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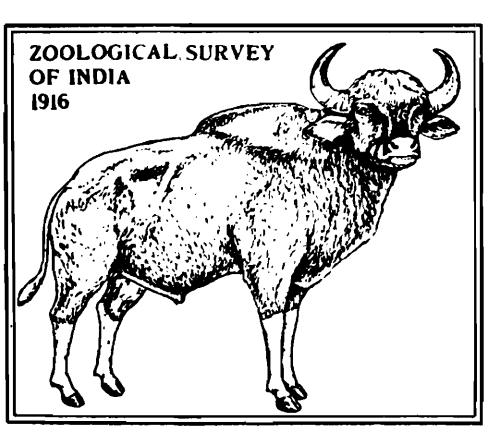

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ZOOLOGIANA

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FOREWORD

It has been generally felt that the results of researches of the scientists of the Zoological Survey of India should reach a wide circle of ever increasing Nature lovers and popular science readers of our country. ZOOLOGIANA attempts to meet this long felt need. It will be mainly a home journal containing articles written in a non-technical language as far as practicable and will contain information and results of inquiries on different aspects of animal groups. It is hoped that this bi-annual publication will make an interesting as well as useful reading to all concerned.

T. N. Ananthakrishnan
Director
Zoological Survey of India

Zoologiana, No. 1

FACTS AND FANCY OF ELEPHANT LIFE

S. MOHAMMAD ALI

Zoological Survey of India, Calcutta

The climax of proboscidian evolution was attained only in Pleistocene, when they were represented by eleven genera—*Mastodon*, *Stegodon*, *Stegolophodon*, *Mammuthus*, *Loxodonta*, *Elephas*, *Anancus* (having straight tusk), *Stegomastodon*, *Notiomastodon*, *Cuverionius* (having twisted tusk) and *Dinotherium*. They extended their ranges to every continent of the world except Australia and its associated and islands oceania. But now only one family Elephantidae of the order Proboscidea has been left on the surface of the earth. The family is represented by two genera, *Loxodonta* and *Elephas*, each with one species only. The species *Loxodonta africana* (Fig. 1) thrives in Africa and the other *Elephas maximus* (Fig. 2) is found in Asia. These are generally referred to as African and Asian elephants respectively. The African bull elephants are known to grow upto 366 cm. (12 feet) in height and cow elephants to 308 cm. (10 feet), while the Asian bulls now seldom grow, with a few exceptions, upto 305 cm., the average being 275 cm. and the usual height of an Asian cow is about 244 cm.

The height of a wild elephant is estimated by measuring the circumference of the print of the fore-foot. In general, twice the circumference gives the approximate height at the shoulder. The ear flaps in the African elephants are much bigger, measuring 183 cm. across but in the Asian's they are rarely as big as 61 cm. The former has a distinct ridge near the end of its spine and two finger like tabs on the tip of its trunk, while the latter has a ridge on its forehead and only one finger-like tab projects from the end of the trunk. The Asian elephant has four visible toe-nails on each hind foot, the African has three.

Asian elephants are mostly found in India and are also distributed in Sri Lanka, Burma, Thailand, Cambodia, Vietnam, Laos, South China *i.e.* Yunnan, Malaya, Borneo and Sumatra. The chief glory of an elephant is the tusks. Among the Asian beasts only the bull carry the tusks (Fig. 3a & 3b) of any importance and not even all of them, for there are males called *maknas*, that are just as big as the tuskers, but are tuskless. In India and Burma, *maknas* are almost as common as tuskers. In Malaya a *makna* is quite a rarity,

while in Sri Lanka the rarity is a tusker. Both, the *maknas* and the cow elephants have no tusks, but have short protrusions called as tushes. (Fig. 4) Such tushes are sometimes nearly 30 cm. long but generally get broken off before the elephant is middle aged. In African species both, cows and bulls grow sizable tusks, but those of the bulls are heavier and harder than the cow's tusks.

The longest recorded tusks from the African species are 336 cm. (11'5½"), but the average length along the curvature, is 152 to 244 cm. Among the Asian beasts the maximum length of tusks have so far been recorded are 299 cm. (9' 10½"), but generally it varies from 152 to 182 cm. The size of the tusks is influenced by the conditions under which the elephants live. If good food and water have been scarce, the animal is apt to have small tusks, while those that have had an abundance of food and water is gifted with larger ones. Tusks vary with locality too. In Africa the tusks grown by the forest elephants in Congo are small and slender, while the longer ones are worn by the beasts of Kenya and Tanganyika. Among the Indian elephants the differences are not very sharp, but the elephants of Assam and Karnataka possess heavier tusks, which may rarely exceed the length of 182 cm. in a well developed male.

The tusks show at birth and contrary to earlier belief are not replaced. Some elephants may be born with only one tusk or none at all. The animal possessing only one tusk are called '*Ganesh*' (Fig. 5) while the other with none is *makna* (Fig. 6). Yet a few elephants with multitusk have been recorded. Some of these are really remarkable, such as around 1900 an elephant was shot in the residency of Palembag which had four tusks, double tusk being on either side. The double tusk of which one was about straight, the other twisted around the first. In 1947 in the Kasongo a bull was shot that had two perfectly formed tusks on both sides. However, the tusks in the elephants begin to develop during the first year of its life and continue to grow during the entire life span.

The second pair of incisors in the upper jaw have been modified into tusks, by which they can inflict mortal wounds during fight and toss aside with ease even a large animal like gaur. The other incisors, all canine and premolars teeth have been lost. The molars are of great importance to their well-being. When the molars become worn out from the great amount of chewing, a new, set, one on each of both upper and lower jaws grows just behind them and not under them at about two, six, nine, fifteen to twenty and twenty five to forty years of age.

The elephants have a useful and powerful nose called trunk. The trunk is composed of flexible muscles, skin and sinews. With this organ the elephant can touch, taste, smell, suck and breathe, but the trunk is never used in fighting.

A trunk is not limited to handle only bulky objects. But the one or two finger like tabs at the tip of the trunk in Asian and African beasts, respectively, are quite sensitive and this makes it possible for an elephant to pick up an object as flat as a coin even on a dusty road or a single pea-nut from the earth. The trunk as a true nose can pick up the smell of an enemy at a great distance if the wind is blowing in the right direction. If an airborne scent is above the level of the elephant's head, the trunk is raised high to investigate by swinging it aloft in the different directions. It further acts as premonitive during natural calamities. It has been reported twice from Assam that elephants were well able to perceive the approach of earthquakes and announced it by trumpeting followed by a distinct clamour just prior to the actual jolt. Besides these multifarious functions the trunk is also used by the mother-elephant in taking care or in training her developing calf. The trunk also helps the elephant to fan the entire body, particularly the under parts, with the help of a leafy branch to get rid of insects.

The eyes are quite small and so widely separated that the vision when looking straight ahead is poor. The poor sight is compensated, however, with a sense of both, smell and hearing, which pick up an alien presence.

The great earflaps can be extended to act as sounding boards, collecting any threatening noise around them. These flaps are often fanned back and forth to drive effectively the disturbing insects from their head.

The temporal gland, between the eye and the ear, is indicated by a small slit-like opening. The function of this gland is not clearly understood. When the elephant becomes excited or nervous, this gland secretes an unusual amount of dark oily substance that has a strong unpleasant odor and stain a portion of the elephant's face. During this condition the elephant is designated as *musth*. The bulls, both tuskers and *makna*, as well as some of the cows seem to be affected by this conditions which may continue for 10 to 20 days or even more. In *musth* often the bulls are comparatively more dangerous and bad tempered than the cows in similar condition. Contrary to the general belief, this condition has no definite relation to the elephants sex life.

The tail is comparatively short with a few bristles like hairs at its tip. It is constantly used to sweep off insects from the posterior parts of the body. It has also been reported that the tail is used by the female to advertise her condition. A cow elephant coming into season soaks the hairs of her tail-tip in her genital discharge, the tail is then held aloft in the air and waved about as a scent-flag.

The bull elephant has a retractable penis between his hind legs. The testicles are not descended in a scrotal sac, as in other mammals, but remain up inside the body. It is a feature which is also found in primitive mammals, e.g. *Ornithorhynchus* and *Echidna* as also in all aquatic mammals like Dolphin,

dugong, manatees, whale, seal and sea-lion as well as in arboreal and terrestrial forms of two-toed sloth, Hyrex etc.

