplastra long and slender, in contact with or narrowly separated from one another; four plastral callosities, hyo-hyoplastral and xiphiplastral are well developed in the fully grown adults, in aged turtles a fifth callosity is also present upon the entoplastron (Fig. 79). Limbs are with three claws. Tail is short in both sexes. Dorsal colouration is olive-green; carapace is dull olive or greenish with irregular dark reticulations; plastron is ivory white; head is greenish, with a black longitudinal streak from between the eyes on to the nape and three oblique black streaks on either side diverging from it; another streak starting from behind the eye. Juveniles are greenish with a reticulated pattern of four irregular ocelli on the carapace; sometimes with black longitudinal line on the top of the head.

Distribution: The species inhabits the Ganga, Sind and Mahanadi river systems. It is common in N. W. Pakistan, Bangladesh and the Nepal foothills.

Habits and habitat: The species is highly aquatic inhabiting the deep turbid rivers but it is frequently seen basking on sandy banks or resting in shallow water with its head striking out of water. It is an omnivorous species and the diet comprises a wide range of aquatic vegetation and animal food like fish, molluscs, frogs and crustaceans. It is a very prominent scavenger also. Breeding takes place in late September to October. The spherical and hard shelled eggs with a diameter of 3 cm. are laid on the sandy river banks (Plate 47).

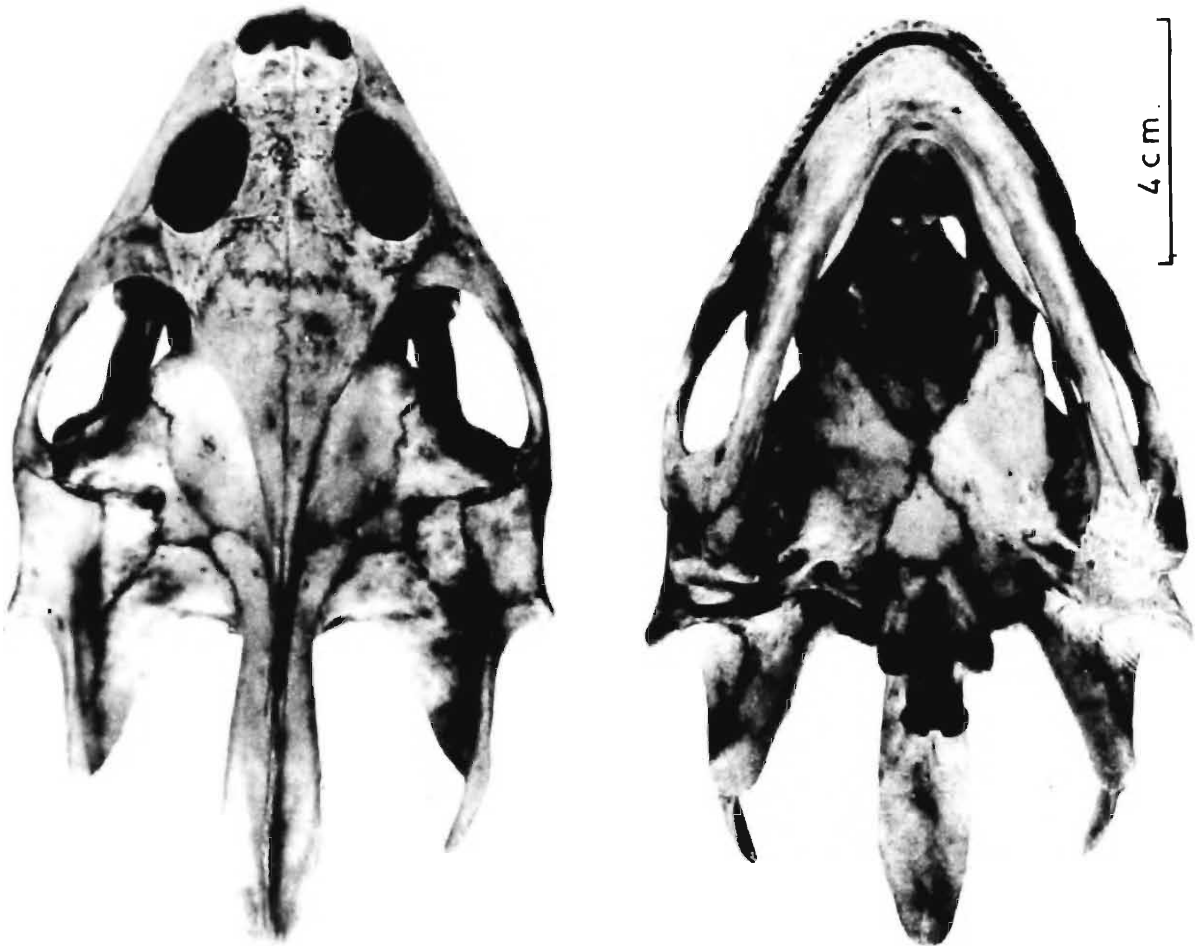
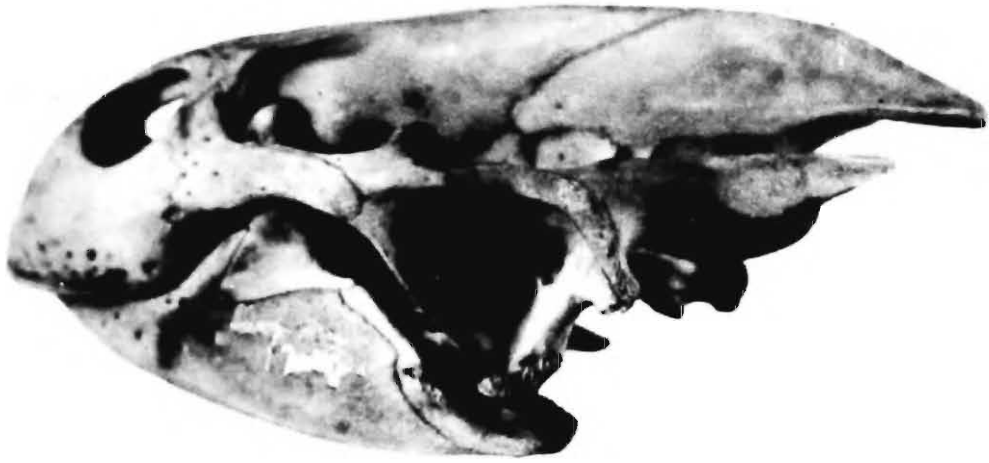


78. Carapace of *Trionyx gangeticus* (Cuvier)



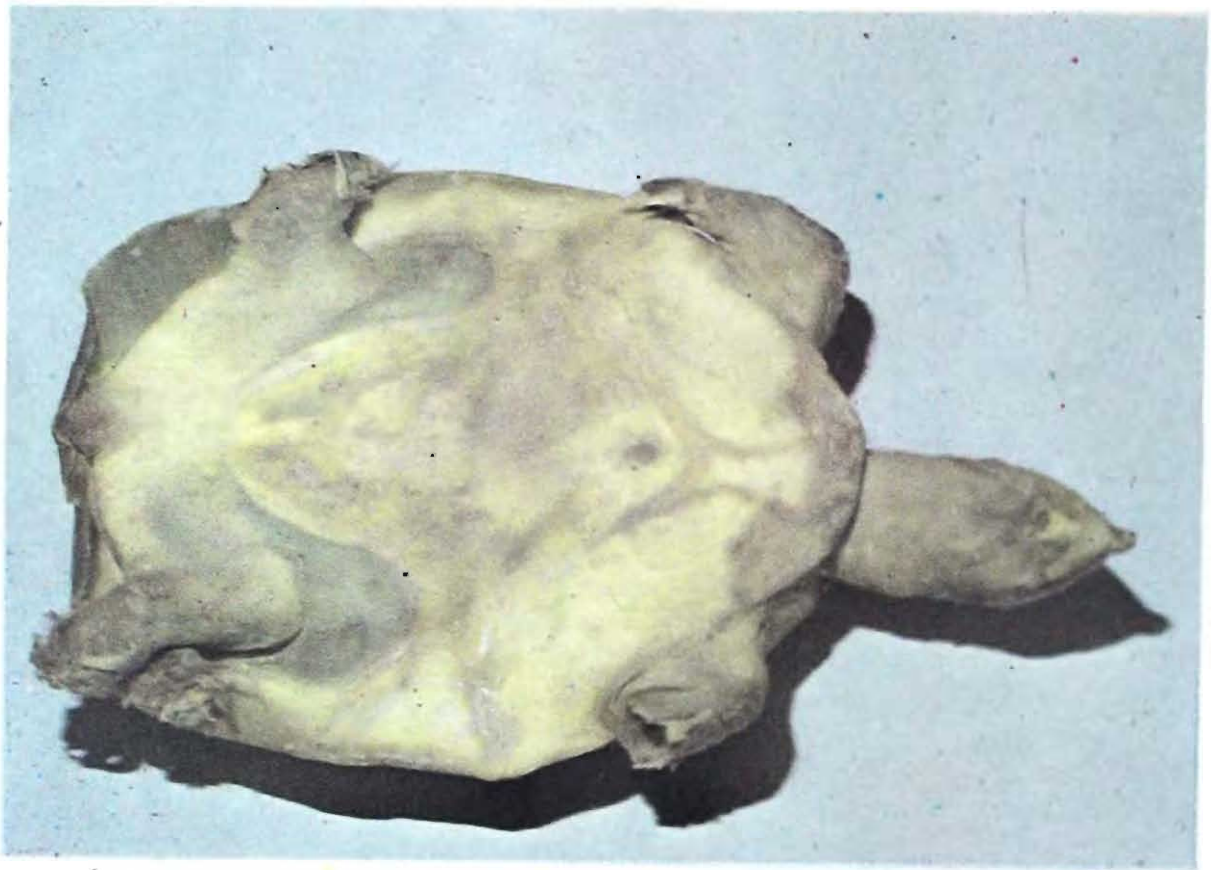
79. Plastron of *Trionyx gangeticus* (Cuvier)

PLATE 35

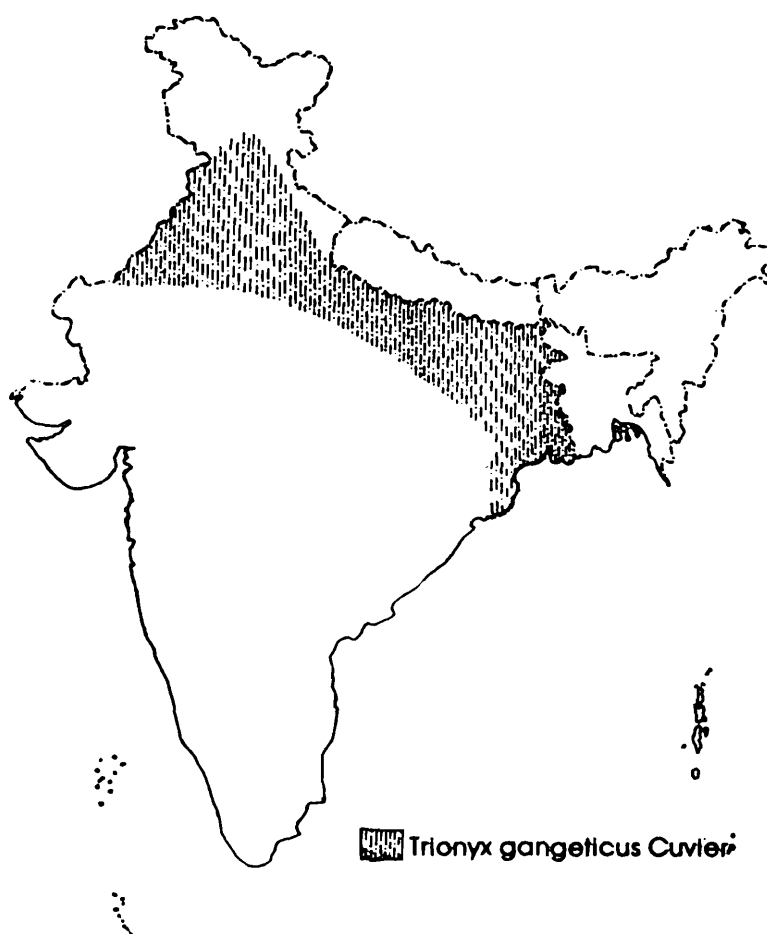


Skull—*Trionyx gangeticus* Cuvier—Lateral view, Dorsal view, Ventral view.

PLATE 36



Ganga Soft-shelled Turtle—*Trionyx gangeticus* cuvier Dorsal view, Ventral view.



Map showing the distribution of *Trionyx gangeticus* (Cuvier)

Status: The species has become endangered on account of excessive killing of the adults for flesh, and overexploitation of eggs for food. The flesh of this turtle is highly liked as an important food item at various places in Bengal and Orissa. Habitat destruction is also a principal factor of threat to this species.

Conservation: Nominally protected by legislation but adequate measures are not followed strictly. Exact data on the population are not available but the number has reduced drastically. A detailed study on the status and ecology will lead so as to formulate suitable management plans to conserve this endangered species. This turtle species has already been included in the Appendix I of IUCN.

PENINSULAR SOFT-SHELLED TURTLE

31. *Trionyx leithi* Gray 1872

(Plates 37, 38; figs. 80, 81)

This very large, soft-shelled turtle reaches slightly above 50 cm. in length. This species is quite similar to *Trionyx gangeticus* in the taxonomic characters of the carapace (Fig. 80) and plastron (Fig. 81) but differs from it in having a bony snout longer than the diameter of the orbit; postorbital arch one-half to one-third the diameter of the orbit; alveolar surface of upper jaw is flat and with a fairly well defined median maxillary groove between them; inner edge of mandible not raised; the mandibular symphysis is flat, its length is equal to or greater than the diameter of the orbit in the adult. Dorsal colouration is olive-green with lighter vermiculations. Ventrums is whitish. Head is greenish with black longitudinal lines from between

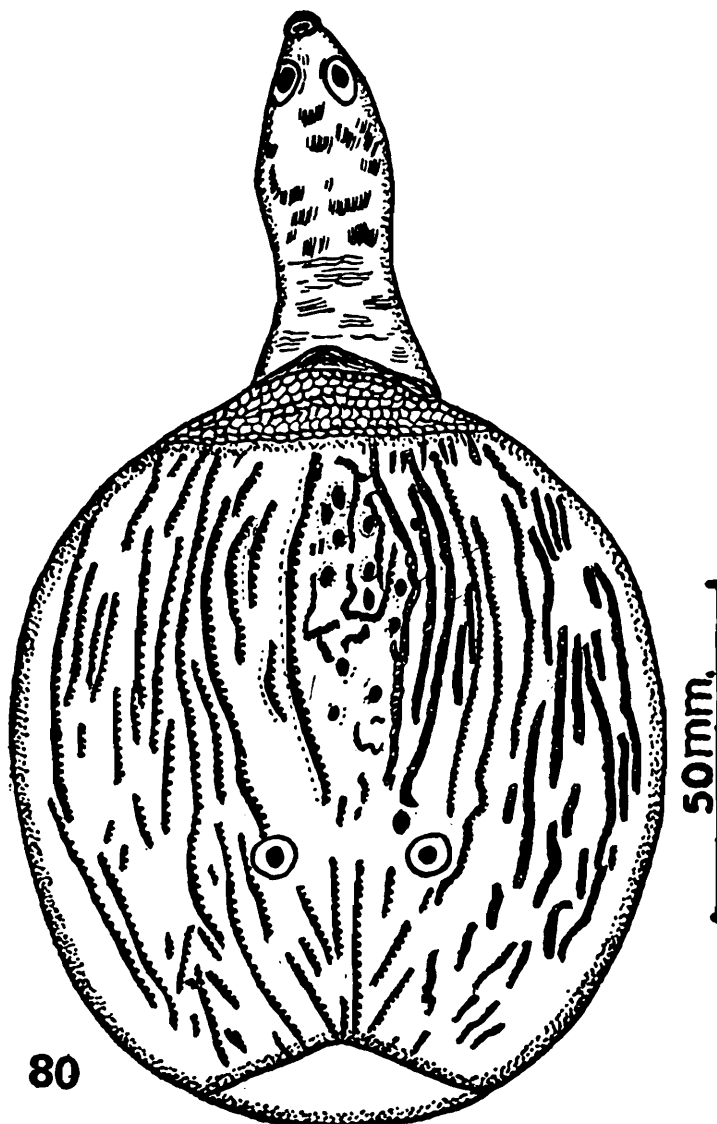
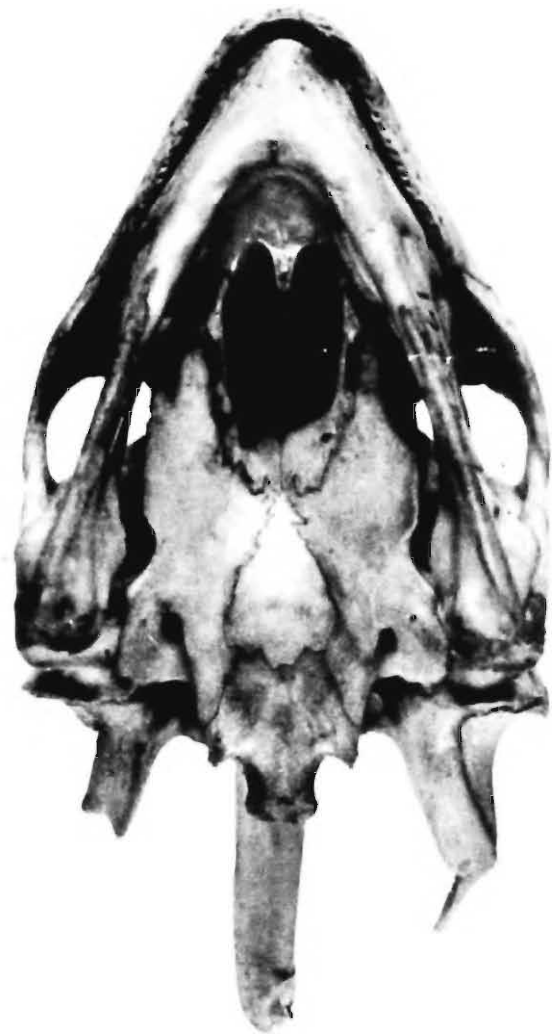
80. Carapace of *Trionyx leithi* Gray