In cow elephant, the vaginal opening is situated at the rear part of the abdomen, more or less at the same position like that of the bull. Only one pair of mammary gland is developed, each with one nipple, shaped much like the human breasts, located between and just behind the fore-lumbs, in a similar position to that of human. Similar mammary glands are found in mermaids *i.e.* dugong and manatees. In this respect the elephant is somewhat different from other mammals like cow, horse etc., which have multiple nipples, located below the hind quarter.

In India the wild elephants occur in broad belts of montane and submontane forests which have territorial and floral continuity. They are found in the states of Assam, Arunachal, Meghalaya, Tripura, West Bengal, Bihar, Orissa, Uttar Pradesh, Karnataka, Kerala and Tamil Nadu. But somehow they are absent from Andhra Pradesh, Madhya Pradesh, Maharashtra, and Nagaland, though these States hold many forests especially hill forests of the kind that elephants favour. The approximate population of the wild elephants in the country is estimated by the present author to be between 9000 and 10000.

As a rule, elephants travel in herds forming a single file. A search for food, water, shelter etc. is the reason for most of the migrations of a herd. When the herd is on the move it follows precisely the same routes, time after time and the females, males and babies stay together and their leader is generally the oldest cow elephant. A master bull is treated with respect among his fellows and is one of the powerful male which can subdue any other junior members of the herd by force. A herd is no more than an over grown family party. A herd when it numbers around 9 to 17 is usually made up of one family with one master bull, several adult females, subadults of both sexes including infants (Fig. 7). Normally different herds do not mix-up, but during migration several herds may join together in such cases the herd may be as big as 80 or more with more than one master bull.

Lone elephants are older bulls, at times they may have company with similar other males. Some young bulls when they have reached an age of 18 to 20 years, also prefer the solitary life like that of older bulls. These bulls pay the herd only occasional visits and take care that their visits to the herd do not coincide, a chance encounter which may result to end in the death of one of them.

The elephants do not have a fixed territory, yet they have a tendency to stay in the same general area. Like most animals, elephants also need a varied diet to keep them sound and each of the many plants they feed on has its own season. The instinct of the old leader never fails to interpret any sign on the

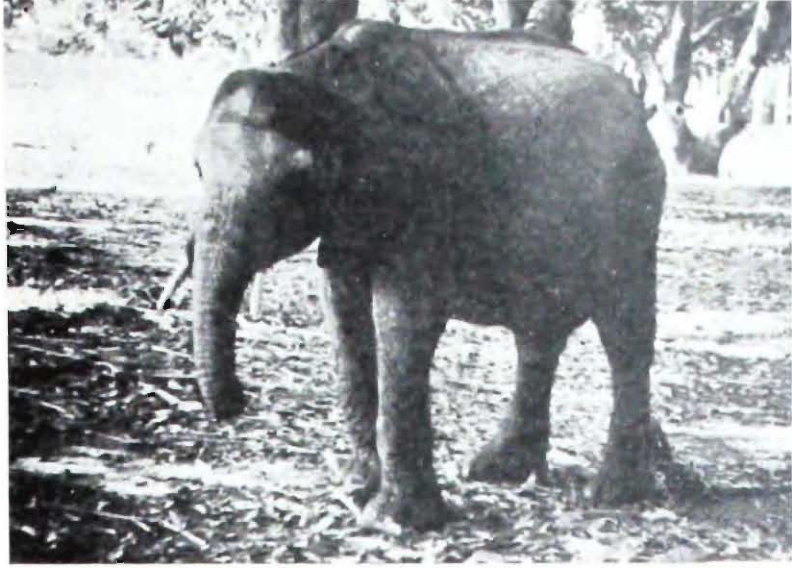

Fig. 1. 5 years male calf of an African elephant at Mysore Zoo

Fig. 2. Adult male tusker.

Fig. 3. (a) A young tusker.

Fig. 3. (b) A big male tusker.

Fig. 4. Adult female with tuskes.

Fig. 5. Adult male possessing tusk on one side only, called '*Ganesh*'. (Photo by Courtesy Shri N. Sundarraj, Bangalore)

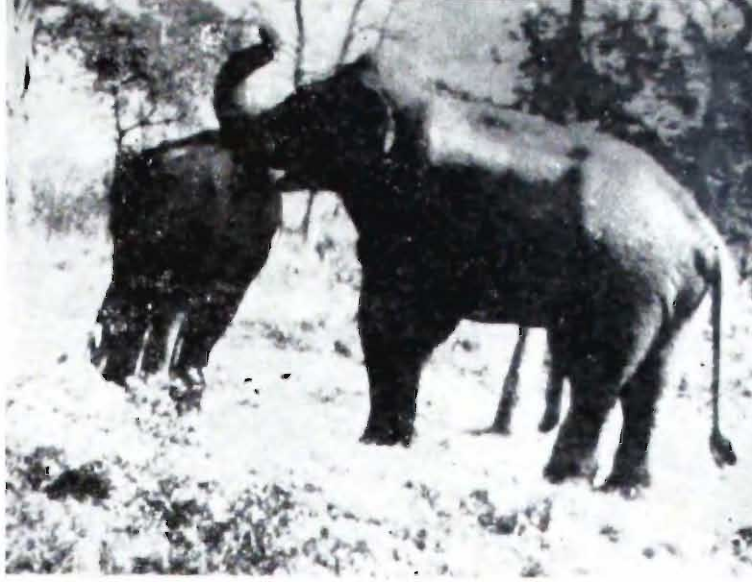

Fig. 6. Adult male, without tusk, called '*Makna*'. Before covering the male pressing the rump of a cow elephant by the base of its trunk to submit.

Fig 7. A herd of elephant moving under the leadership of the oldest cow elephant.

Fig. 8. Movement of an elephant in distress.

face of nature that might affect the welfare of her herd. This make them to wander at all seasons of the year. The herd normally leads a regular and ordered routine feeding and drinking in accustomed places and lying up to rest in its usual retreat. During feeding period a herd may subdivide into smaller groups ranging from 3 to 5 individuals, and spend most of their times in such small parties. The female groups are of two types : (i) the lactating females with infants and (ii) non- lactating females with juveniles. The adult males are primarily solitary. But members of these groups maintain frequent contact at several fixed points, namely resting place, rubbing trees and water pool, all of which provide opportunities for regrouping of the herd.

They generally feed on all species of bamboo (*Dendrocalamus* and *Bambusa*), a few species of grasses (*Andropogan, Imperata, Panicum, Cymbopogon, Saccharum*) Wild plantain (*Musa sp.*), besides barks of several trees e.g. 'Banian' (*Ficus bengalensis*), Pakri (*F. infectoria*) 'Pipal' (*F. religiosa*), 'Gular' (*F. glomerata*), 'Kheri (*Acacia katechu*), Teak (*Tectona grandis*), 'Asana' (*Bridalia retusa*), 'Ghogar' (*Garuga pinnata*), 'Jingan' (*Lannea grandis*), 'Piasal' (*Terminalia tomentosa*), 'Tesu' (*Butea monosperma*) etc. and fruits of 'Ber' (*Zizyphus*), 'Bael' (*Aegle marmelos*) and 'Mahua' (*Madhuka latifolia*) *etc.* when the herd is close to cultivated fields, raid crops like 'Sugarcane' (*Saccharum officinarum*), 'Paddy' (*Oryza sativa*), 'Maize' (*Zea maze*), 'Bajri' (*Pennisetum typhoideum*) etc.

The elephants begin feeding in the early hours of the morning and the midday is a time for sleep or rest under tree-shaded regions of the forest to avoid the hot hours of the day. They generally spend their nights in the less forested area and then as the day grow hot, move into the thick cover. When the sun begins to set again they come out of the thicket to begin feeding again. Not only do they begin a meal by pulling down branches and pushing over trees, but they scream and gurgle as they chew their great green mouthful. When they are enjoying their meals, one animal often tries to push another aside. This leads to grumbles and grunts of protest and an occasional scream. An elephant has an expressive voice, a shrill cry of pleasure, produced by blowing through the trunk. Anger may bring forth a roar from the throat. An elephant sensing danger, may warn his comrades with still another type of long drawn soft quiver. The elephant, with all its bulk and with the blazing sun overhead, feels uncomfortably thirsty. Then the herd sets out towards the most convenient water pool. Orderly at first, in a file behind the leader, as soon as they reach the water, they break ranks with a shrill cry of pleasure. They assume playful moods and cover their bodies with dust. Once they are all in water, after drinking they will begin to play, blowing water onto their bodies with their trunks or simply rolling about in the life-enhancing wetness. This would appear to be the best hour of the day for an elephant. They are free to enjoy the delights of the watering time for about half an hour. After it

is ended they communicate among themselves, perhaps, giving an unseen and unheard signal, which, indicates that it is a time to go. They lumber out of the water onto the bank where with their trunks they scoop up dirt or mud and blow it over their bodies. The dirt or mud is refreshing because it helps keep insects from lighting on their skins and it is also a protection against hot sun since the mud bath is both cooling and refreshing to the skin, the elephant often delights in wallowing in mud. They scoop up trunkful of mud to plaster on his head and back during the hot hours (*i.e.* noon) of the day in summer months. When the mud has dried he scrapes it off quite thoroughly even by rubbing against a tree.