PLATE 37

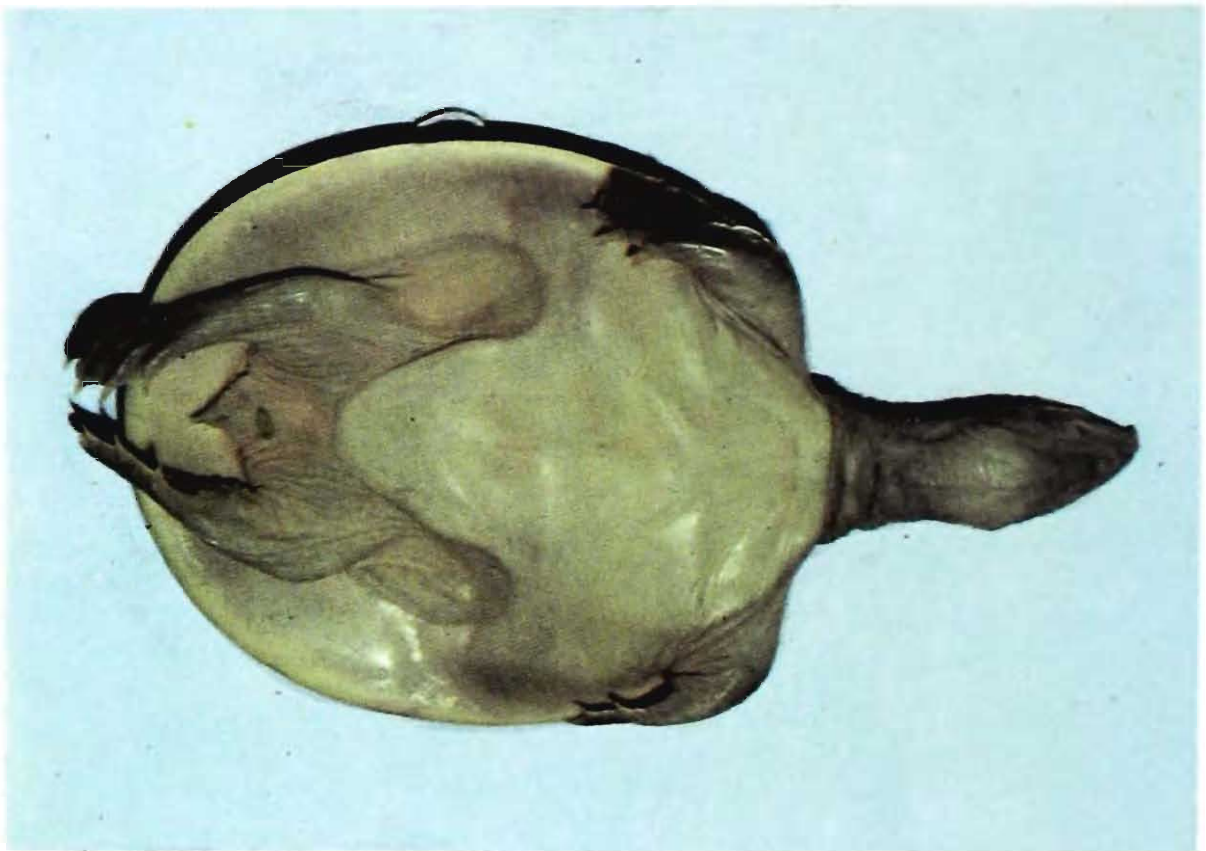


2 cm.

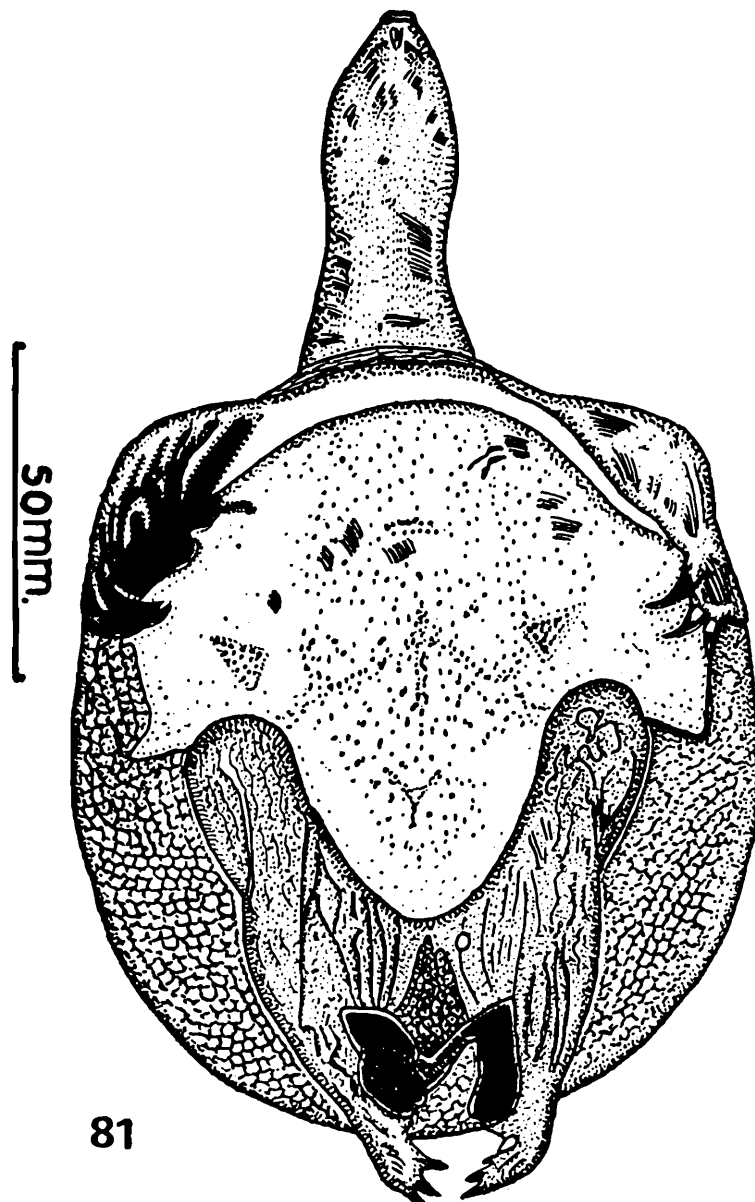


Skull—*Trionyx leithi* Gray— Lateral view, Dorsal view, Ventral view.

PLATE 38



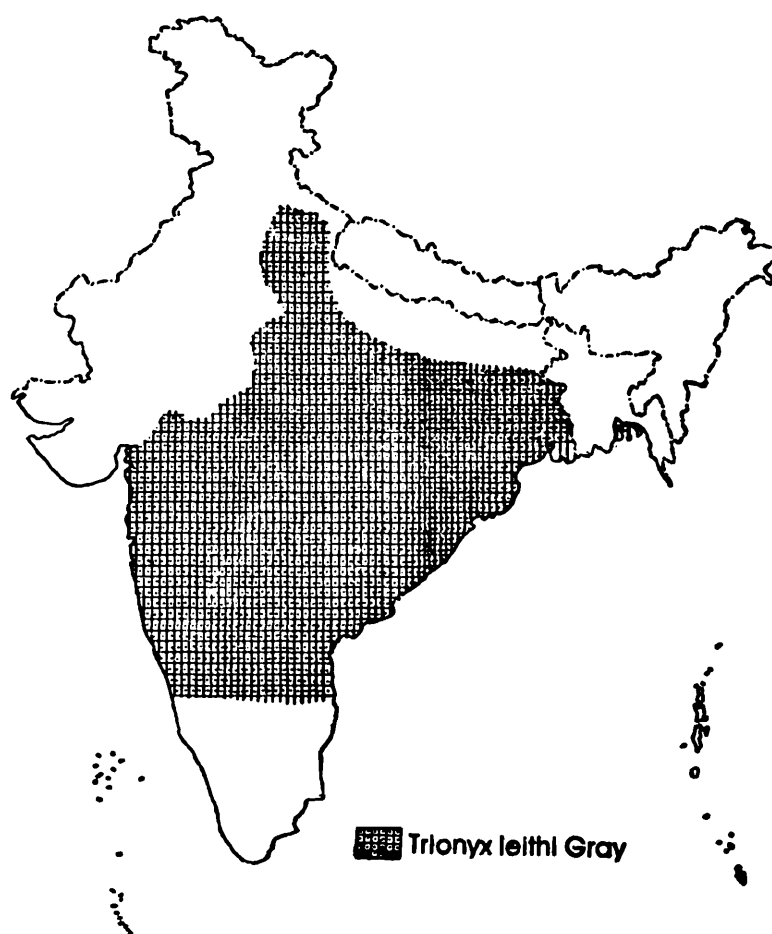
Peninsular Soft-shelled Turtle—*Trionyx leithi* (Gray) Dorsal view, Ventral view.

81. Plastron of *Trionyx leithi* Gray

the eyes and two or three oblique black streaks emerge on either side and one streak starts behind the eye. The carapace in the juveniles is with four distinct ocelli (concentric circles).

Distribution: Ganga river systems and all the rivers of Peninsular India as far south as Madras.

Habits and habitat: The species is perfectly aquatic and like *Trionyx gangeticus* is frequently seen basking on sandy banks or resting in shallow water with its head sticking out of water. The species inhabits deep turbid rivers as well as canals, marshes, ponds and lakes. The species is completely omnivorous like *Trionyx gangeticus* and is also a scavenger. Eggs are slightly oval.



Map showing the distribution of *Trionyx leithi* (Gray)

Status: This species is also endangered on account of excessive killing of the adults for flesh, and overexploitation of eggs for food. Habitat destruction and urbanisation is another factor responsible for its decline.

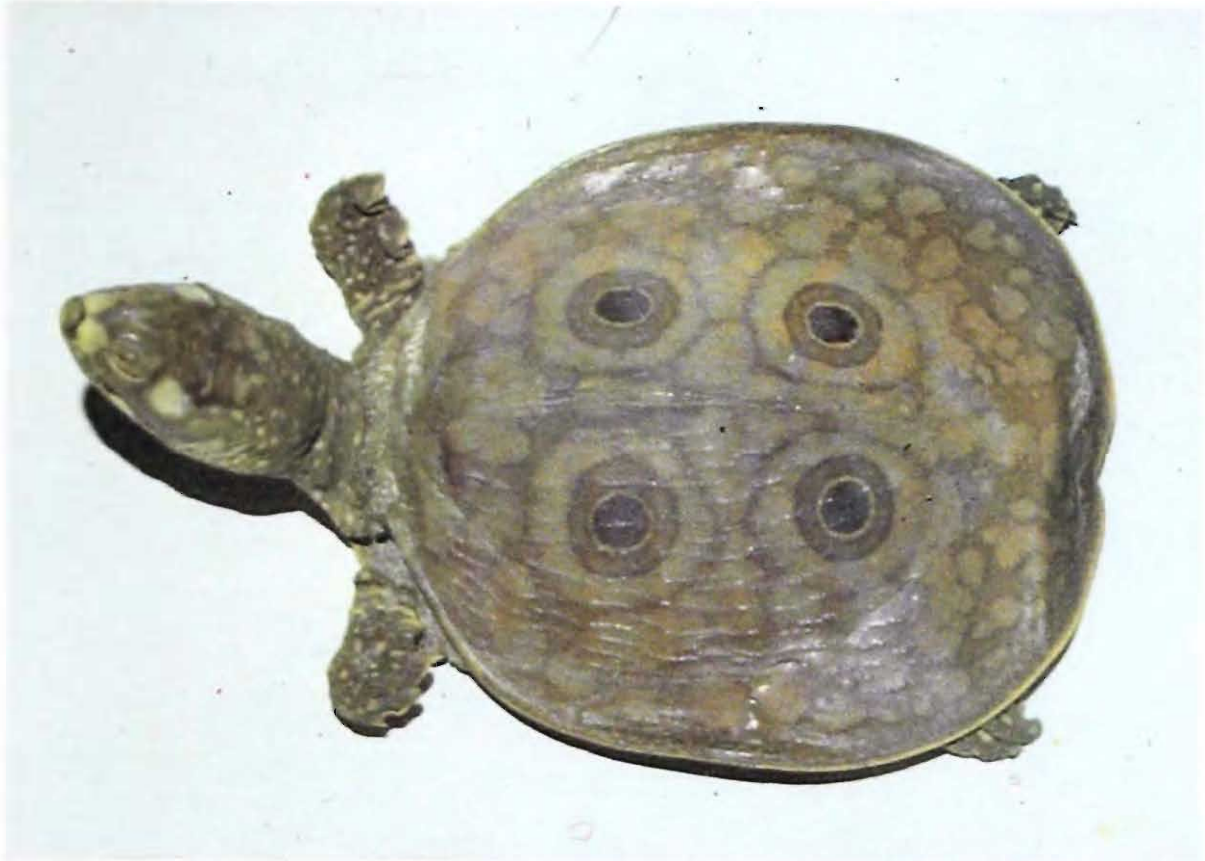
PEACOCK-MARKED SOFT-SHELLED TURTLE

32. *Trionyx hurum* Gray 1831

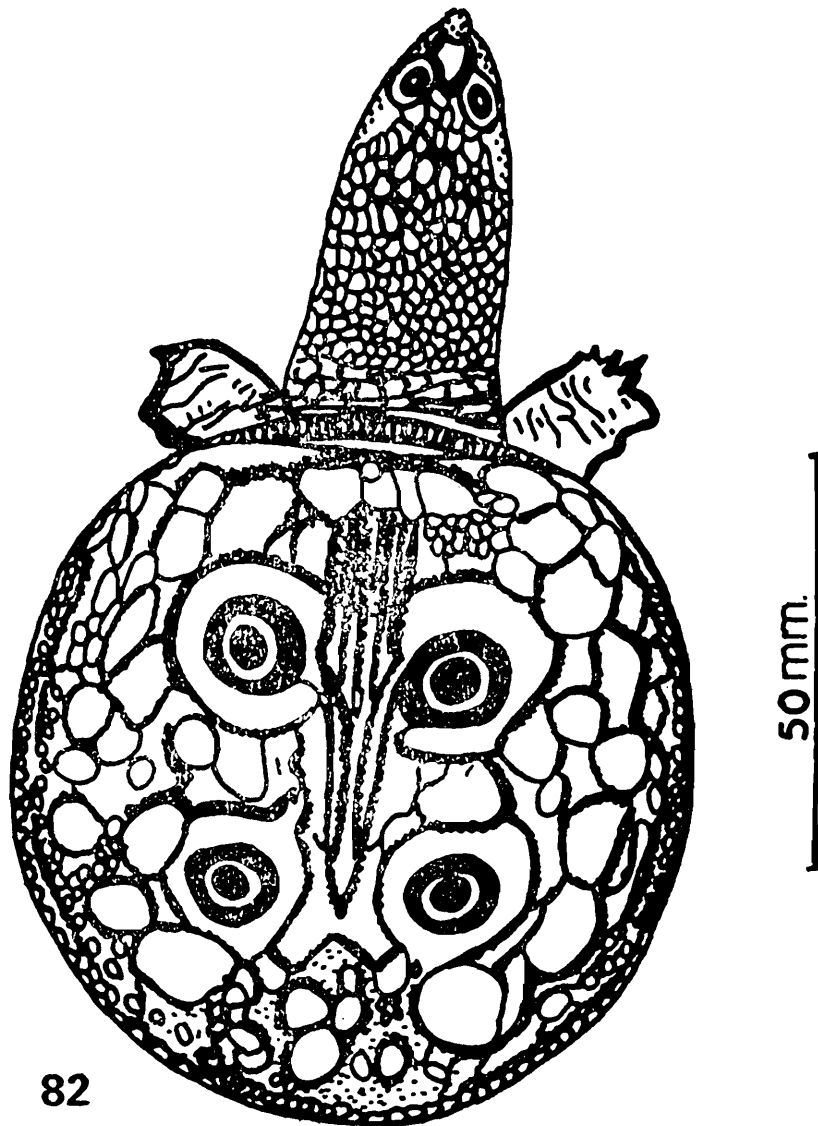
(Plate 39; figs. 82, 83)

This is a gigantic soft-shelled species in which length reaches up to 60 cm. and above. The head is comparatively large and its snout is prominently projecting down turned and is longer than the diameter of the orbit; postorbital arch one-half to one-third the diameter of the orbit; alveolar surfaces of upper jaw sloping gradually to meet the median maxillary groove;

PLATE 39



Peacock—marked Soft-shelled Turtle—*Trionyx hurum* (Gray) Dorsal view, Ventral view.

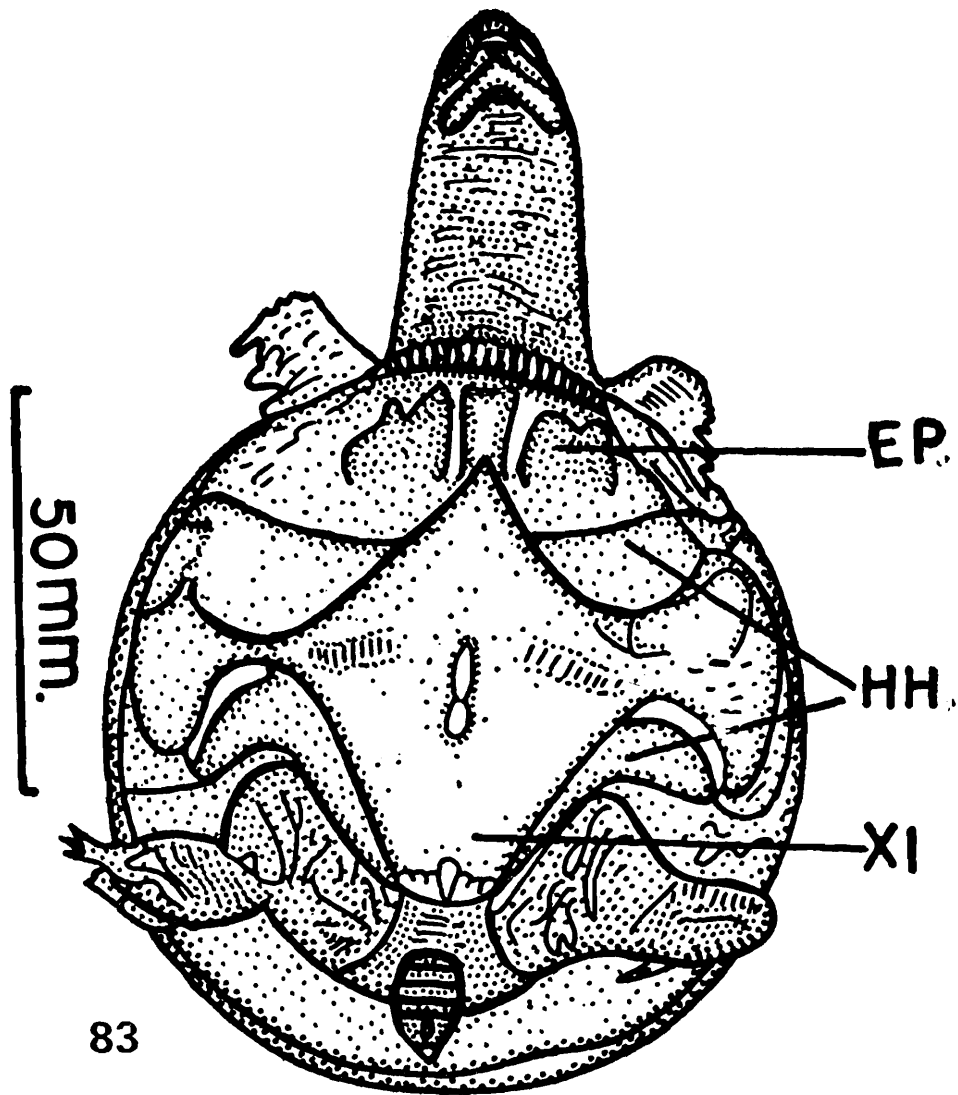


82

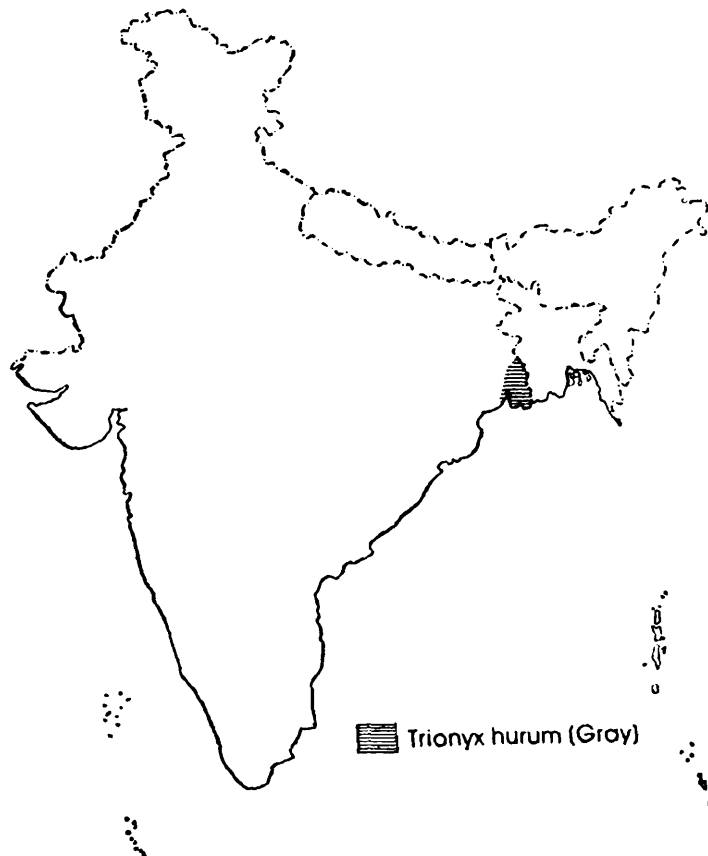
82. Carapace of *Trionyx hurum* (Gray)

mandibular symphysis has a median groove which is longer than the orbital diameter. Other taxonomic characters of carapace (Fig. 82) and plastron (Fig. 83) are as available in *Trionyx gangeticus*. Dorsum is olive-green, reticulated with black and generally with four striking ocelli (like the peacock eye) with a narrow yellow rim and large number of broken longitudinal markings. Head is dark green with several yellow spots. Carapace, ocelli and yellow head spots become less distinct with the advancement of age. A pale yellow spot across the snout is always present. Plastron is ivory-white.

Distribution: The species is available in the lower reaches of the Ganga and Brahmaputra rivers.



83. Plastron of *Trionyx hurum* Gray



Map showing the distribution of *Trionyx hurum* Gray

Habits and habitat: The species is markedly aquatic and omnivorous.

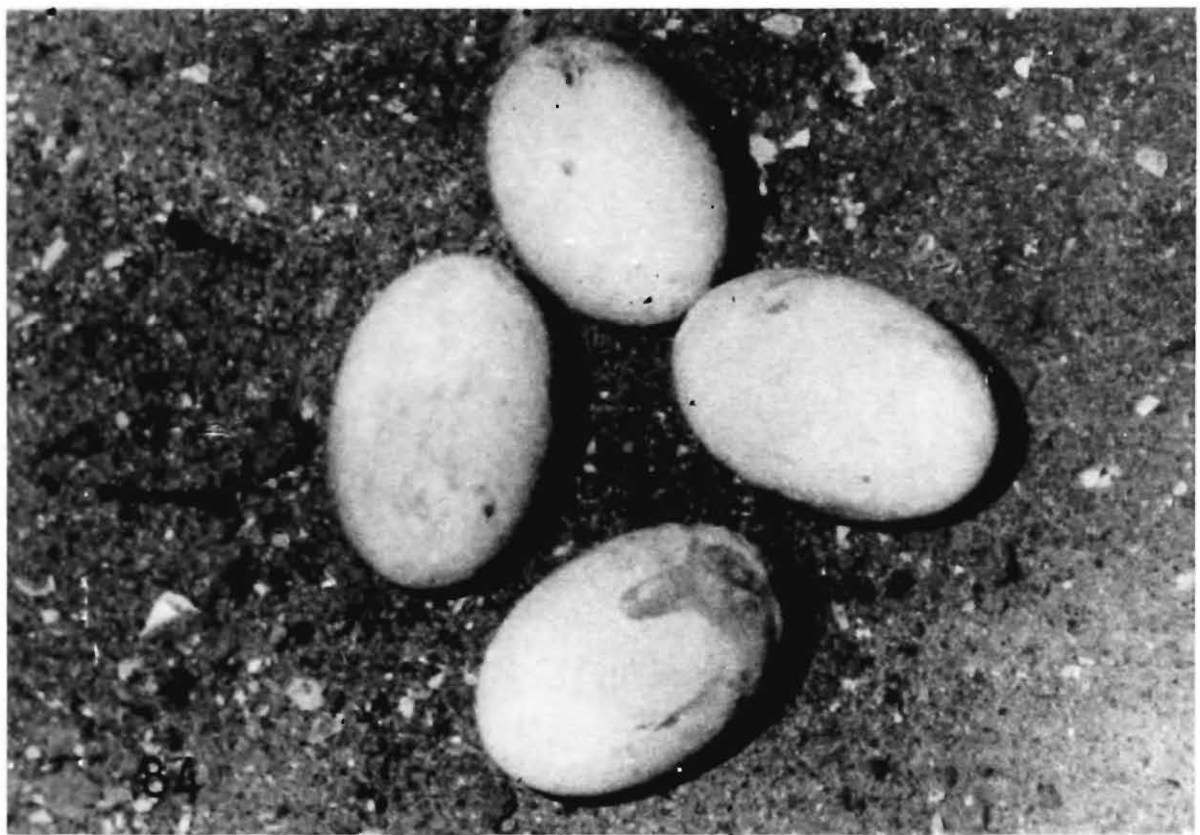
Status: The species has become endangered on account of habitat loss and by the predation of man and animals for food.

Conservation: Nominally protected by legislation but adequate measures are not followed strictly.

PLATE 40

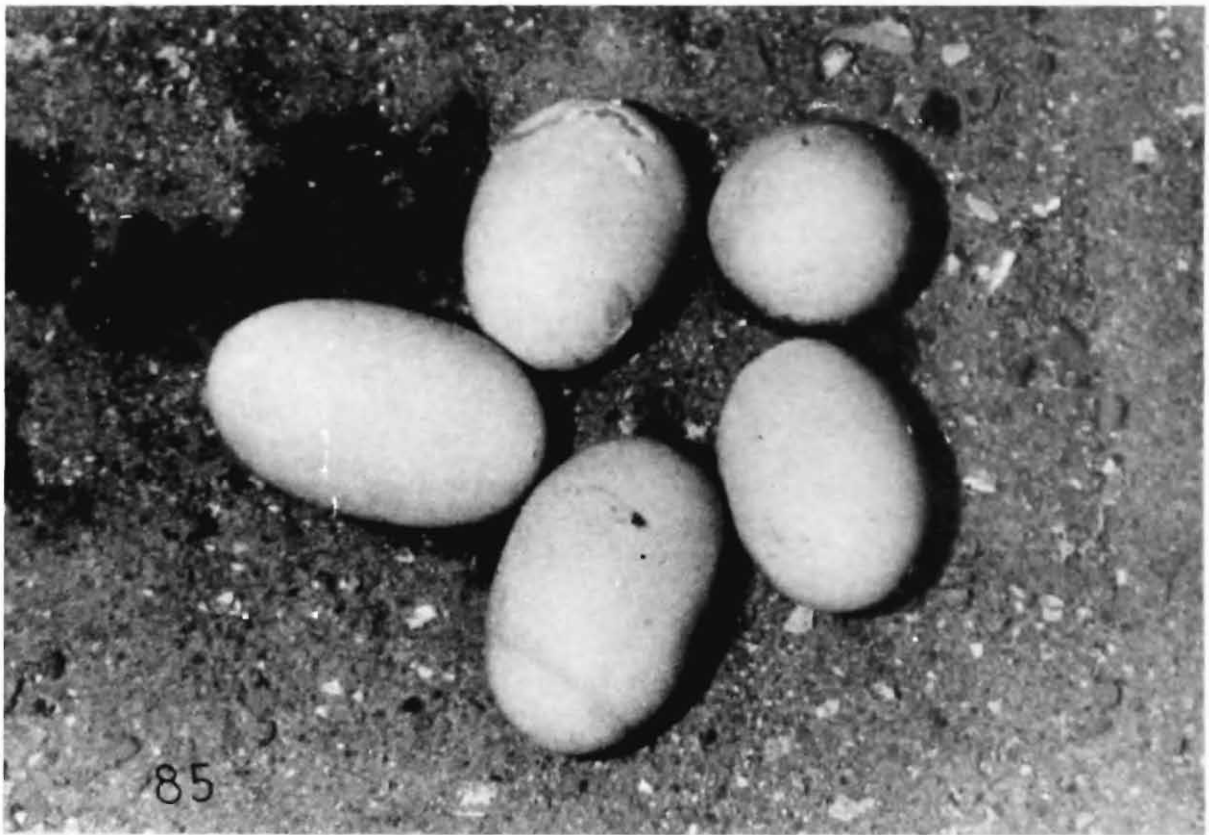


Chelonia mydas (Linnaeus)



Hardella thurgi (Gray)

PLATE 41

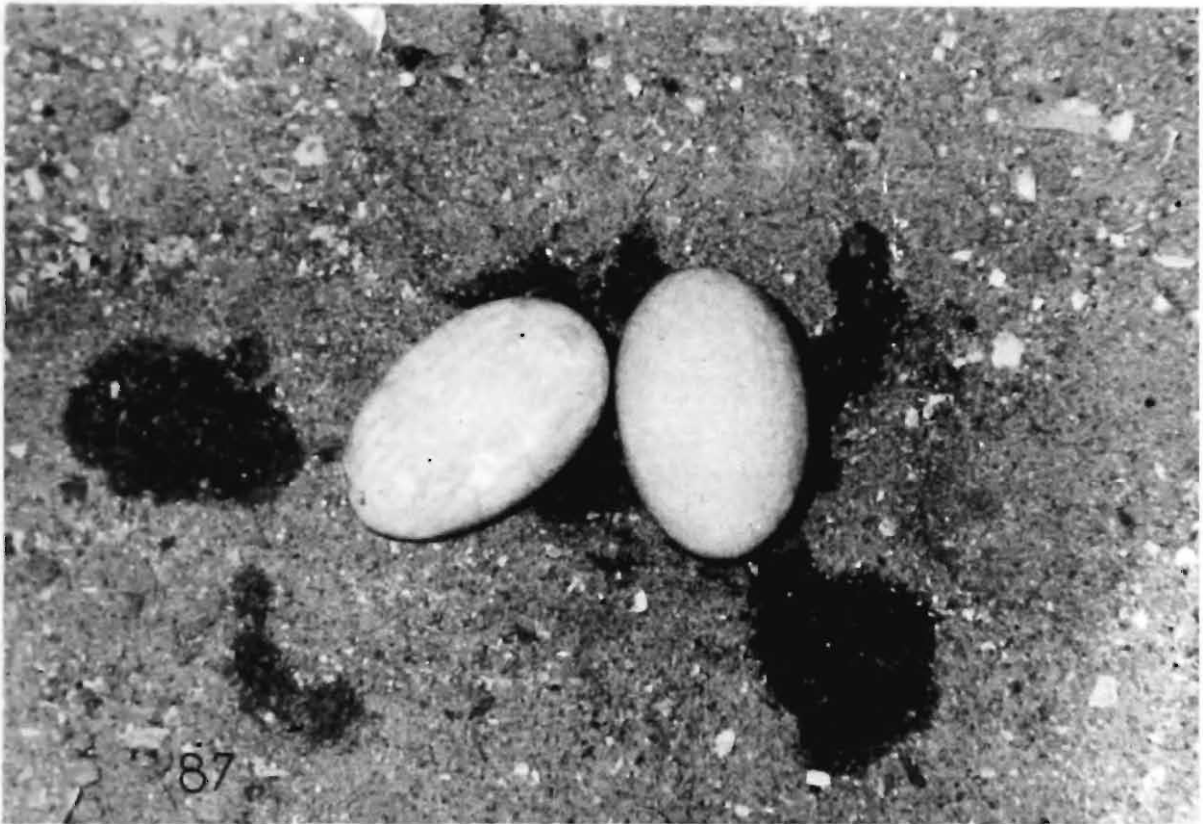


Kachuga dhongoca (Gray)