Like other mammals, the elephants also need salt at regular interval to maintain their normal health, particularly during winter months. They scoop up with their trunks the lumps of clay having richer deposits of salt.

In the forests the simple occupation of eating as carried on by a herd is enough to raise quite an uproar. When they are feeding at night, they seem even noisier than during the day. They feed in the open forest or raid crops after nightfall, but retire to sleep again after mid-night.

When they suspect an enemy is at hand, they move through the jungle almost soundlessly. There is just a soft brushing sound, as if a breeze is stirring the foliage. But if a herd becomes alarmed suddenly the elephants are likely to plunge widely towards what they hope is safety, breaking down branches and even trees (Fig. 8) as they go when there is a sufficient cause for alarm, one member of the herd may act as a rear guard. So the life of the beast noted for its majesty goes on in the forest now carefully protected under rigorous laws.

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UNUSUAL SNAKES

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We are quite familiar with those snakes that seek light and are active on land. But we scarcely know about the existence of harmless and pretty snakes that dwell underground and escape our notice. One can have a glimpse of these astonishingly beautiful snakes only in the evergreen forests of the Western ghats often at high altitudes. While feasting your eyes on the scenic beauty around Kodaikanal, Ooty or Mahabaleshwar next time, turn a loose stone in a damp area and be in for a surprise. There you will see the thumb-sized worm snakes wriggling their way in the soil instead of a hissing viper or a cobra which are normally expected to make the scene.

Commonly called 'Rough-tails' (Uropelts) because of their unique spiny tail, these little known snakes lead sheltered lives in the deep muddy soil or decaying forest vegetation. With their short and rigid cylindrical bodies, dimunutive eyes, slender pointed heads and blunt tail ends which are obviously the adaptations for their mode of life, they pass off as typical burrowers To a casual observer the tiny head of these snakes looks like the tail end and the blunt tail as the head. When they move it seems as if they are crawling backward.

Never exceeding a foot in length, these snakes are timid and inoffensive by nature. Devoid of a neck to raise their heads or deadly fangs to put out on show, they will never attempt to bite even if handled or irritated. Instead they would love to be fondled and carried over long distances by their captors around whose fingers they entwine themselves when picked up. Though they shy away light and lead concealed lives, they are brilliantly coloured-red, orange, blue, and purple. Some of the black forms are remarkable for their irridiscence. This unusual and perhaps unnecessary colouration which is either incidental or has "warning" significance has, however, played havoc with their existence. With their pretty spots and blotches, they are often mistaken as vipers, kraits or some other deadly variety and done with mercilessly by the laymen.

They feed on insects, earthworms and grubs. Some lay eggs while a majority bring forth their young-three to eight at a time alive.

Distribution.—These primitive snakes-about 44 kinds are described so far are unique in that they are exclusively found in the wooded districts of Goa, Maharashtra, Karnataka, Tamil Nadu, and Kerala and Sri Lanka and nowhere else in the globe. They have eluded the herpetologists-those who care for the study of amphibians and reptiles-for long because of their secretive existence at high altitudes in the remote forests escaping easy capture and observation. However, R.H. Beddome, a Colonel cum Herpetologist of the East India Company has exploited the entire Western Ghats to such purpose in the séventies and eighties of the last century that he has hardly left any of these snakes to be discovered by any later enthusiast. Unfortunately for us, most of his magnificent collections were turned over to the British Museum.

Conservation.—They used to be so abundant some decades ago in the forests of the Western Ghats that they were a common sight on ghat roads during and after a heavy downpour. But the sholas and huge trees which are the mainstay for these poorly evolved snakes are disappearing as more and more original forests are cleaned and brought under cultivation. In the circumstances it is too much to expect of these snakes to migrate to other suitable habitats elsewhere, and in the process, we are not sure, how many of them have disappeared from the scene.

Under the 'Man and Biosphere' programme of the centre aimed at preserving the "totality of life" in a specified area, these snakes may be assured of a safe corner to continue their existence. Otherwise, it would be a pity if we are left in the end with a few specimens of these rare and specialised snakes peacefully resting in spirit.

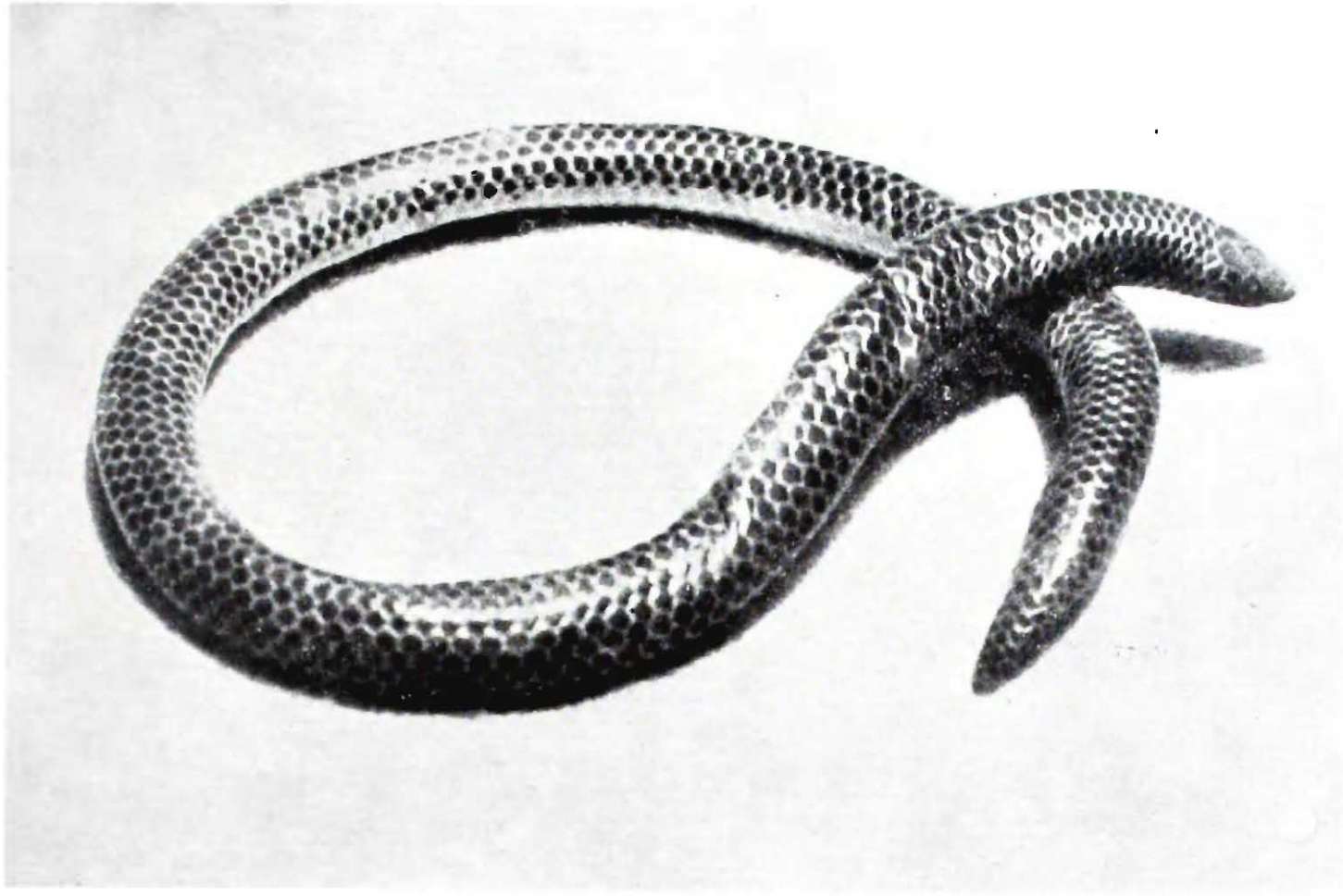

Fig. 1. The common rough tailed snake *Uropeltis pulneyensis* (Beddome) found around Kodaikanal, Palani Note the similarity of the head and tail and almost blind eyes.

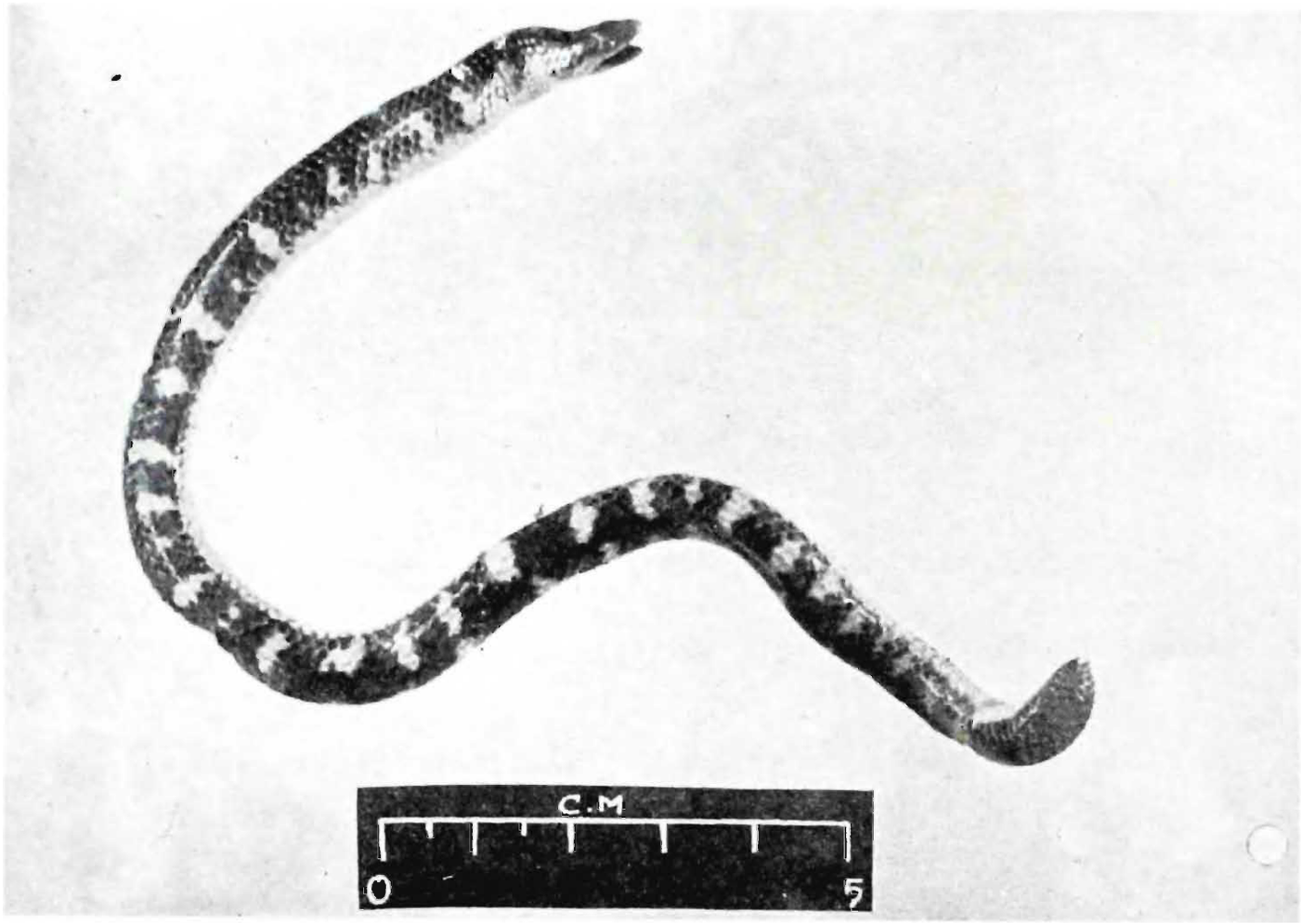

Fig. 2. *Uropeltis ceylanicus* Cacteau commonly found in the Travancore Hills. Note the characteristic spiny tail and the yellowish spots on the back.

Zoologiana, No. 1

CURIOUS CAT FISHES OF INDIA

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Catfishes as their name implies possess prominent whisker-like barbels, two to four pairs in number, mostly sensory in function and giving them a rather feline resemblance. They are entirely devoid of scales, the first ray in the dorsal fin being ossified as a spine in most genera. A further characteristic is the presence of a second dorsal fin called the adipose dorsal fin, which is smooth in all the Indian genera*. Most of them are inhabitants of quiet and slow moving waters.

In India 13 families under 48 genera and about 140 species are present. The habits and popular notions, utility etc. are discussed in this article. A list of families and genera known only from India, Pakistan, Bangladesh and Burma with their popular names is given at the end.

The Places They Live

As a rule, catfishes are found in slow moving, muddy, slushy waters and are found living near the bed of the river. The wider and deeper the rivers are the more suited they are for them. Consequently the larger forms are

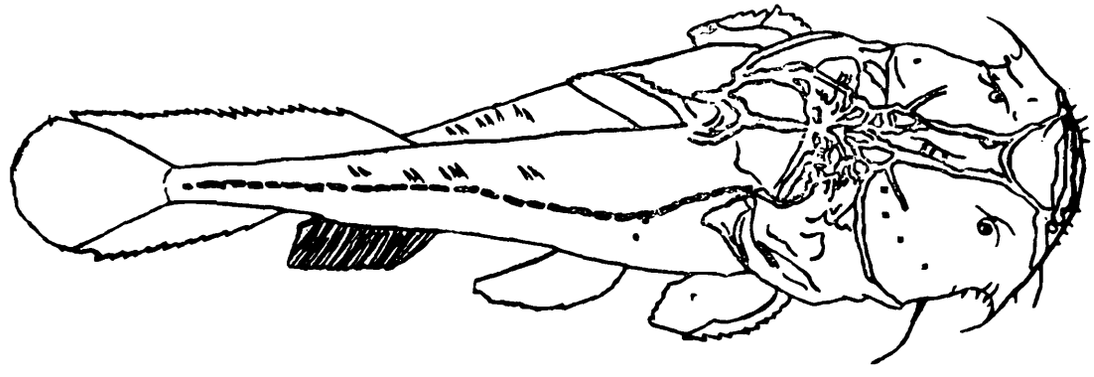

Fig. 1. Lateral view of *Chaca chaca* (Hamilton)

comparatively rare in South India unlike in the North Indian rivers such as the Yamuna, Ganga and Brahmaputra. Some as *Chaca chaca* Hamilton lie

* *Clarotes* Kner from Africa has the adipose fin also rayed.

embedded in the slush of the river bed. A species of the Magur family, *Horaglanis krishnai* Menon is known to live in the wells of Kottayam and

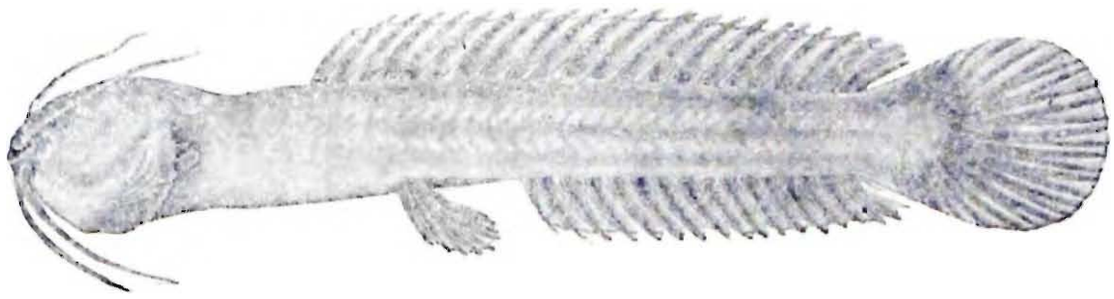

Fig. 2. Lateral view of *Horaglanis krishnai* Menon. (*After* Menon, A.G.K. *Rec. Indian Mus.*, 48, pl. 1, 1950)

because of this habitat it has lost the use of its eyes. Fishes of the family Sisoridae and notably the genera *Conta, Pseudecheneis, Glyptothorax* live in fast flowing hill streams and have developed an adhesive apparatus on their ventral surface for holding themselves to rocks and boulders and to prevent them from