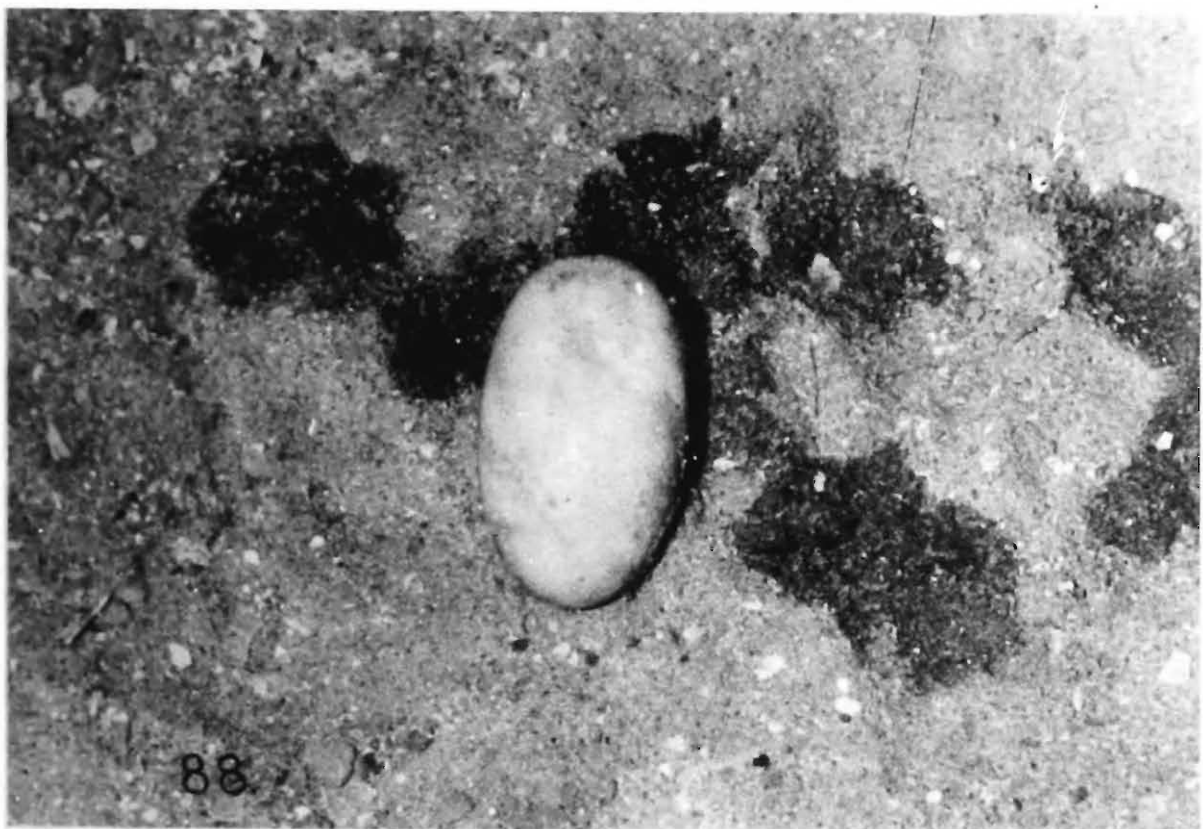


Kachuga kachuga (Gray)

PLATE 42



Kachuga smithi (Gray)

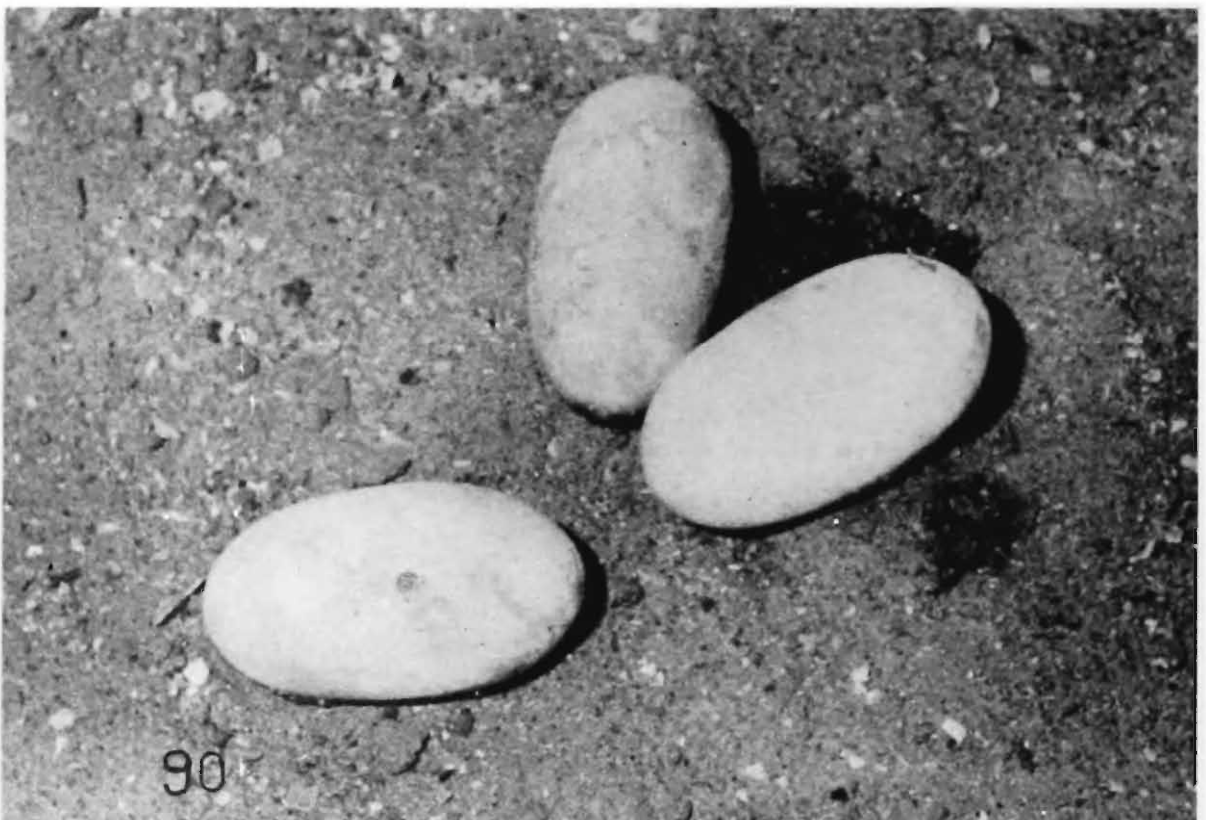


Kachuga sylhetensis (Jerdon)

PLATE 43

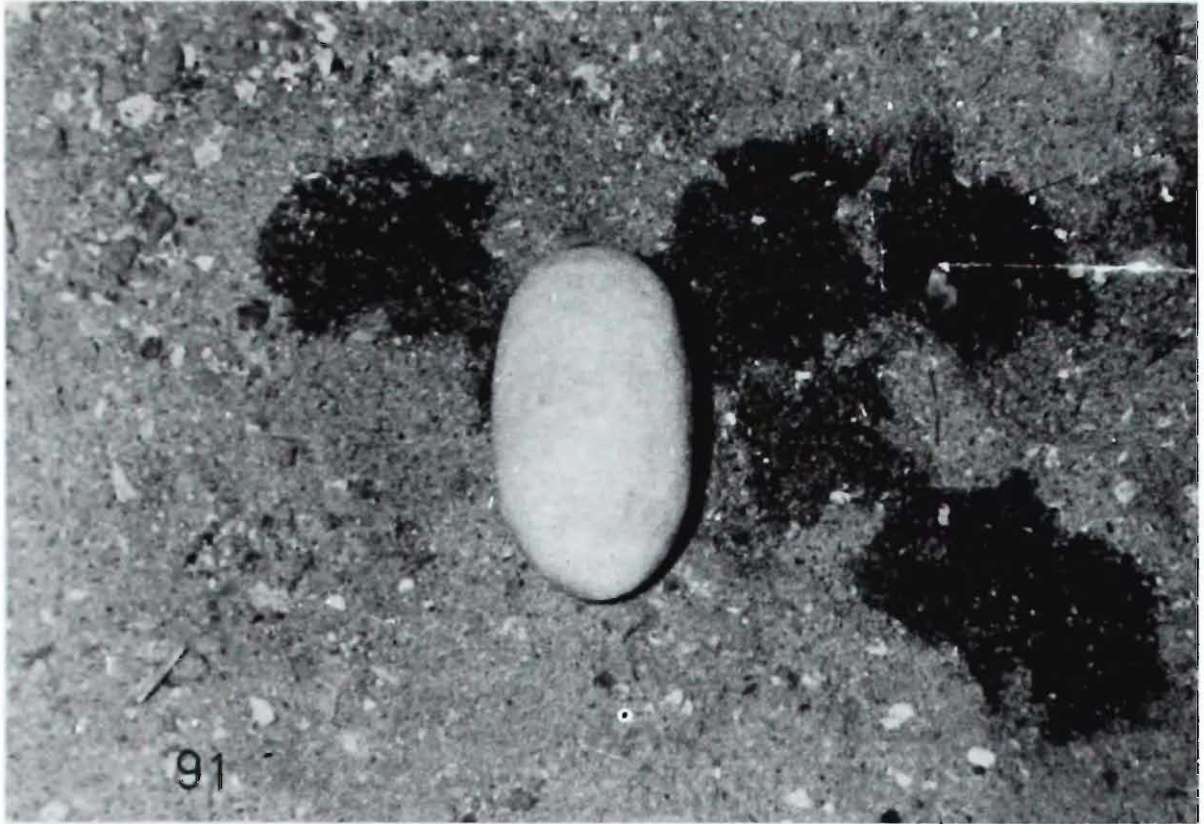


Kachuga tecta (Gray)

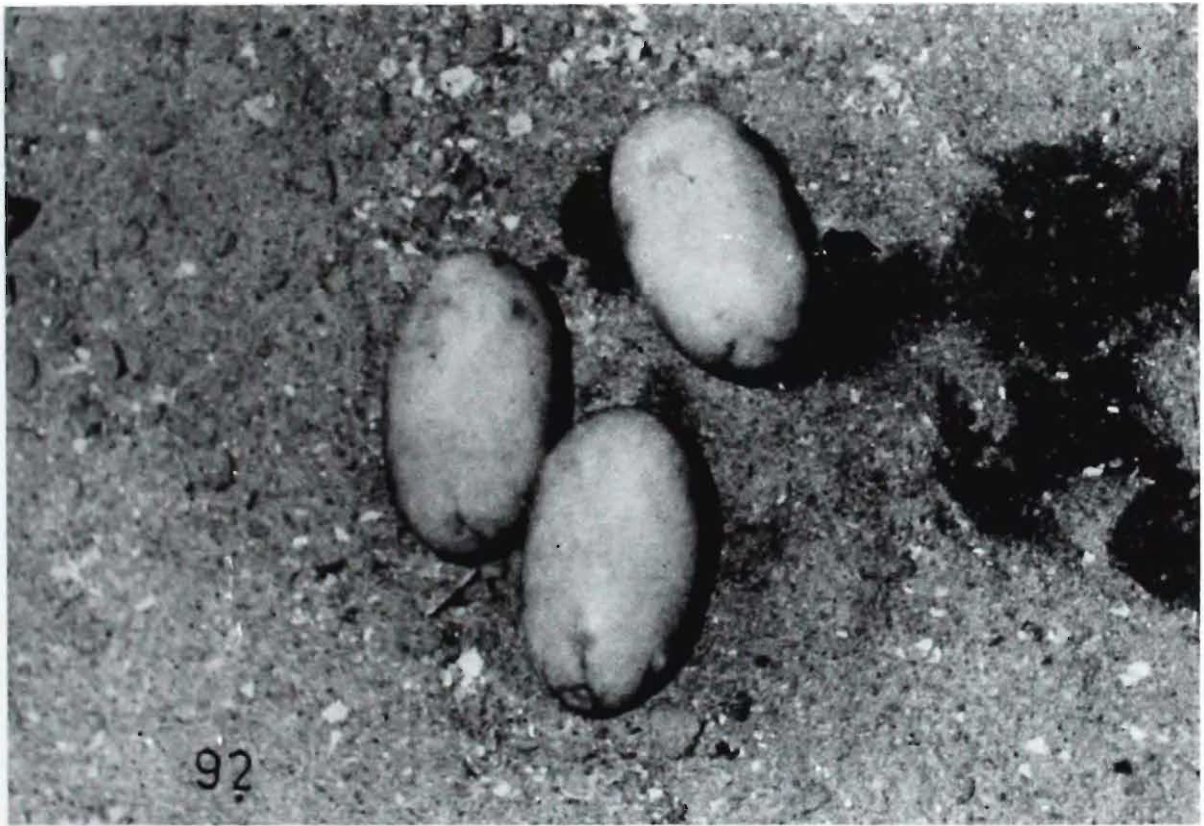


Cyclemys dentata (Gray)

PLATE 44

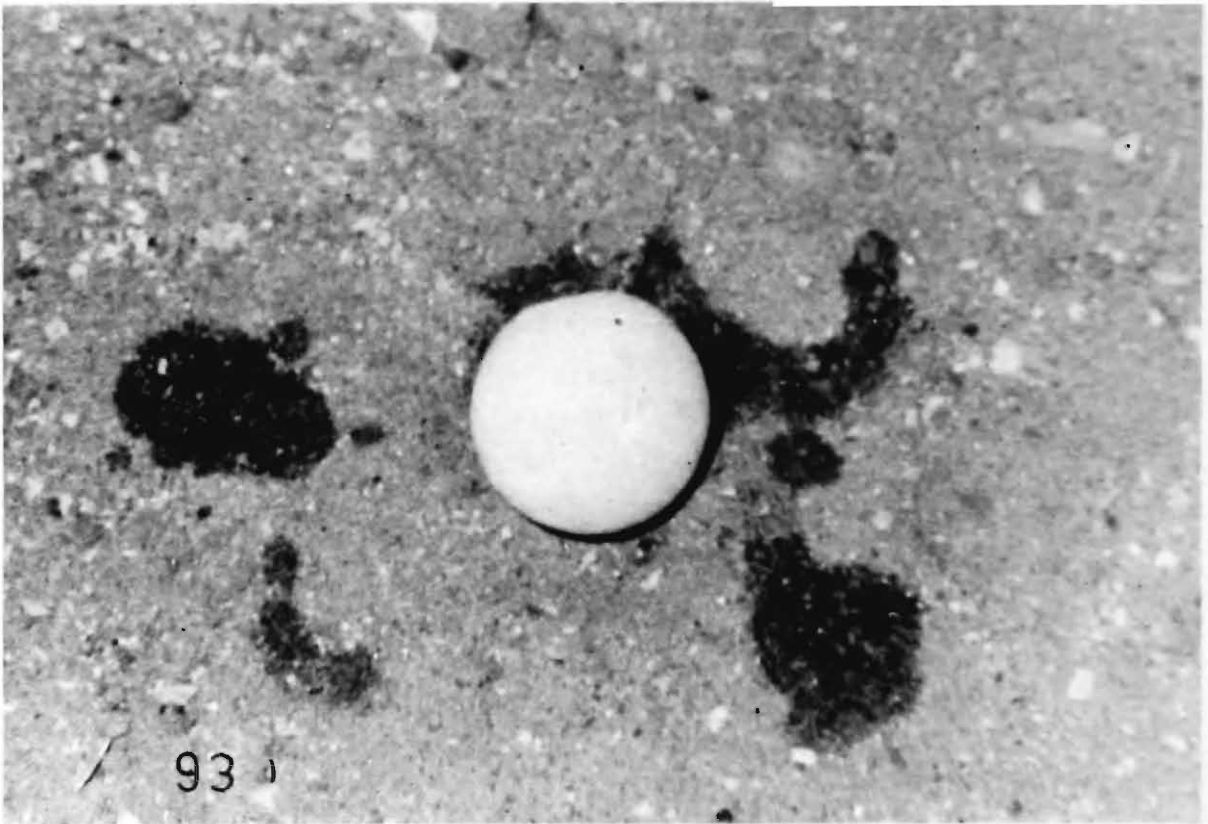


Cyclémyis mouhoti (Gray)