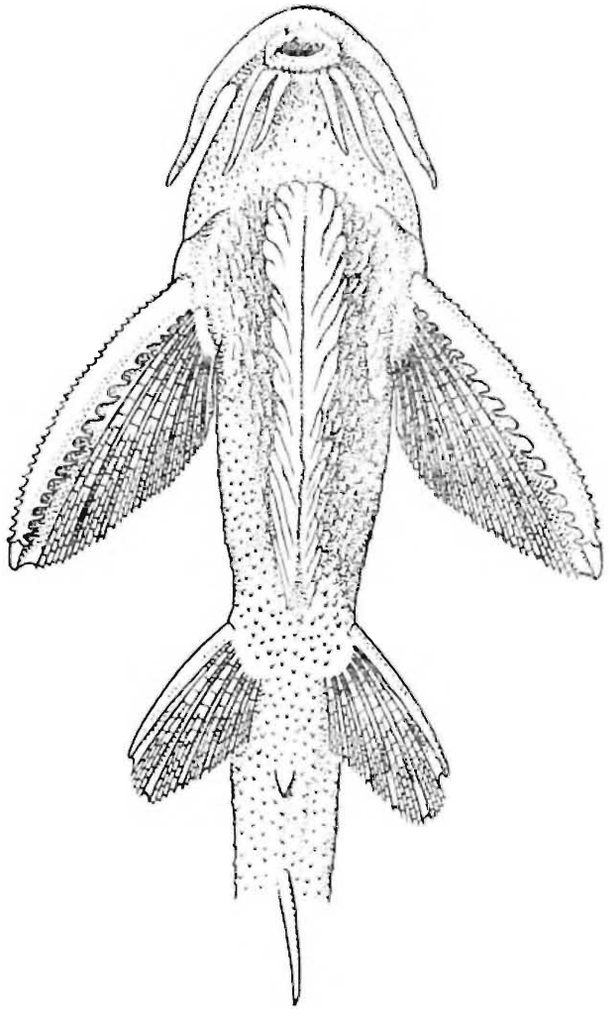

Fig. 3. Ventral view of *Conta conta* (Hamilton) to show adhesive apparatus on the ventral surface.

being washed away by the strong current. Some south American Catfishes of the family Loricariidae live even in torrential streams and have developed modification in body structure to such a life. These have spines over the body to resist the abrasion by water current and have slender, whip like caudal fin. Of the 13 families, the family Plotosidae is exclusively marine and Ariidae is both marine and freshwater ; the remaining 11 are entirely inhabitants of freshwater rivers, lakes, ponds and pools**. Fishes like Singi, (*Heteropneustes fossilis* Bloch), Magur (*Clarias batrachus*) can withstand drought conditions and can remain alive out of water for some hours. They have a mucous secretion over their body which help them in such condition. Besides, they have accessory air breathing structures such as an air-sac in *Singi* and a respira-

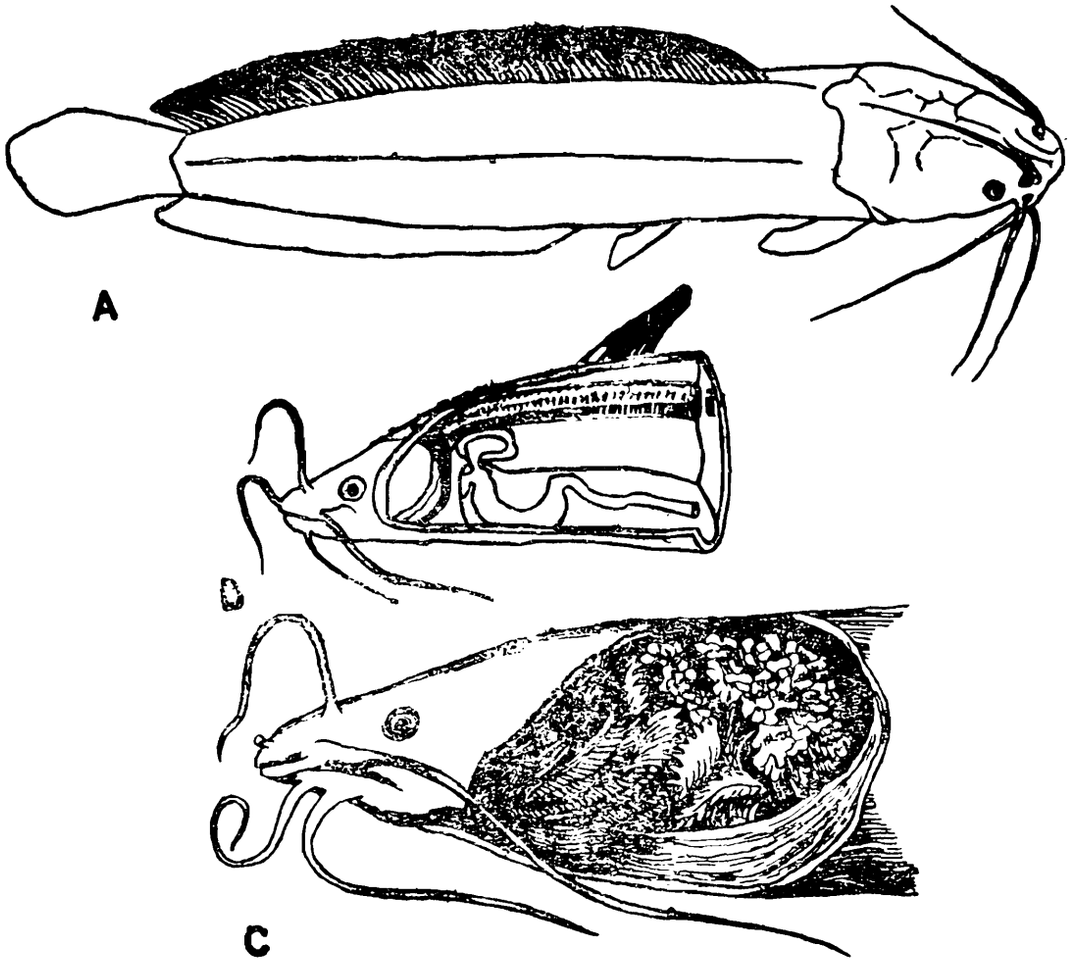

Fig. 4. A. lateral view of "Magur" *Clarias batrachus* (Linn.) B. "Singi" *Heteropneustes fossilis* (Bloch) dissected to show air-sac. C. *Clarias batrachus* dissected to show branchial respiratory tree on the gills.

tory branchial tree on the gills in the latter. Some of the fishes of the family Sisoridae such as *Euchiloglanis, Myersglanis, Glyptosternum* occur in cold streams at an altitude of 1,000—1,500 meters.

** *Mystus gulio* is the only species of Bagridae which may be occasionally caught in the sea also.

The Life They Lead

The barbels are their chief aids in securing their food in the dim lit water in which they live. Of these the maxillary pair are the longest and they as a rule aid in locating the food item, even at a distance, and also help in avoiding obstacles. With the help of these feelers the fish is able to move easily in and out of crevices, holes and narrow passages amongst bottom obstacles. The mandibulary or mental barbels on the underside of head serve to test and sieve the food at the bottom before they are eaten. It has been experimentally proved that the barbels have taste buds studded on their tips and they are all sensitive to acid and salt but not to sugar or quinine. The barbel of catfishes differ from similar structures found in some carps such as *Barbus* species. The barbel of the latter category do not have an axial rod of cartilaginous tissue as the catfishes (see Jayaram, 1978 for further details).

Catfishes are known to eat all kinds of food. They prefer small crustaceans, or bottom living invertebrates. Singi (*Heteropneustes fossilis*) and Magur (*Clarias batrachus*) are predacious in habit, but not markedly piscivorous. Insects, Ostracods, worms, algal matter debris constitute the main items of food. Pungas (*Pangasius pangasius*) feeds mainly on gastropod molluscan shells, besides insects and smaller fish. In fact the culture of *Pangasius* has been advocated for control of molluscs (Hora, 1952; 1953). *Aorichthys senghala* the "*aad tengra*" is a predator with marked piscivorous tendencies. Small fishes such as *Puntius filamentosus* and *Cirrhina reba* have been found often in the stomach of this fish, particularly from the Cauvery river. Insect larvae, gastropod and aquatic weeds are taken rarely. *Wallago* and *Bagarius* are large sized catfishes of considerable appetite. Both are often called the freshwater shark, are highly predatory and extremely destructive to fish life. *Wallago attu's* large mouth well armed with teeth helps it to attack and destroy even medium sized fishes. A variety of items including parts of human limbs are recorded from its stomach. *Bagarius* the Goonch has a wide mouth and is piscivorous in diet. It is very voracious, and takes a live bait.