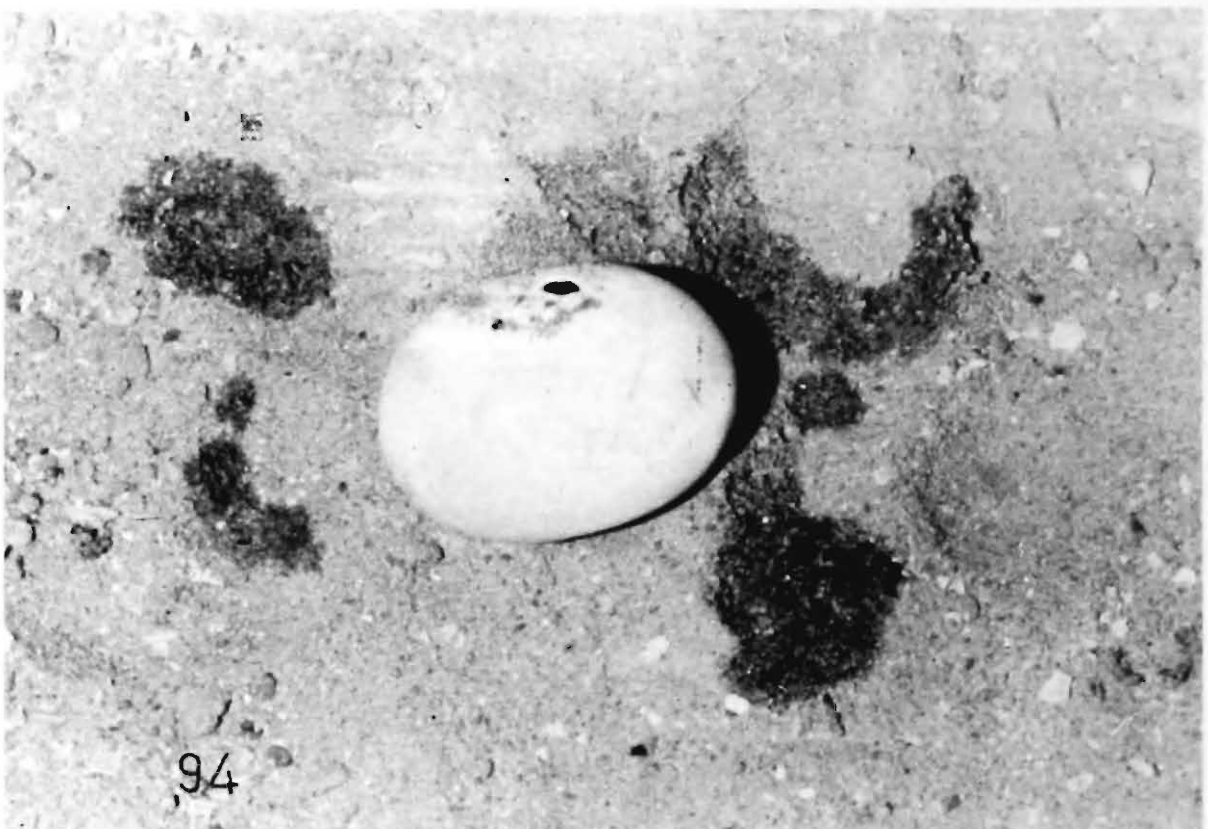


Melanochelys tricarinata (Blyth)

PLATE 45



Geochelone elegans (Schœpff)

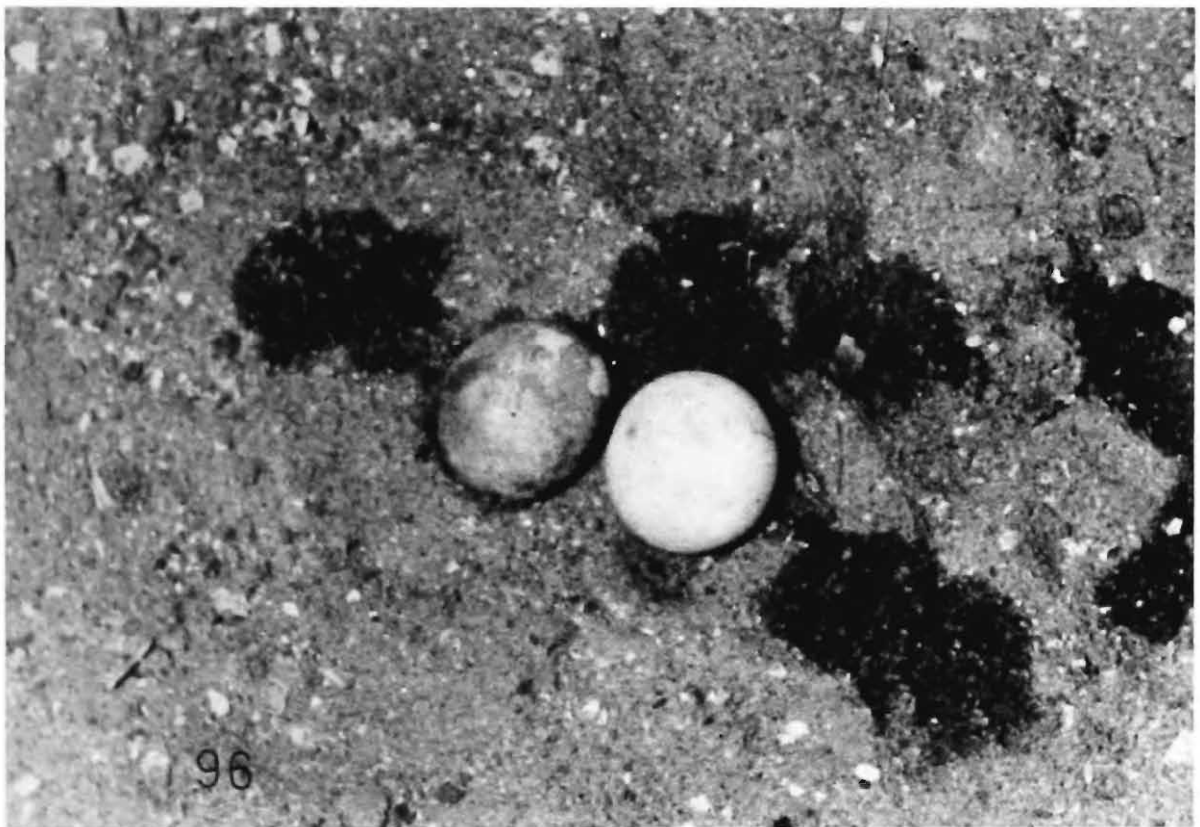


Geochelone elongata (Blyth)

PLATE 46

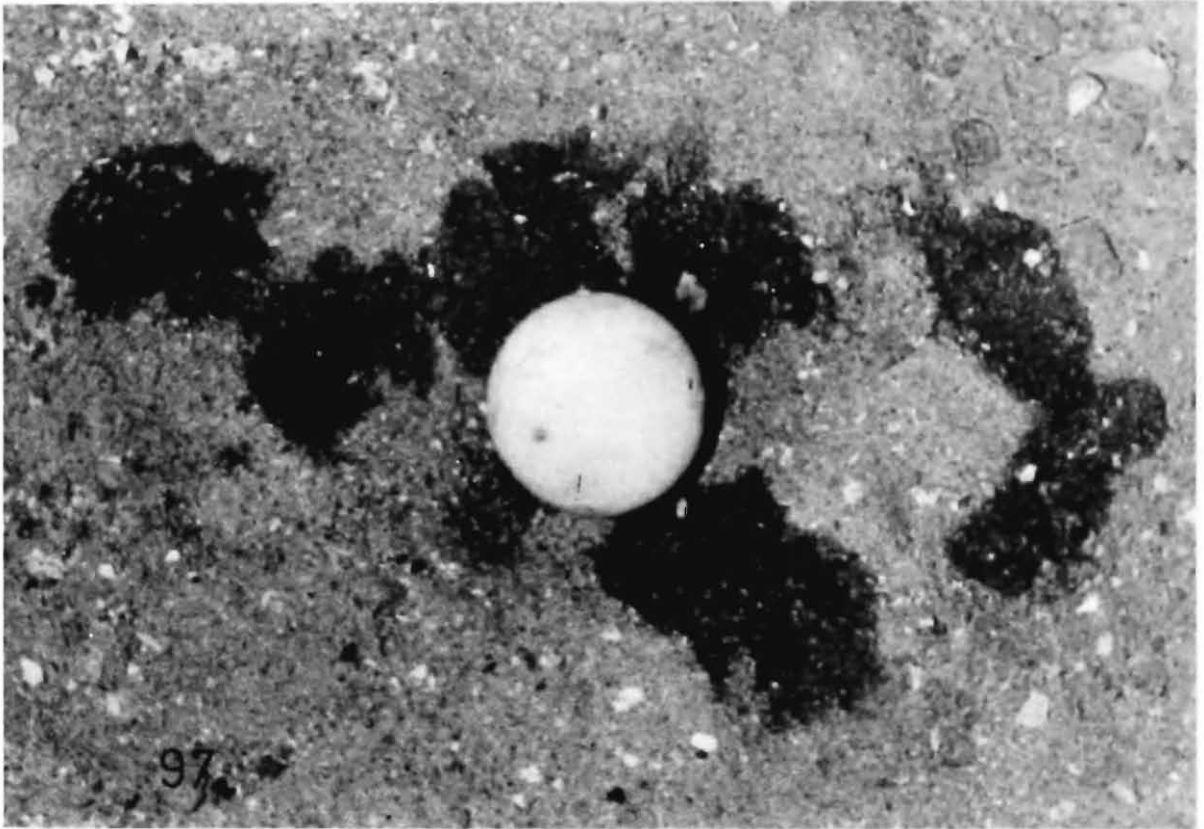


Geochelone travancorica (Boulenger)

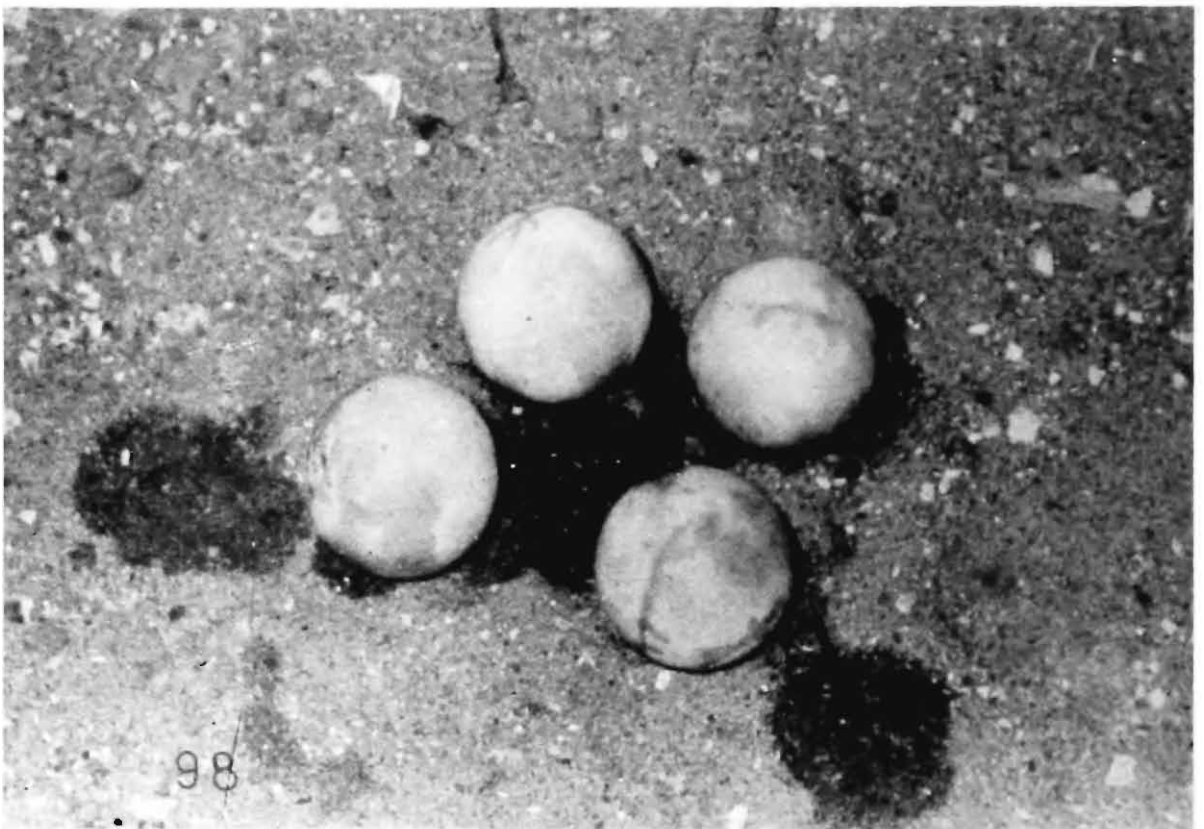


Lissemys punctata granosa (Schoepff)

PLATE 47



Chitra indica (Gray)



Trionyx leithi (Gray)

BIBLIOGRAPHY

- Allen, E. R. and Neill, W. T. 1957. Another record of the Atlantic leatherback, *Dermochelys coriacea*, nesting on the Florida Coast. *Copeia*, 1957 (2) : 143-144.
- Alvarez del Toro, M. 1960. *Los Reptiles de Chiapas*. Chiapas, Mexico, Instituto Zoologico del Estado, Tuxtla Gutierrez,: 7-204.
- Anderson J, 1872. Notes on *Trionyx gangeticus* Cuvier and *Trionyx hurum* B.—Hamilton. *Ann. Mag. Nat. Hist.*, (4) 9: 382-383.
- Anderson, J. 1876. Note on plastron of the Gangetic Mud-Turtle (*Emyda dura* of Buchanan-Hamilton). *J. Linn. Soc., Zool.*, 12: 514-516.
- Anderson, J. 1878-79. *Anatomical and Zoological researches and Zoological results of the Yunnan Expeditions*. Reptilia and Amphibia: 705-860, 21 col. and 5 uncol. pls. Calcutta.
- Annandale, N. 1906. Contributions to Indian Herpetology. No. 4. Notes on the Indian Tortoises. *J. & Proc. Asiat. Soc. Beng.* (n.s.), 2: 203-206, pl.
- Annandale, N. 1907. The distribution of *Kachuga sylhetensis*. *Rec. Indian Mus.*, 1: 171.
- Annandale, N. 1912. The Indian Mud-Turtles (Trionychidae), *Rec. Indian Mus.*, 7: 151-178, & 2 pls.
- Annandale, N. 1912. The Aquatic chelonia of the Mahanadi and its Tributaries. *Rec. Indian Mus.*, 7: 261-266.
- Annandale, N. 1913. The Tortoises of Chota Nagpur. *Rec. Indian Mus.*, 9: 63-78, 2 pls.
- Annandale, N. 1915. Notes on some Indian Chelonia. *Rec. Indian Mus.*, 11: 189-195.
- Appa Rao, T. and Dutt, S. 1965. Chemical composition of the flesh of the turtle *Chelonia mydas* (Boulenger). *Curr. Sci.*, 34: 695.
- Babcock, H. L. 1930. Variations in the number of Costal shields in *Caretta*. *Amer. Nat.*, 64: 95-96.
- Babcock, H. L. 1937. The sea turtles of the Bermuda Islands, with a survey of the present state of the turtle fishing industry. *Proc. Zool. Soc. London*, (A) 107: 595-601.
- Bacon, P. R. 1969. *Report on the Trinidad sea turtle Conservation Project*. Annual Report of the Trinidad Field Naturalists club for 1969, 18-35.
- Bacon, P. R. 1970. Studies on the leatherback turtle, *Dermochelys coriacea* (L.), in Trinidad, West Indies. *Biol. conserv.* 2 (3): 213-217.
- Bacon, P. R. 1973. The orientation circle in the beach ascent crawl of the leatherback turtle, *Dermochelys coriacea*; in Trinidad. *Herpetologica*, 29 (4): 343-348.
- Balasingham, E. 1965. Conservation of green turtles (*Chelonia mydas*) in Malaya. *Malaya Nat. J.*, 19: 235-236.

- Balasingham, E. 1967. The ecology and conservation of the leathery turtle, *Dermochelys coriacea* (Linn.) in Malaya. *Proc. 11th Pacific Science Congress, Tokyo*: 37-43.
- Balazs, G. H. 1975. Green turtle's uncertain future, *Defenders*, **50** (6): 521-523.
- Balazs, G. H. 1976. Green turtle migrations in the Hawaiian Archipelago. *Biol. Conservation*, **9**: 125-140.
- Balazs, G. H. and Ross, E. 1974. Observations of the basking habit in the captive juvenile Pacific green turtle. *Copeia*, 1974(2): 542-544.
- Banks, E. 1937. The breeding of the edible turtle (*Chelone mydas*). *Sarawak Mus. J.*, **4**: 523-532.
- Barth, R. 1962. Observacoes sobre a grande tartaruga marinha, *Chelonia mydas* L., feitas ne ilha de Trindade. *An. Acad. Bras. cienc.*, **34**: 405-409.
- Baur, G. 1890. The genera of Cheloniidae. *Am. Nat.*, **24**: 486-487.
- Bell, T. 1825. A Monograph of the Tortoises having a movable sternum, with remarks on their Arrangement and Affinities. *Zool. J., London*. **2**: 299-310.
- Bell, T. 1827-28. Descriptions of three new species of Land-Tortoises. *Zool. J., London*, **3**: 419-420.
- Bell, T. 1827-28. Characters of the Order, Families, and Genera of the Testudinata. *Zool. J., London*, **3**: 513-516.
- Bell, T. 1836-42. *A Monograph of the Testudinata*. London: 63 col. pls.
- Bjorndal, K. A. (Ed.) 1982. *Biology and conservation of sea Turtles* (Papers presented at the World Conference on Sea Turtle conservation, Nov. 26-30, 1979, Washington D. C.). Smithsonian Institute Press, Washington D.C.: 583 pp.
- Booth, J. and Peters, J. A. 1972. Behavioural studies on the green turtle (*Chelonia mydas*) in the sea. *Animal Behaviour*, **20** (4): 808-812.
- Boulenger, G. A. 1889. *Catalogue of the chelonians, Rhynchocephalians, and Crocodiles in the British Museum (Natural History)*. London.
- Boulenger, G. A. 1890. *The Fauna of British India including Ceylon and Burma*. Reptilia and Batrachia: 541 pp. text figs. London.
- Boulenger, G. A. 1907. A new Tortoise from Travancore. *J. Bombay nat. Hist. Soc.*, **17**: 560-561, col. pls.
- Boyer, D. R. 1965. Ecology of the basking habit in turtles. *Ecology*, **46**: 99-118.
- Burne, R. H. 1905. Notes on the Muscular and Visceral Anatomy of the Leathery Turtle (*Dermochelys coriacea*). *Proc. Zool. Soc. London*, **1905**: 291-324.
- Brongersma, L. D. 1961. Notes upon some sea turtles. *Zool. Verh. Leiden*, **51**: 1-46.
- Brongersma, L. D. 1967. *British Turtles*. *Brit. Mus. (Nat. Hist.)*, London: 1-22.
- Brongersma, L. D. 1968. Notes upon some turtles from Surinam. *Proc. Kon Ned. Akad. Wetensch. Amsterdam, (C)*, **71**: 114-127.

- Brongersma, L. D. 1968 a. The great sea serpent and the leathery turtle, 1. *Proc. Kon. Ned. Akad. Wetensch. Amsterdam, (C)*, **71**: 209-223.
- Brongersma, L. D. 1968b. Notes upon some sea turtles from the Canary Islands and from Madeira. *Proc. Kon. Ned. Akad. Wetensch. Amsterdam, C*, **71**: 128-136.
- Brongersma, L. D. 1969. Miscellaneous notes on turtles, II A. *Proc. Kon. Ned. Akad. Wetensch. Amsterdam, C*, **72**: 76-102.
- Brongersma, L. D. 1972. European Atlantic turtles. *Zool. Verh. Mus. Leiden*, **121**: 1-318.
- Bustard, H. R. 1967. Mechanism of nocturnal emergence from the nest in green turtle hatchlings. *Nature. London*, **214**: 317.
- Bustard, H. R. 1970. The adaptive significance of coloration in hatchling green sea turtles. *Herpetologica*, **26**: 224-227.
- Bustard, H. R. 1972. *Australian sea turtles*. Collins: 220 pp. London and Sydney.
- Bustard, H. R. and Greenham, P. M. 1969. Nesting behaviour of the green sea turtle on a Great Barrier Reef Island. *Herpetologica*, **25**: 93-102.
- Bustard, H. R. and Limpus, C. 1970. First international recapture of an Australian tagged loggerhead. *Herpetologica*, **26**: 358-359.
- Bustard, H. R. and Limpus, C. 1971. Loggerhead turtle movements. *Brit. J. Herpetol.*, **4**: 228-230.
- Bustard, H. R., Simkiss, K. and Jenkins, N. K. 1969. Some analysis of artificially incubated eggs and hatchlings of green and loggerhead sea turtles. *J. Zool., London*, **158**: 311-316.
- Caldwell, D. K. 1959. On the status of the Atlantic leatherback turtle, *Dermochelys coriacea coriacea*, as a visitant to Florida nesting beaches with natural history notes. *Quart. J. Fla. Acad. Sci.* **21** (3) (1958): 285-291.
- Caldwell, D. K. 1962a. Sea turtles in Baja California waters (with special reference to those of the Gulf of California), and the description of a new subspecies of northeastern Pacific green turtle. *Contrib. Sci. Los Angeles Country Mus.*, **61**: 1-31.
- Caldwell, D. K. 1962b. Carapace length-body weight relationship and size and sex ratio of the northeastern Pacific green sea turtle, *Chelonia mydas carrinegra*. *Contrib. Sci. Los Angeles Country Mus.*, **62**: 3-10.
- Caldwell, D. K. 1966. A nesting report on the American ridley. *Int. Turt. Tort. Soc. J.*, **1**: 10-13, 30.
- Caldwell, D. K. 1969. Hatchling green sea turtle, *Chelonia mydas*, at sea in the northeastern Pacific Ocean, *Bull. South, Calif. Acad. Sci.*, **68**: 113-114.
- Caldwell, D. K. and Caseber, R. S. 1964. A note on the nesting of the eastern Pacific ridley sea turtle, *Lepidochelys olivacea*, *Herpetologica*, **20** (3): 213.

- Caldwell, D. K. and Caldwell, M. 1969. Addition of the leatherback sea turtle to the known prey of the killer whale *Orcinus orca*. *J. Mammalogy*, **50** (3): 636.
- Caldwell, D. K., Rathjen, W. F. and Hsu, B.C.C. 1969. Surinam ridleys at sea. *Int. Turt. Tort. Soc. J.*, **3**: 4-5, 23.
- Carr, A. F. 1942. Notes on sea turtles. *Proc. N. Engl. Zool. club*, **21**: 1-16.
- Carr, A. F. 1948. Sea turtles on a tropical island. *Fauna*, **10**: 50-55.
- Carr, A. F. 1952. *Handbook of turtles*. Comstock Publ. Assoc., Cornell Univ. Press: 542 pp.
- Carr, A. F. 1956. *The windward road*. Alfred Knopf Inc.: 258 pp. New York.
- Carr, A. F. 1957. Notes on the Zoogeography of Atlantic sea turtles of the genus *Lepidochelys*. *Rev. Biol. Trop.*, **5** (1): 45-61.
- Carr, A. F. 1961. Pacific turtle problems. *Nat. Hist.*, **70**: 64-71.
- Carr, A. F. 1961. The ridley mystery today. *Animal Kingdom*, **64** (1): 7-12.
- Carr, A. F. and Hirth, H. 1962. The ecology and migrations of sea turtles, 5. Comparative features of the isolated green turtle colonies. *Am. Mus. Novit.*, **2091**: 1-42.
- Carr, A. F. 1962. Orientation problems in the high seas travel and terrestrial movements of marine turtles. *Am. Sci.*, **50**: 359-374.
- Carr, A. F. 1962. *Guide posts of animal navigation*. Am. Inst. Biol. Sci., D. C. Heath Co., B.S.C.S. No. 1. Boston.
- Carr, A. F. 1965. The navigation of the green turtle. *Sci. Am.*, **212** (5): 78-86.
- Carr, A. F. 1967. *So Excellent a Fishe*. Natural History Press: 248 pp. New York.
- Carr, A. F. 1970. Green sea turtles in peril. *Natl. Parks Conserv. Mag.*, **44**: 19-24.
- Carr, A. F. and Caldwell, D. K. 1956. The ecology and migrations of sea turtles. 1. Results of field work in Florida, 1955. *Am. Mus. Novit.*, **1793**: 1-23.
- Carr, A. F. and Giovannoli, L. 1957. The ecology and migrations of sea turtles. 2. Results of field work in Costa Rica, 1955. *Am. Mus. Novit.*, **1835**: 1-32.
- Carr, A. F. and Goodman, D. 1970. Ecologic implications of size and growth in *Chelonia*. *Copeia*, 1970: 783-786.
- Carr, A. F. and Sweat, D. 1969. Long-range recovery of a tagged Yearling *Chelonia* on the east coast of North America. *Biol. Conserv.*, **1**: 341-342.
- Carr, A. 1967. Adaptive aspects of the scheduled travel of *Chelonia*. In R. Storm (ed.), *Animal orientation and navigation*, Oregon State University Press, Corvallis: 35-52.
- Carr, A. 1975. The Ascension Island green turtle colony. *Copeia*, 1975 (2) : 547-555.
- Carr, A. and Carr, M. H. 1970. Modulated reproductive periodicity in *Chelonia*. *Ecology*, **51** (2): 335-337.

- Carr, A. and Coleman, P. J. 1974. Seafloor spreading theory and the odyssey of the green turtle from Brazil to Ascension Island, Central Atlantic. *Nature, London*, 249 (5453): 128-130.
- Carr, A. and Hirth, H. 1961. Social facilitation in green turtle siblings. *Anim. Behav.*, 9 (1-2): 68-70.
- Carr, A. and Ogreen, L. 1959. The ecology and migrations of sea turtles. 3: *Dermochelys* in Costa Rica. *Am. Mus. Novit.* 1958:1-29.
- Carr, A. and Ogreen, L. 1960. The ecology and migrations of sea turtles. 4. The green turtle in the Caribbean sea. *Bull. Am. Mus. Nat. Hist.*, 121: 1-48.
- Carr, A., Ross, P. and Carr, S. 1974. Internesting behaviour of the green turtle, *Chelonia mydas*, at a mid-ocean island breeding ground. *Copeia*, 1974 (3): 703-706.
- Carr, A. and Staneyk, S. 1975. Observations on the ecology and survival outlook of the hawksbill turtle. *Biol. Conserv.*, 8: 161-172.
- Ckhikvadze, V. M. 1973. *Interrelation of forms and functions of the turtle shell showing the direction of natural selection.* *Acad. Sci. Georgian S.S.R., Palaeontological Institute* 6: 65-78.
- de Silva, G. S. 1969. Statement on marine turtles in the State of Sabah. *IUCN Publ. New Ser. Suppl. Pap.*, 20: 75-79.
- Deraniyagala, P. E. P. 1933. The loggerhead turtles (Caretidae) of Ceylon. *Ceylon J. Sci.*, (B), 18: 61-72.
- Deraniyagala, P. E. P. 1939. *The tetrapod reptiles of Ceylon*: 412 pp. Colombo.
- Deraniyagala, P. E. P. 1952. The loggerhead turtles (Caretinae) of Europe. *Herpetologica*, 8: 57-58.
- Dodge, E. S. 1944. Status of the ridley turtle in Massachusetts waters. *Copeia*, 1944 (2) : 120-121.
- Domantay, J. S. 1953. The turtle fisheries of the Turtle Islands. *Bull. Fish. Soc. Philipp.*, 3-4: 3-27.
- Domantay, J. S. 1968. Notes on the development and breeding habits of *Chelonia mydas*. *Acta Manilana*, (A) 4: 87-109.
- Donoso-Barros, R. 1966. *Reptiles de Chile.* *Univ. of Chile*: 458 pp. Santiago.
- Duncan, D. D. 1944. Capturing giant turtles in the Caribbean. *Nat. Geogr. Mag.*, 84 (2) 177-190.
- Dunlop, C. E. 1955. Notes on the visceral anatomy of the giant leatherback turtle (*Dermochelys coriacea* (Linnaeus)). *Bull. Tulane Med. Fac.* 14 (2): 55-69.
- Eder, H. M. 1969. Turtling in Coastal Oaxaca. *Pacific Discovery*, 22 (1): 10-15.
- Ehrenfeld, D. W. 1968. The role of vision in the sea-finding orientation of the green turtle (*Chelonia mydas*). 2. Orientation mechanism and range of spectral sensitivity. *Anim. Behav.*, 16: 281-287.
- Ehrenfeld, D. W. 1974. Conserving the edible sea turtle: Can mariculture help? *Am. Sci.* 62 (1): 23-31.

- Ehrenfeld, D. W. and Koch A. 1967. Visual accommodation in the green turtle. *Science Wash.*, **155** (3764): 827-828.
- FAO/UN 1968. Report to the Governments of the People's Republic of Southern Yemen and the Seychelles Islands on the green turtle resource of South Arabia, and the status of the green turtle in the Seychelles Islands. Based on the work of Dr. H. Hirth, FAO/TA Marine Turtle Biologist. *Rep. FAO/UNDP (TA)*, **2467**: 59 pp.
- Felger, R. S., Clifton, K. and Regal P.J. 1976. Winter dormancy in sea turtles: independent discovery and exploitation in the Gulf of California by two local cultures. *Science*, **191**: 283-285.
- Ferguson, H. S. 1907. A new Tortoise from Travancore. *J. Bombay nat. Hist. Soc.*, **18**: 186.
- Ferreira, M. M. 1968. Sobre a alimentacao de aruana, *Chelonia mydas* Linnaeus, ao longo da costa do estado do ceara. *Arg. Estac. Biol Mar. Univ. Fed. Ceara*, **8**: 83-86.
- Fitter, R. S. R. 1961. The leathery turtle or luth. *Oryx*, **6** (2): 116-125.
- Ford, J. 1879. The leather turtle. *Am. Nat.*, **13** (10): 633-637.
- Frazier, J. 1971. Observations on sea turtles at Aldabra Atoll. *Phil. Trans. Roy. Soc. London*, (B) **260**: 373-410.
- Gadow, H. 1901. Amphibia and Reptiles. In: *The Cambridge Natural History*, **8**: 668 pp. (Reprinted 1909). London.
- Gallagher, R. M., Hollinger, M. L., Ingle, R. M. and Futch C.R. 1972. Marine turtle nesting on Hutchinson island, Florida in 1971. *Fla. Dept. of Nat. Res., Special Scientific Report*, **37**: 11 pp.
- Goeldi, E. A. 1906. Chelonios do Brasil. *Bol. Mus. Goeldi do Hist. Nat. Ethnographica* (Para), **4**: 699-756.
- Gray, J. E. 1830-1835. *Illustrations of Indian Zoology: Chiefly selected from the collection of Major-General Hardwicke*, 2 Vols., London.
- Gray, J. E. 1834. Characters of several new species of Freshwater Tortoises (*Emys*) from India and China. *Proc. Zool. Soc. London*, **1834**: 53-54.
- Gray, J. E. 1855. *Catalogue of the Shield Reptiles in the collection of the British Museum.—Part I. Testudinata (Tortoises)*. *Br. Mus. (N.H.)*: Vt 79 pp. pls. 1-42., London.
- Gray, J. E. 1856. Notice of some Indian Tortoises, including the description of a new species presented to the British Museum by Professor Oldham. *Proc. Zool. Soc. London*, **1856**: 181-183, 2 pls.
- Gray, J. E. 1862. Notes on Two new species of *Batagur* in the collection of the British Museum. *Proc. Zool. Soc. London*, **1862**: 264-266.
- Gray, J. E. 1869. Notes on the Families and Genera of Tortoises (Testudinata) and on the characters afforded by the study of their skulls. *Proc. Zool. Soc. London*, **1869**: 165-225.
- Gray, J. E. 1870. *Supplement to the catalogue of Shield Reptiles in the collection of the British Museum.—Part I. Testudinata (Tortoises)*, with figures of skulls of 36 genera: 120 pp. figs. 1-40, London.

- Gray, J. E. 1872. *Appendix to the catalogue of Shield Reptiles in the collection of the British Museum—Part I. Testudinata (Tortoises)*. *Br. Mus. (N.H.)*: 28 pp. London.
- Gray, J. E. 1872. Notes on the Mud-Tortoises of India (*Trionyx Geoffroy*). *Ann. Mag. Nat. Hist.*, (4) **10**: 326-340.
- Groombridge, B. and Wright L. 1982. *The IUCN Amphibia—Reptilia Red Data Book. Part I. Testudines, Crocodylia, Rhynchocephalia*. IUCN: 426 pp. Gland, Switzerland.
- Gunther, Albert C. L. G. 1864. *The Reptiles of British India*: 452 pp., pls. 1-26, London.
- Hardy, J. D. 1969. Records of the leatherback turtle, *Dermochelys coriacea coriacea* (Linnaeus), from the Chesapeake Bay. *Bull. Maryland Herp. Soc.*, **5** (3): 92-96.
- Harrisson, T. 1950. The Sarawak Turtle Islands "Semah" *J. Malay Branch R. Asiatic Soc.*, **23**: 105-126.
- Harrisson, T. 1969. The marine turtle situation in Sarawak. *IUCN Publ. New. Ser. Suppl. Pap.*, **20**: 70-74.
- Henderson, J. R. 1912. Preliminary notes on a new Tortoise from South India. *Rec. Indian Mus.*, **7**: 217-218.
- Henderickson, J. R. 1958. The green sea turtle, *Chelonia mydas* (Linn.), in Malaya and Sarawak. *Proc. Zool. Soc. London*, **130**: 455-535.
- Hill, R. L. 1971a. Surinam turtle notes—1: Polymorphism of coastal and vertebral laminae in the sea turtle *Lepidochelys olivacea*. *STINASU, Surinam*: 3-9.
- Hill, R. L. 1971b. Surinam turtle notes—3: The effect of rupturing eggs in sea turtle nests on the hatchling emergence percentage. *STINASU, Surinam*: 14-16.
- Hill, R. L. and Green, D. J. 1971. Surinam turtle notes—2: Investigation of the damage by the crab *Ocypode quadrata* to the eggs of the green turtle, *Chelonia mydas*. *STINASU, Surinam*: 11-13.
- Hirth, H. F. 1962. Cloacal Temperatures of the green and hawksbill sea turtles. *Copeia*, **1962**: 647-648.
- Hirth, H. F. 1971. Synopsis of biological data on the Green Turtle *Chelonia mydas* (Linnaeus) *FAO Fisheries Synopsis*, **85**: 1:1—8:19.
- Hirth, H. F. and Carr, A. F. 1970. The green turtle in the Gulf of Aden and the Seychelles Islands. *Verh. K. Ned. Akad. Wet. (Afd. Nat. Tweede Sect.)*, **58**: 1-44.
- Hornell, J. 1927. *The turtle fisheries of the Seychelles Islands*. H. M. Stationery Office: 55 pp. London.
- Houck, W. J. and Joseph, J. C. 1958. A northern record for the Pacific ridley, *Lepidochelys olivacea*. *Copeia*, **1958** (3): 219-220.
- Hughes, D. A. and Richard, J. D. 1974. The nesting of the Pacific ridley turtle, *Lepidochelys olivacea* on Playa Nancite, Costa Rica. *Mar. Biol.*, **24**: 97-107.
- Hughes, G. R. 1967. Marine turtle hatchlings of Tongaland. *Afr. Wildl.* **23** (1): 5-19.