Hill stream genera such as *Glyptosternum*, *Euchiloglanis* scrap the algae from stones to which they are attached besides insect larvae and insects found over rocks and boulders.

Breeding and Bionomics

Most of the catfishes spawn during the monsoon months in flooded rivers at suitable places and the eggs are fertilised externally in the usual manner. However, a few of them have peculiar habits. *Aorichthys aor* and *Aorichthys seenghala* build nests at small pits in the shallow river bottom during April to July. Generally a parent fish with young are found in each nest, but no eggs are seen (Raj, 1940, Saigal & Motwani, 1962). *Tachysurus* and *Osteogeniosus*

species on the other hand exhibit remarkable parental care. The eggs *ca* 10 mm in diameter, 15 to 20 in number are carried inside the mouth of the male till they are hatched and occasionally young fry and fingerlings are seen to be harboured inside the oral cavity. At such times the male virtually starves and becomes emaciated. Magur (*Clarias batrachus*) exhibits parental care of the brood, deposits the eggs in the holes made on the pond bank below the water surface. *Mystus gulio*, *Mystus malabaricus* have a pre-anal papilla which is large, resembling a copulatory penis. Some authors (Mookerjee *et al.*, 1941)

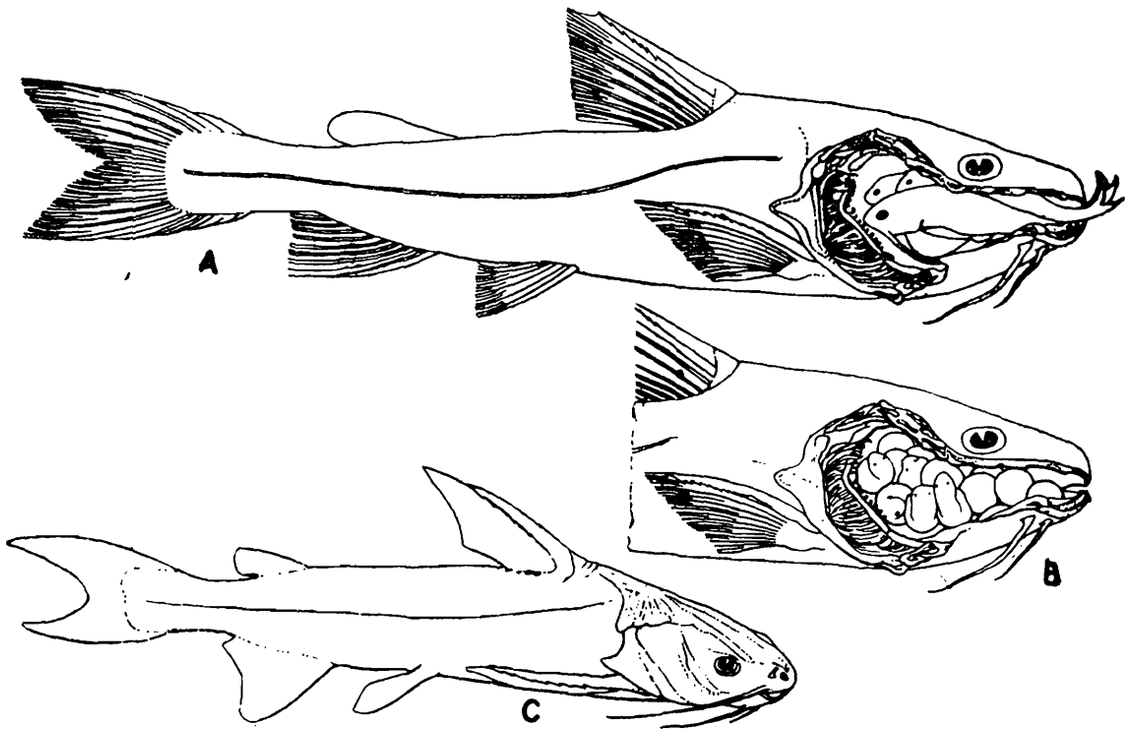

Fig. 5. A. Mouth with fry and fingerlings. B. Mouth with eggs. C. Lateral view of *Tachysurus arius* (Hamilton) (*After* HORA, S.L. *J. Asiat. Soc.* 17, pl. 18 fig. 4, 1951)

have infact thought that they are so in function. Hora & Law (1941) repudiated this and made it clear they are not indicative of any such use.

Catfish Culture

With increasing demand for fish protein all over the world, catfishes which were considered secondary to carps are now being taken up for culture, notably in western countries. Since most catfishes are carnivorous, their culture was not boldly undertaken even though many of them are not piscivorous. Extensive culturing of magur (*Clarias batrachus*) is practised in Thailand. Culture of singi (*Heteropneustes fossilis*) in natural conditions has not so far been very profitable, though attempts at artificial induced spawning has yielded results.

Pangasius is well cultured. As already mentioned elsewhere Pungas feeds extensively on molluscan shells and as such it can be safely utilised as a biological control agent and consequently in preventing infestation of diseases such as schistosomiasis for which molluscs are known vectors. Hora (1952) reported the culture of *Pangasius* in Khulna district, at present in Bangladesh. As in the case of Magur, *Pangasius* culture is extensively practised in Thailand and also in Viet-Nam.

Utility of Catfishes

Though as a source of food item it is only secondary, some species are preferred. The live fish (*Jiol Macch*) Magur, Singi are considered as invigorating and are specially prescribed for convalescing patients. Biological control of snails by Pungas culture has already been mentioned. Species such as *Mystus vittatus, M. bleekeri* because of their attractive banded colour patterns are often used as aquarium pets. *Horabagus brachysoma* from Kerala, previously known as *Mystus chryseus* is golden coloured as its name indicates and is a hardy brackish water fish fit for aquarium. A crude form of isin-glass is prepared from the air-bladder of some marine catfishes. Smaller sized species are extensively salted and dried.

Harmful Species

The spines of catfishes are a dread for all fishermen. As soon as they are netted the pectoral spines are broken because of their possible injury to those handling them and also damage to nets. The spines being sharp besides being barbed on one or two edges, cause a burning sensation, besides excruciating pain. Occasionally a benumbed sensation followed by swelling may also be caused because of the prick. The pectoral spines of singi and *Plotosus* are known to possess a poison gland at their bases (Bhimachar, 1944). It is believed tetanus would result because of this poison. *Chaca chaca* lies concealed in the mud with its formidable dorsal spine erect and the unwary fisherman inadvertently stamping on it is much afflicted. The flesh of this fish is also considered poisonous. Similarly the flesh of *Wallago* is considered unclean as it is a foul feeder.

Curious Facts About Catfishes

Size : Amongst the Indian Siluroids *Bagarius bagarius*, the Goonch is known to grow to a size of 9 feet or 1,800 mm and weight 60 Kgs. *Pangasionodon gigas* known from the Mekong river in Thailand is equally a giant of recorded size upto 2 meters. *Aorichthys aor* and *seenghala, Wallago attu, Pangasius*, and even *Clarias* are known to grow to considerable sizes of

over a meter and half. On the other hand species of *Erethistes*, *Laguvia*, *Leiocassis* do not grow more than 5 or 6 cm in length.