- Hughes, G. R. 1969. Report to the Survival Service Commission on marine turtles in southern Africa. *In: Marine Turtles: Proceedings of the Working Meeting of Marine Turtle Specialists organised by IUCN at Morges, Switzerland, 10-13 March, 1969*: 56-66.
- Hughes, G. R. 1970. Further studies on marine turtles in Tongaland. 3. *Lammergeyer*, 12: 7-25.
- Hughes, G. R. 1970. Further studies on marine turtles in Tongaland. 4. *Lammergeyer*, 12: 26-36.
- Hughes, G. R. 1971. The marine turtles of Tongaland. V *Lammergeyer*, 13: 7-24.
- Hughes, G. R. 1971. Sea turtle research and conservation in south east Africa. *In Marine Turtles: Proc. 2nd Meet. Mar. Turtle Specialists*, IUCN Pub. (New Ser.) 31: 57-67.
- Hughes, G. R. 1972. The marine turtles of Tongaland. 6. *Lammergeyer*, 15: 15-26.
- Hughes, G. R. 1974. The sea turtles of south-east Africa. 1. Status morphology and populations. *South Afr. Assoc. Mar. Biol. Res. Inv. Rep.*, 35: 144 pp.
- Hughes, G. R. 1974. The sea turtles of south-east Africa. 2. The biology of the Tongaland loggerhead turtle *Caretta caretta* L. with comments on the leatherback turtle *Dermochelys coriacea* L. and the green turtle *Chelonia mydas* L. in the study region. *South Afr. Assoc. Mar. Biol. Res. Inv., Rep.*, 36: 96 pp.
- Hughes, G. R., Bass, A. J. and Mentis, M. T. 1967. Further studies on marine turtles in Tongaland, I. *Lammergeyer*, 3: 5-54.
- Hughes, G. R. and Mentis, M. T. 1967. Further studies on marine turtles in Tongaland. 2. *Lammergeyer*, 3: 55-72.
- Hutchinson, A. D. 1969. Shipwreck search on the Caribbean Banks. *Explorers Journal, March 1969*: 41-49.
- Kaufmann, R. 1966. Das Vorkommen von Meeresschildkroten in Kolumbien und ihre Nutzung als Nahrungsquelle. *Natur und Museum*, 96 (2): (1.2): 44-49.
- Kaufmann, R. 1967. Wachstumsraten in Gefangenschaft gehaltener Meeresschildkroten. *Mitt. Inst., Colombo-Aleman Invest. cient.* 1: 65-72.
- Kaufmann, R. 1968. Zur Brutbiologie der Meeresschildkroten *Caretta caretta* L. *Mitt. Inst., Colombo-Aleman Invest. cient.*, 2: 45-56.
- Kaufmann, R. 1972. Wachstumsraten in Gefangenschaft gehaltener Meeresschildkroten. 2. *Mitt. Inst. Colombo-Aleman Invest. cient.*, 6: 105-112.
- Klukas, R. W. 1967. [ms.] Factors affecting nesting success of loggerhead turtles at cape Sable, Everglades National Park. *Report on a phase of RSP-7, Everglades National Park*: 57 pp.
- Koch, A. L., Carr A. F. and Ehrenfeld D. W. 1969. The problem of open-sea navigation: the migration of the green turtle to Ascension Island. *J. Theor. Biol.*, 22: 163-179.

- Leary, T. H. 1957. A schooling of leatherback turtles, *Dermochelys coriacea*, on the Texas Coast, *Copeia*, 1957: 232.
- Le Buff, C. R. 1969. The marine turtles on Sanibal and Captiva Islands, Florida. *Sanibal-Captive Cons. Found., Spec. Pub.*, 1: 13, pp.
- Le Buff, C. R. and Beatty R. W. 1971. Some aspects of nesting of the loggerhead turtle, *Caretta caretta* (Linnaeus) on the Gulf Coast of Florida. *Herpetologica*, 27 (2): 153-156.
- Lewis, C. B. 1940. The cayman Islands and Marine Turtle. *Bull. Inst. Jamaica*, 2 (Appendix): 56-65.
- Loveridge, A. and Williams E. E. 1957. Revision of the African tortoises and turtles of the suborder Cryptodira. *Bull. Mus. Comp. Zool. Harvard.*, 115 (6): 161-557.
- Lydekker, R. 1889. On the Tortoises described as *Chaibassia*. *J. Asiat. Soc. Bengal.* 58: 327-333.
- Lydekker, R. 1876-87. Indian Tertiary and Post-Tertiary Vertebrata. *Palaeontologica Indica*, 10.
- Lydekker, R. 1886. On a new Emydine chelonian from the Pliocene of India. *Quart. J. Geol. Soc.*, 42: 540-541, Pl. 15.
- Marquez, R. and Doi T 1973. Ensayo teorico sobre el analisis de la poblacion de tortuga prieta, *Chelonia mydas carrinegra* Caldwell, an aguas del Golfo de California, Mexico. *Bull. Tokai Regional Fisheries Research Lab.*, 73: 1-22.
- Mawson, N. 1921. Breeding habits of the Green Turtle (*Chelonia mydas*). *J. Bombay nat. Hist. Soc.*, 27: 956-957.
- Mc Askie, I. B. and Forrester C. R. 1962. Pacific leatherback turtles (*Dermochelys*) on the coast of British Columbia. *Copeia*, 1962: 646.
- Mc Coy, M. A. 1974. Man and turtle in the Central Carolines. *Micronesica*, 10 (2): 207-221.
- Medem, F. 1962. Estudio sobre tortugas marinas. Informe sobre la comision realizada en la costa atlantica. Corporacion Autonoma Regional de los Valles del Magdalena Y del Sinu: 12 pp.
- Mellem, I. M. 1925. Marine turtles sleep on Hawaiian sands. *Bull. N. Y. Zool. Soc.*, 28: 160-161.
- Mertens, J. M. 1966. The captive softshell (Trionychoidea): Checklist of World's softshells and their care. *Int. Turtle and Tortoise Soc. J.*, 1 (1): 14-17, 31-33, 38, 45.
- Mertens, R. 1969. Eine neue Rasse der Dachschildkrote, *Kachuga tecta*. *Senckenbergiana biol.*, 50 (1/2): 23-30.
- Minton, S. 1966. A contribution to the herpetology of West Pakistan. *Bull. Amer. Mus. Nat. Hist.*, 134 (2): 27-184.
- Moorehouse, F. W. 1933. Notes on the green turtle (*Chelonia mydas*). *Rep. Great Barrier Reef Comm.*, 4 (1): 1-22.
- Mowbray, L. S. Caldwell, D. K. 1958. First record of the ridley turtle from Bermuda, with notes on other sea turtles and the turtle fishery in the islands. *Copeia*, 1958 (2): 147-148.

- Mrosovsky, N. 1970. The influence of the sun's position and elevated cues on the orientation of hatchling sea turtles. *Animal Behaviour*, **18**: 648-651.
- Mrosovsky, N. 1972. The water-finding ability of sea turtles. *Brain, Behav. Evol.* **5** (2/3): 202-225.
- Mrosovsky, N. and Carr A. 1967. Preferences for light of short wavelengths in hatchling green sea turtles, *Chelonia mydas*, tested on their natural nesting beaches. *Behaviour*, **28** (3/4): 217-231.
- Mrosovsky, N. and Shettleworth S. J. 1968. Wavelength preferences and brightness clues in the water-finding behaviour of sea turtles. *Behaviour*, **32**: 211-257.
- Mrosovsky, N. and Shettleworth S. J. 1975. On the orientation circles of the leatherback turtle, *Dermochelys coriacea*. *Animal Behaviour*, **23** (3): 568-591.
- Nishimura, S. 1964. Considerations on the migration of the leatherback turtle, *Dermochelys coriacea*, in the Japanese and adjacent waters. *Publ. Seto Marine Biol. Lab.*, **12** (2): 61-73.
- Nishimura, S. 1967. The loggerhead turtles in Japan and neighbouring waters (Testudinata: Cheloniidae), *Publ. Seto Marine Biol. Lab.*, **15** (1): 19-35.
- Nishimura, S. and Yasuda T 1967. Records of the hawksbill turtle, *Eretmochelys imbricata* (Linnaeus), in the Japan Sea. *Publ. Seto Marine Biol. Lab.*, **15** (4): 297-302.
- Oliver, J. A. 1946. An aggregation of Pacific sea turtles. *Copeia* **1946** (2): 103.
- Parshad, B. 1914. Notes on Aquatic Chelonia of the Indus System. *Rec. Indian Mus.*, **10**: 267-271.
- Parker, G. H. 1929. The growth of the loggerhead turtle *Am. Nat.* **63**: 367-373.
- Parsons, J. J. 1962. *The green turtle and man*. Univ. of Florida Press: 126 pp. Gainesville.
- Peters, J. A. 1956-57. The eggs (turtle) and I. *Biologist*, **39**: 21-24.
- Pritchard, P. C. H. 1966. Occurrence of mesoplastra in a cryptodiran turtle, *Lepidochelys olivacea*. *Nature, London*, **210**: 652.
- Pritchard, P. C. H. 1967. *Living turtles of the World*. T.F.H. Publications: Jersey city.
- Pritchard, P. C. H. 1967. To find the ridley. *Int. Turt. Tort. Soc. J.*, **1** (4): 30-35, 48.
- Pritchard, P. C. H. 1969. Sea turtles of the Guianas. *Bull. Florida State Mus.* **13** (2): 85-140.
- Pritchard, P. C. H. 1969. The survival status of ridley sea-turtles in American waters. *Biol. conserv.* **2** (1): 13-17.
- Pritchard, P. C. H. 1971. Galapagos Sea Turtles-Preliminary Findings. *J. Herpetol.* **5** (1-2): 1-9.
- Pritchard, P. C. H. 1971. The leatherback or leathery turtle *Dermochelys coriacea*. *IUCN Monogr.* **1**: 39 pp.

- Pritchard, P. C. H. 1973. International Migrations of South American sea turtles (Cheloniidae and Dermochelidae). *Anim. Behav.*, **21** (1): 18-27.
- Pritchard, P. C. H. 1979. *Encyclopedia of Turtles*. T.F.H. Publications: 895 pp. Hong Kong and New Jersey.
- Pope, C. H. 1935. The reptiles of China. *In: Natural History of Central Asia. Am. Mus. Nat. Hist.*, **10**: 604 pp.
- Rainey, W. E. and Pritchard P. C. H. 1972. *Distribution and management of Caribbean sea turtles*. Virgin Islands Ecological Research Station, Caribbean Research Institute, College of the Virgin Islands, **105**: 10 pp. St. Thomas.
- Rainey, W. E. and Pritchard P. C. H. 1972. *Distribution and management of Caribbean sea turtles*. Ecological Research Station, Virgin Islands, **105**: 1-21.
- Rebel, T. P. 1974. *Sea Turtles and the turtle industry of the West Indies, Florida, and the Gulf of Mexico*. Univ. of Miami Press: 250 pp.
- Roth, C. E. 1973. *Caretta*. *The Curious Naturalist*, **12** (7): 1-13.
- Routa, R. A. 1967. Sea turtle nest survey of Hutchinson Island, Florida. *Quart. Jour. Fla. Acad. Sci.*, **30** (4): 287-294.
- Schmidt, J. 1916. Marking experiments with turtles in the Danish West Indies. *Medd. Komm. Harvunders.* (Ser. Fish), **5**: 1-26.
- Schulz, J. P. 1968. *Zeeschildpadden, Deel 2: Zeeschildpadden in Suriname*. (2nd Ed.), Dienst Lands Bosbeheer, Paramaribo: 1-103.
- Schulz, J. P. 1970. Nesting beaches of sea turtles in West French Guiana. *Proc. Kon. Ned. Akad. Wet. Amsterdam.* (C) **74** (4): 396-404.
- Shah, R. V. 1962. A comparative study of the respiratory muscles in *Chelonia*. *Breviora*, **161**: 1-16.
- Siebenrock, F. 1902. Zur Systematik der Schildkrotten familie Trionychidae Bel, nebst der Beschreibung einer neuen *Cyclanorbis*—Art. *Sitzungsb. Acad. Wiss. Wein*, **3** (1): 807-846.
- Smith, M. A. 1931. *The fauna of British India including Ceylon and Burma. Reptilia and Amphibia—Loricata, Testudines*. Taylor and Francis, **1**: xxviii+185 pp., London.
- Spoczynska, J. O. 1969. The fascinating *Kachugas*. *Int. Turtle Tortoise Soc. J.*, **3** (2): 8-11.
- Steinbeck, J. 1962. *The log from the Sea Cortez*. Viking compass Books: 282 pp.
- Suwelo, I. S. 1973. *Notes on turtle ranching at Tidung Island*. Universitas Nasional: 1-3 Jakarta.
- Swinton, W. E. 1939. A new fossil freshwater tortoise from Burma. *Rec. Geol. Surv. India*, **74** (4): 548-551.
- Theobald, W. 1874. Observations on some Indian and Burmese species of *Trionyx*. *Proc. Asiat. Soc. Beng.*, **1874**: 75-86, 2 pls.
- Theobald, W. 1875. Observations on some Indian and Burmese species of *Trionyx*, with a rectification of their Synonymy and a description of two new species. *Proc. Asiat. Soc. Beng.*, **1875**: 170-180, 3 pls.

- Theobald, W. 1876. *Descriptive catalogue of the reptiles of British India*. Calcutta.
- Tickell, S. R. 1862. A rare and little described species of turtle. *J. Asiat. Soc. Beng.*, **31**: 367-370, Col. Pl.
- Travis, W. 1967. *The voice of the turtle*. George Allen and Unwin: 203 pp. London.
- Tufts, C. E. 1972. Report on the Buritaca Marine Turtle Nesting Reserve with emphasis on biological data from "Operation Tortuga 1972" and Recommendations for the Future. MS.: 73 pp.
- Tufts, C. E. 1973. Operacion Tortuga. Informe Final del Proyecto 1973: 40 pp.
- Uchida, I. 1967. On the growth of the loggerhead turtle, *Caretta caretta*, under rearing conditions. *Bull. Jap. Soc. Sci. Fish.*, **33** (6): 497-507.
- Uchida, I. 1973. Pacific loggerhead turtle—and its mystery of oceanic life. *Anima*, **3**: 5-17, 79.
- Urban, E. K. 1970. Nesting of the green turtle (*Chelonia mydas*) in the Dahlak Archipelago, Ethiopia. *Copeia*, **1970** (2): 393-394.
- Villiers, A. 1958. Tortues et crocodiles de l' Afrique Noire Francaise. *Init. Afr.*, **15**: 354 pp.
- Wermuth, H. 1956. Die Sud-Rasse der Indischen Dachschildkrote. *Aquar. Terror.*, Leipzig & Jena, **3** (8).
- Wermuth, H. and Mertens R. 1977. Testudines, Crocodylia, Rhynchocephalia. *Das Tierreich*, **100**: 1-174.
- Willgoos, J. F. 1957. Occurrence of the leather turtle in the Northern North Sea and off Western Norway. *Nature, London*, **179**: 163-164.
- Williston, S. W. 1925. *The osteology of the Reptiles*: 298 pp. Cambridge, Mass.
- Witham, R. and Carr A 1968. Returns of penreared green turtles. *Quart. J. Fla. Acad. Sci.*, **31**: 49-50.
- Yerger, R. W. 1965. The leatherback turtle on the Gulf Coast of Florida. *Copeia*, **1965**: 364-366.
- Zahl, P.A. 1973. One strange night on turtle beach. *Nat. Geogr. Mag.*, **Oct. 1973**: 570-581.
- Zangerl, R. 1969. The turtle shell. In: *Biology of Reptilia*. Chapter 6. Academic Press, **1**: 311-339. London and New York.

GLOSSARY

- Alveolar.** – Pertaining to the margin of the jaw where the teeth are generally situated.
- Ankylose.** – To grow together into one.
- Areola.** – Part of the carapace of a Testudine which persists at the time of birth, and from which the new growth of shell proceeds.
- Axillary.** – Pertaining to the axilla or armpit.
- Azygous.** – Not one of a pair.
- Bicuspid.** – Having two points or cusps.
- Bridge.** – That portion of the shell connecting the carapace of plastron.
- Callosity.** – An abnormal hardness and thickness of the skin.
- Carapace.** – Bony upper shield of a turtle or tortoise.
- Carinate.** – Having a keel.
- Caudal.** – Of the tail.
- Centrum.** – The body of a Vertebra.
- Choanae.** – The posterior nares.
- Cloaca.** – Chamber into which open the anus, urinary duct and genital ducts.
- Columnar.** – Vertically elongated.
- Columella auris.** – A delicate rod-like bone in the middle ear.
- Concentric.** – Having a common centre.
- Condyle.** – An articular prominence on a bone.
- Coprodaeum.** – A part of the cloaca.
- Costal** – Pertaining to the ribs.
- Crenulated.** – Feebly indented or crenate.
- Crepuscular.** – Active at twilight or preceding dawn.
- Cusp.** – A point.
- Cyclical.** – Recurring in cycles or periods.
- Denticulate.** – Having small tooth like projections.
- Dimorphism.** – The occurrence of two forms, distinct, either in structure or colouration or both.
- Disc.** – The dorsal or ventral shield.
- Emarginate.** – Opened in the form of a broad notch at the margin.
- Facet.** – A small flat and smooth articular surface of bone.
- Femoral.** – Of the thigh.
- Frontal.** – Head shield.
- Frontanella.** – The space left between two or more bones; it may or may not fill up later in life.
- Fossa.** – A shallow depression or cavity.
- Gular.** – Pertaining to the throat.
- Herbivorous.** – Feeding on plant and vegetable matter.
- Homologous.** – Having the same relative position, corresponding.
- Humeral.** – Pertaining to the humerus or bone of the upper arm.
- Imbricate.** – Overlapping like tiles on a roof.
- Inguinal.** – Groin area.

- Intercalated.** – Interposed.
- Intercentrum.** – A pad of cartilage or bone interposed between the centra or bodies of the vertebrae.
- Internasal.** – Shield between nasal shields.
- Juxtaposed.** – Placed in opposition to not imbricate.
- Keel.** – Elongated ridge on scale.
- Labyrinth.** – The cavities of the internal ear.
- Lamellae.** – Thin plates.
- Lanceolate.** – Tapering at the end.
- Lareal.** – Space between the snout and the eye.
- Lumbar.** – Pertaining to loin.
- Mandible.** – The bone of the lower jaw.
- Marginal.** – Plates forming the edge of the carapace.
- Maxillary groove.** – A name proposed for a well marked groove in the mid-line of the palate which is found in some species of *Trionyx*.
- Mental.** – Of the chin.
- Mesial.** – Situated in the middle line of the body.
- Nares.** – The nasal opening.
- Neural.** – Pertaining to the nerves or nervous tissue.
- Nodose.** – Knobbed.
- Nuchal.** – Pertaining to the neck.
- Occipital.** – Pertaining to the occiput or back part of the head.
- Ocellus.** – A coloured spot surrounded by a ring of different colour.
- Omnivorous.** – Feeding on both animal and vegetable matter.
- Ossicle.** – A little bone.
- Oviparous.** – Producing young by means of eggs which are laid.
- Pectoral.** – Pertaining to the breast.
- Pentadactyle.** – Having five fingers and toes.
- Phalanges.** – Digit bones.
- Plastron.** – Bony ventral shield of a turtle or tortoise shell.
- Plantar.** – Pertaining to the sole of the foot.
- Poikilothermous.** – Animals in which the body temperature varies with the temperature of the environment.
- Prefrontal.** – Head shield preceding frontal shield.
- Preocular.** – in front of eye.
- Procoelous.** – Vertebrae with the anterior end of the centrum or body concave.
- Reticulate.** – Arranged like a net.
- Reverted.** – Turned back.
- Rostral.** – Of the snout.
- Scutes.** – Scales or plates.
- Serrated.** – Notched or toothed on the edge, like a saw.
- Sigmoid.** – Taking a shape like the letter S.
- Stapes.** – The columella of the auditory chain.
- Sub.** – Somewhat; slightly.

Supracaudal. – Above the tail.

Supranasal. – Above the nostril.

Symphysis. – The union of two bones in the median plane of the body, such as the two halves of the lower jaw.

Tectiform. – Roof-like.

Temporal. – Pertaining to the temple.

Tricuspid. – Having three cusps or points.

Truncate. – Cut short.

Timpanic. – Pertaining to the tympanum or middle ear.

Vacuity. – A space.

Vermiculate. – Marked with wavy impressions, like worm-tracks.

Vertebral. – Pertaining to the vertebrae or backbone.

Zygapophysis. – The articular process of Vertebra.

ALPHABETICAL INDEX

	Page
Assam Freshwater tortoise	12, 84
Assam Land tortoise	112
Assam Saw-back turtle	12, 68
<i>baska</i> , <i>Batagur</i>	11
Batagur	8, 11, 48, 50, 53, 54
<i>Batagur</i>	8, 11
<i>Batagur baska</i>	9, 11, 49, 50, 51, 52
Bengal Roofed turtle	12, 62
Black & Yellow Giant tortoise	13, 112
Black-spotted Pond turtle	12, 78
Brahminy River turtle	12, 54
Brown River turtle	16, 65
Brown tortoise, Burmese	112
Burmese Brown tortoise	112
<i>Caretta</i>	11, 16
<i>Caretta caretta</i>	7, 11, 16, 17, 18, 19, 20, 22, 23
<i>caretta</i> , <i>Caretta</i>	11
<i>Chelonia</i>	11, 15, 24
<i>Chelonia mydas</i>	7, 11, 19, 20, 22, 24, 25, 26
CHELONIIDAE	7, 11, 14
<i>Chitra</i>	10, 13, 117, 123
<i>Chitra indica</i>	10, 13, 123, 124, 125
<i>coriacea</i> , <i>Dermochelys</i>	1, 7, 11, 20, 22, 42, 43, 44
<i>coronata</i> , <i>Melanochelys trijuga</i>	8, 12, 95, 96
CRYPTODIRA	11, 14
<i>Cyclemys</i>	8, 12, 48, 81
<i>Cyclemys dentata</i>	8, 12, 81, 82, 83
<i>Cyclemys mouhoti</i>	8, 12, 84, 85, 86
<i>dentata</i> , <i>Cyclemys</i>	8, 12, 81, 82, 83
DERMOCHELYIDAE	7, 11, 14, 41
<i>Dermochelys</i>	11, 42
<i>Dermochelys coriacea</i>	1, 7, 11, 20, 22, 42, 43, 44
<i>dhongoka</i> , <i>Kachuga</i>	12
Dhongoka turtle	12, 59
<i>elegans</i> , <i>Geochelone</i>	9, 13
<i>elongata</i> , <i>Geochelone</i>	9, 13
EMYDIDAE	8, 11, 14, 47
<i>emys</i> , <i>Geochelone</i>	9, 13, 112, 113
<i>Eretmochelys</i>	11, 15, 30
<i>Eretmochelys imbricata</i>	7, 11, 19, 20, 22, 30, 31, 32, 33
Flap-shelled turtle, North Indian	13
Flap-shelled turtle, Southern	13

Forest turtle, Kavalai	12
Freshwater tortoise, Assam	12, 84
Freshwater tortoise, North Indian	12
Ganga Soft-shelled turtle	13, 127
<i>gangeticus, Trionyx</i>	10, 13
Garo & Khasi Hill tortoise	12, 81
<i>Geochelone</i>	1, 9, 13, 101, 102
<i>Geochelone elegans</i>	9, 13, 102, 103, 104, 105
<i>Geochelone elongata</i>	9, 13, 102, 106, 107, 108
<i>Geochelone emys</i>	9, 13, 102, 112, 113, 114, 115
<i>Geochelone travancorica</i>	9, 13, 102, 109, 110, 111
<i>Geoclemys</i>	8, 12, 48
<i>Geoclemys hamiltoni</i>	8, 12, 78, 79, 80
Giant tortoise, Yellow & Black	13, 112
<i>granosa, Lissemys punctata</i>	10, 13
Green Sea turtle	7, 11, 24, 27, 28, 29
<i>hamiltoni, Geoclemys</i>	8, 12
<i>Hardella</i>	8, 12, 48, 54
<i>Hardella thurgi</i>	8, 12, 54, 55, 56, 57
Hawksbill Sea turtle	7, 11, 30, 33, 34, 35
<i>Heosemys</i>	8, 12, 48, 86
<i>Heosemys silvatica</i>	8, 12, 86, 87, 88, 89
Hill tortoise, Garo & Khasi	12
<i>hurum, Trionyx</i>	10, 13
<i>imbricata, Eretmochelys</i>	7, 11
Indian Snail-eating turtle	12, 92
Indian Soft-shelled turtle	13, 127
Indian Starred tortoise	13, 102
<i>indica, Chitra</i>	10, 13
<i>indopeninsularis, Melanochelys trijuga</i>	8, 12
<i>Kachuga</i>	8, 12, 48, 57, 58
<i>Kachuga dhongoka</i>	8, 12, 58, 59, 60, 61
<i>Kachuga kachuga</i>	8, 12, 58, 62, 63, 64
<i>Kachuga, Kachuga</i>	8, 12, 58
<i>Kachuga smithi</i>	8, 12, 58, 65, 66, 67, 68
<i>Kachuga sylhetensis</i>	8, 12, 58, 68, 69, 70
<i>Kachuga tecta</i>	8, 12, 71, 72, 73, 74
<i>Kachuga tentoria</i>	8, 12, 74, 75, 76, 77
Kavalai Forest turtle	12, 86
Khasi & Garo Hill tortoise	12
Keeled tortoise, Three	12
Land tortoise, Assam	112
Leatherback Sea turtle	1, 7, 11, 42, 44, 45
<i>leithi, Trionyx</i>	10, 13
<i>Lepidochelys</i>	11, 16, 36
<i>Lepidochelys olivacea</i>	7, 11, 19, 20, 22, 36, 37, 38

<i>Lissemys</i>	10, 13, 116, 117
<i>Lissemys punctata</i>	10
<i>Lissemys punctata granosa</i>	10, 13, 117, 121, 122
<i>Lissemys punctata punctata</i>	10, 13, 117, 118, 119, 120
Loggerhead Sea turtle	7, 11, 16
<i>Melanochelys</i>	8, 12, 48, 90
<i>Melanochelys tricarinata</i>	8, 12, 90, 91, 92
<i>Melanochelys trijuga</i>	8, 12
<i>Melanochelys trijuga coronata</i>	8, 12, 95, 96
<i>Melanochelys trijuga indopeninsularis</i>	8, 12, 97, 98
<i>Melanochelys trijuga thermalis</i>	8, 12, 98, 99, 100
<i>Melanochelys trijuga trijuga</i>	8, 12, 92, 93, 94
<i>mouhoti, Cyclemys</i>	8, 12
<i>mydas, Chelonia</i>	7
Narrow-headed Soft-shelled turtle	13, 123
North Indian Flap-shelled turtle	13, 118
North Indian Freshwater tortoise	12, 78
North Indian Roofed turtle	12, 71
<i>olivacea, Lepidochelys</i>	7, 11
Olive Ridely Turtle	7, 11, 36, 37, 39, 40
Peacock-marked Soft-shelled turtle	13, 132
Peninsular Soft-shelled turtle	13, 130
Pond turtle, Black-spotted	12
<i>punctata, Lissemys</i>	10
<i>punctata granosa, Lissemys</i>	10, 13
<i>punctata punctata, Lissemys</i>	10, 13
Red-nosed tortoise	106
Ridley Turtle, Olive	7, 11, 37
River Terrapin	11, 50
River turtle, Brahminy	12
River turtle, Brown	12
Roofed turtle, Bengal	12
Roofed turtle, North Indian	12
Roofed turtle, South Indian	12
Saw-back turtle, Assam	12, 68
Sea turtle, Green	7, 11
Sea turtle, Hawksbill	7, 11
Sea turtle, Leatherback	1, 7, 11
Sea turtle, Loggerhead	7, 11
Shell Turtle, Tortoise	30
<i>silvatica, Heosemys</i>	8, 12
Six-footed tortoise	112
<i>smithi, Kachuga</i>	8, 12
Snail-eating turtle, Indian	12
Soft-shelled turtle, Ganga	13
Soft-shelled turtle, Indian	13

Soft-shelled turtle, Narrow-headed	13
Soft-shelled turtle, Peacock-marked	13
Soft-shelled turtle, Peninsular	13
South Indian Roofed turtle	12, 74
Southern Flap-shelled turtle	13, 121
Star tortoise	13, 102
Starred tortoise, Indian	13
<i>sylhetensis</i> <i>Kachuga</i>	8, 12, 68, 69, 70
<i>tecta</i> , <i>Kachuga</i>	8, 12
<i>tentoria</i> , <i>Kachuga</i>	8, 12
Terrapin, River	11
TESTUDINES	11, 14
TESTUDINIDAE	9, 13, 14, 101
<i>thermalis</i> , <i>Melanochelys trijuga</i>	8, 12
Three Keeled tortoise	12, 90
<i>thurgi</i> , <i>Hardella</i>	8, 12
Tortoise, Assam Freshwater	12
Tortoise, Assam Land	112
Tortoise, Burmese Brown	112
Tortoise, Garo & Khasi Hill	12
Tortoise, Indian Starred	13
Tortoise, North Indian Freshwater	12
Tortoise, Red-nosed	106
Tortoise Shell turtle	30
Tortoise, Six-footed	112
Tortoise, Star	13
Tortoise, Three Keeled	12
Tortoise, Travancore	13
Tortoise, Yellow	13, 106
Tortoise, Yellow & Black Giant	13
Tortoise, Yellow-headed	106
Travancore tortoise	13, 109
<i>travancorica</i> , <i>Geochelone</i>	9, 13
<i>tricarinata</i> , <i>Melanochelys</i>	8, 12
<i>trijuga</i> , <i>Melanochelys</i>	8, 12
<i>trijuga coronata</i> , <i>Melanochelys</i>	8, 12
<i>trijuga indopeninsularis</i> , <i>Melanochelys</i>	8, 12
<i>trijuga indopeninsularis</i> , <i>Melanochelys</i>	8, 12
<i>trijuga thermalis</i> , <i>Melanochelys</i>	8, 12
<i>trijuga trijuga</i> , <i>Melanochelys</i>	8, 12
TRIONYCHIDAE	9, 13, 14, 116
<i>Trionyx</i>	10, 13, 117, 126
<i>Trionyx gangeticus</i>	10, 13, 126, 127, 128, 129
<i>Trionyx hurum</i>	10, 13, 126, 132, 133, 134
<i>Trionyx leithi</i>	10, 13, 126, 130, 131, 132
Turtle, Assam Saw-back	12, 68

Turtle, Bengal Roofed	12
Turtle, Black-spotted Pond	12
Turtle, Brahminy River	12
Turtle, Brown River	12
Turtle, Dhongoka	12
Turtle, Ganga Soft-shelled	13
Turtle, Green Sea	7, 11
Turtle, Hawksbill Sea	7, 11
Turtle, Indian Snail-eating	12
Turtle, Indian Soft-shelled	13
Turtle, Kavalai Forest	12
Turtle, Leatherback	1, 7, 11
Turtle, Loggerhead Sea	7, 11
Turtle, Narrow-headed Soft-shelled	13
Turtle, North Indian Flap-shelled	13
Turtle, North Indian Roofed	12
Turtle, Olive Ridley	7, 11
Turtle, Peacock-marked Soft-shelled	13
Turtle, Peninsular Soft-shelled	13
Turtle, South Indian Roofed	12
Turtle, Southern Flap-shelled	13
Turtle, Tortoise Shell	30
Yellow tortoise	13, 106
Yellow & Black Giant tortoise	13, 112
Yellow-headed tortoise	106

This Handbook on Indian Testudines is an attempt to provide up-to-date and complete taxonomic account of Indian Turtles, Tortoises and Terrapins. Apart from providing a full taxonomic treatment of all the species and subspecies known from India along with the keys for their identifications, this book also includes indepth information, wherever known, on various other aspects such as biology, ecology, distribution, conservation and captive breeding.

This is a very primitive group of animals which have a role in the conservation of Nature and are an important protein source. While studies on this group of animals began at the turn of this century, intensive studies were taken up only recently. The present "Handbook" gives a comprehensive information of all the marine, freshwater and land turtles and tortoises of India along with colour illustrations of each species.

This book will help in furthering interest in this fascinating subject of wildlife protection and conservation among our young readers. The authors have provided in this book, line drawings and distribution maps of almost all the species and subspecies of tortoises in the country.

For anyone interested in herpetology, particularly in India, this is an enthralling and informative book. The authors have dealt with the problems and solution of their conservation in the country.

Front cover : Green Sea Turtle : *Chelonia mydas* (Linnaeus), returning from nest to sea after laying of eggs

Back cover : North Indian Flap-Shelled Turtle : *Lissemys punctata punctata* (Lacepede), basking in the sun.

Cover theme and design by Dr. B. K. Tikader.