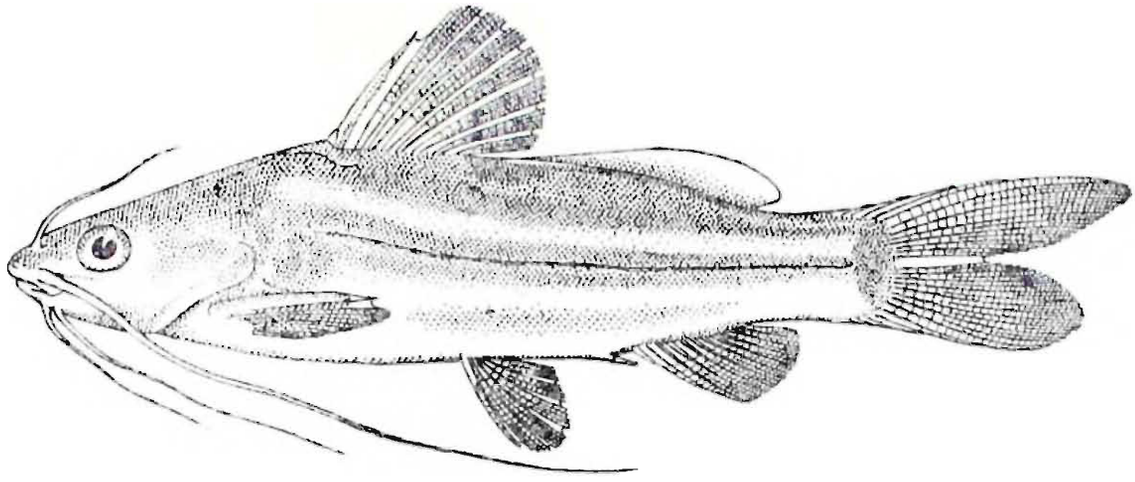

Fig. 6. Lateral view of the "Fiddler fish" of Mysore *Mystus vittatus* (Bloch).

Peculiar Habits : Mystus leucophasis (Blyth) known from Burma is known as the topsy turvy fish since it has a habit of swimming upside down. A similar habit is known with species of the genus *Synodontis* from Africa which also has a sort of neutral buoyancy which can be adjusted. These have branched mental barbels. *Mystus vittatus* is known as the Fiddler fish in Karnataka. It has a habit of putting out its barbels and spine stiffly, very erect when irritated and making a noise resembling the buzzing of a bee. In such conditions they are known to attack smaller fishes in an aquarium.

Wallago attu is easily detected in a river by its habit of jumping out and falling back with a splash when following shoals of fishes.

Live fish are generally avoided in Calcutta from mid February to mid April as it is believed that they spread small-pox. The reason may be because during this period the skin is covered with small rounded patches especially in Singi.

Acknowledgement

Thanks are due to the Director, Zoological Survey of India for facilities.

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List of Indian Genera of Catfishes

Families and Genera	Local Names*	Number of Species
Family I. BAGRIDAE		
Genus 1. *Rita* Bleeker	Rita (Hindi)	4
2. *Batasio* Blyth	Batasio (Bengali)	3
3. *Horabagrus* Jayaram	Manja Yatta (Malayalam)	1
4. *Mystus* Scopoli	Tengra (Hindi, Bengali) Keletee (Tamil) Coorie (Malayalam)	18
5. *Aorichthys* Wu	Aaad, Ari, Seenghala (Hindi)	2
6. *Chandramara* Jayaram	Chandramara (Bengali)	1
7. *Rama* Bleeker	Thunka patasi (Hindi)	1
Family II. SILURIDAE		
8. *Ompok* Lacépède	Butter fish (English) Pufta (Hindi) Chotta-vahlay (Malayalam)	3
9. *Wallago* Bleeker	Boal (Bengali, Hindi) Waley (Tamil)	1
10. *Silurus* Linnaeus		3
Family III. SCHILBEIDAE		
11. *Ailia* Gray	Banspatti (Bengali)	2
12. *Pseudeutropius* Bleeker	Puttahra (Hindi) Doya (Bengali)	2
13. *Proeutropiichthys* Hora	Nai Keletee (Malayalam)	1
14. *Neotropius* Kulkarni	Khavalchor (Marathi)	1
15. *Clupisoma* Swainson	Garua (Bengali) Bachua (Hindi)	3
16. *Eutropiichthys* Bleeker	Vacha, Bachoya (Hindi)	3
17. *Silonia* Swainson	Silond (Hindi)	2
Family IV. PANGASIIDAE		
18. *Pangasius* Valenciennes	Pungas (Hindi)	1
Family V. AMBLYCIPITIDAE		
19. *Amblyceps* Blyth	Billi (Hindi)	1
Family VI. AKYSIDAE		
20. *Akysis* Bleeker		3
Family VII. SISORIDAE		
21. *Bagarius* Bleeker	Goonch (Hindi) Bagh-aad (Bengali)	1
22. *Gagata* Bleeker	Jungla (Bengali) Bibua (Marathi)	3

*Local names of wide parlance alone are given. Genera without any local names are rather uncommon.

23. *Nangra* Day	Jungla (Bengali)	3
24. *Erethistes* Muller & Troschel		1
25. *Erethistoides* Hora		1
26. *Hara* Blyth	Kurkati (Bengali)	4
27. *Conta* Hora	Bot-tengra (Bengali) Powan (Hindi)	2
28. *Glyptosternum* McClelland	Paththar chatu (Hindi)	3
29. *Laguvia* Hora		3
30. *Glyptothorax* Blyth	Kanya tejara (Hindi) Pathar Chatto (Marathi)	22
31. *Euchiloglanis* Regan	Til Kabri (Nepali)	3
32. *Myersglanis* Hora & Silas		1
33. *Oreoglanis* Smith		1
34. *Exostoma* Blyth		4
35. *Pseudecheneis* Blyth	Kabri (Nepali)	1
36. *Coraglanis* Hora & Silas		1
37. *Sisor* Hamilton	Chennuah (Hindi)	1
Family VIII. CLARIIDAE		
38. *Clarias* Scopoli	Magur (Hindi, Bengali)	4
39. *Horaglanis* Menon		1
Family IX. HETEROPNEUSTIDAE		
40. *Heteropneustes* Muller	Singi (Bengali, Hindi) Theylee (Tamil)	2
Family X. CHACIDAE		
41. *Chaca* Gray	Chega (Bengali)	1
Family XI. OLYRIDAE		
42. *Olyra* McClelland	Bot Singi (Bengali)	5
Family XII. ARIIDAE		
43. *Batrachocephalus* Bleeker		1
44. *Osteogeniosus* Bleeker	Sunga (Oriya)	2
45. *Tachysurus* Lacépède	Singara, Err Tengra (Marathi, Hindi)	24
46. *Ketengus* Bleeker		1
47. *Hemipimelodus* Bleeker	Mooken-theydoo (Malayalam)	2
Family XIII. PLOTOSIDAE		
48. *Plotosus* Lacépède	Kanja keletee (Tamil) ; Gang-magur (Hindi) ; Kalan (Marathi)	2

Zoologiana, No. 1

AN APPRAISAL OF SATPURA HYPOTHESIS OF DISTRIBUTION OF THE MALAYAN FAUNA AND FLORA TO PENINSULAR INDIA*

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One of the most remarkable feature of the zoogeography of India is the occurrence of the Malayan element in the freshwater and terrestrial fauna of the Indian Peninsula. This element is rich in species and genera of practically all groups of animals which are found in the hills of Peninsular India and Sri Lanka on the one hand and in the Eastern Himalaya, hills of Assam and Burma and Farther East on the other. The absence of this fauna from the rest of India and the present day discontinuous distribution of a large assemblage of genera and species of Malayan affinities have attracted the attention of naturalists for over a century.

Satpura Hypothesis

The late Dr. S. L. Hora, proposed his Satpura hypothesis for the distribution of the Malayan fauna and flora to Peninsular India (Hora, 1937). His hypothesis was based on the following fundamental conceptions.—

(1) Continuity of the Vindhya—Satpura ranges with the Assam Himalayas in the east and the Western Ghats in the west.

(2) Five to six thousand feet elevation of the Vindhya Satpura ranges and the northern section of the western ghats.

(3) Continuity of an ecological belt of mountains with rainfall of about 254 cms. (100 inches) or above and consequently tropical evergreen forests between Assam Himalayas and the mountains of Ceylon *via* the Vindhya—Satpura Trend and the Western Ghats.

(4) Dispersal of the fauna from east to west and the consequent changes in topography necessary thereof.

(5) The Garo-Rajmahal Gap is a very recent feature of the physiography of India.

* Read at the All India Seminar on Ichthyology, May 23-26, 1977, held in M. M. College (Meerut University), Modinagar.

Ecology of the Malayan Fauna

The peculiar East Himalayan-Assam fauna found today in Peninsular India has the following abiotic characteristics in its environment.

In the case of aquatic animals, swift currents, similar to those of the Khasi Hills in the east and Travancore high ranges in the west, are essential for their existence, as the structural modifications undergone by the majority of them fit them only to this type of habitat.

In the case of terrestrial animals, warmth and dampness seem to be the most essential factors of their environment. For example, the most characteristic feature of climate of the Assam Hills is dampness at all seasons in conjunction with the moderately high and comparatively equable temperature. There is copious rain in Assam, the higher ranges getting over 264.0 cms. (100 inches) and the plains from anythtng between 178.0 cms. to 254.0 cms. (70 to 100 inches). The mean temperature in the plains of Assam is 95°F and it rarely goes upto 100°F.

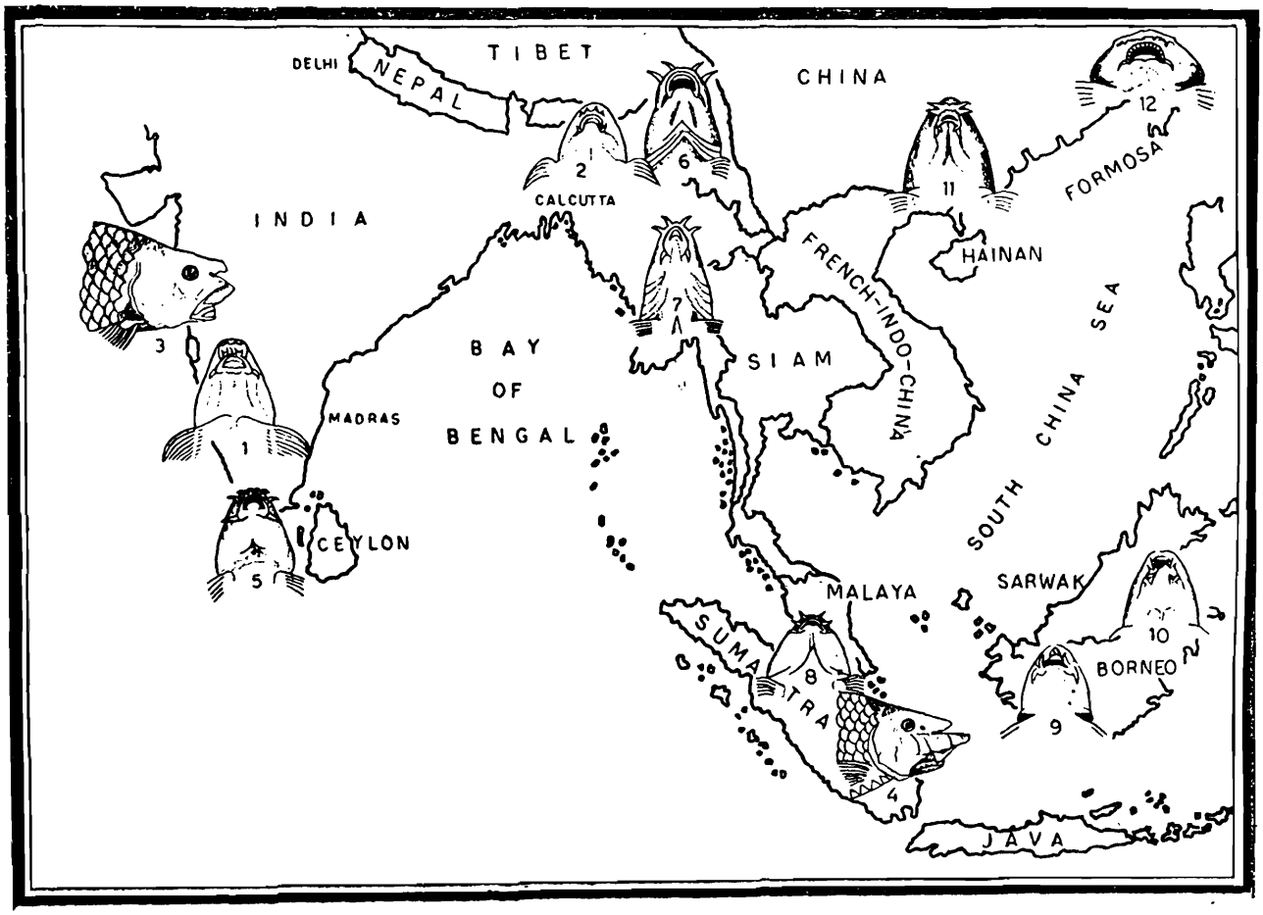

Fig. 1. The Satpura Hypothesis : Discontinuous distribution in some tropical torrential fishes. 1. *Balitora mysorensis* Hora 2. *Balitora brucei* Gray 3. *Schismatorhynchus nukta* (Sykes) 4. *Schismatorhynchus heterorhynchus* Bleeker 5. *Homaloptera montana* Herre 6. *Homaloptera rupicola* (Prashad & Mukerji) 7. *Homaloptera bilineata* Blyth 8. *Homaloptera amphisquamata* Weber & de Beaufort 9. *Homaloptera orthogoniata* Valliant 10. *Pseudohomaloptera tate-regani* (Popta) 11. *Sinohomaloptera kwangsiensis* Fang 12. *Hemimyzon formosanum* (Boulenger)

To satisfy the migration of both terrestrial and aquatic fauna Hora considered it necessary that the Satpura trend of mountains must have had once over 254 cms. (100 inches) of annual rainfall so that the ecological conditions for the fauna must have been analogous to those now prevailing in the hills of Assam or the hills of the Peninsula. Rainfall, Hora considered, to be the most important factor in the ecology of the Malayan forms, as vegetation, temperature, humidity etc., are all dependent on rainfall. To produce a local precipitation of 381.0 to 508.0 cms., (150 to 200 inches) of rainfall per annum, Hora further required that the Vindhyas and Satpuras to be of a height of 1524 to 1828 metres (5000 to 6000 feet) higher and continuous with the Assam Hills on the one hand and the northern section of the Western Ghats on the other. The southern section of the Western Ghats was at that time connected with the hills of Sri Lanka so there were no gaps round which the monsoon could flow. Such a topography could ensure continuity of evergreen and moist deciduous forests for the migration of terrestrial forms and torrential perennial streams for the migration of swift current animals from Assam Himalayas to hills of Sri Lanka.

Further Evidence for Satpura Hypothesis

Extensive field studies were undertaken and the precise systematic position of the Peninsular isolates, *vis-a-vis* the Malayan forms was also investigated (Silas, 1952). A symposium on Satpura Hypothesis was also held under the auspices of the National Institute of Sciences of India (now Indian National Science Academy) (Hora, 1949).

Geological Obstacles Against Satpura Hypothesis

Studies on the geological history of the region (Auden, 1949) in the light of earth movements which affected the Peninsula during the Tertiary and Post-Tertiary areas, however, revealed that the Satpura Trend of mountains were never higher than what they are today.

According to geologists the Garo-Rajmahal gap is an old feature of the physiography of India. The present area of the Garo and Khasi Hills was under sea until the end of Mesozoic and that the sea fell back from the Khasi Hills during the upper Eocene and from the Garo Hills during the Miocene. The Shillong plateau came probably into existence in the Miocene at which time the structural sag of the Garo-Rajmahal gap also formed, the implication being that there never existed a topographical expression between the Garo and Rajmahal Hills (Auden, *op. cit.*).

The Satpura Hypothesis, thus, lacked the support of the geologists as direct geological evidences were lacking pertaining to the existence of a former elevated Satpura-Vindhya range of mountains and to a recent dating of the

Garo-Rajmahal gap and as a result geologists and zoogeographers severely criticised the Hypothesis (Auden, *op. cit.*, Mayr, 1950 ; Beaufort, 1951 ; Dilger, 1952).

Pleistocene Ice Age and Climatic Conditions

Geologists Medlicott and Blanford (1879), have used the faunal and floral evidence and the presence of the Malayan element in the Peninsula as collateral evidence of the cold period having affected India in the late Tertiary or Post-Tertiary times.

In India the glaciers or the Kashmir valley descended to the present elevation of 1676 metres (5500 feet) during the first and second glaciations. In the central and eastern Himalayas there are definite signs of glaciation down to present-day elevations of 2133 to 2590 metres (7000 to 8500 feet). But these elevations were clearly not those that obtained during the Ice Age, because the Himalayas are known to have risen very considerably in late Pleistocene and recent times. The tilting of the Kerewas in Kashmir is probably only 20,000 years ago showing vividly how strong and recent these elevations have been.

It is likely that the land in Northern India may have been from 304 to 914 metres (1000 to 3000 feet) lower in the early Pleistocene than it now is, and that the glaciers must have descended to levels which were then much nearer sea-level. While the present glaciers of Karakoram and Himalaya have little effect on the climate of the Peninsula, it is almost certain that with a snow line and glacial line probably 1828 to 2438 metres (6000 to 8000 feet) lower than what now obtains (allowing for glacier recession and isostatic rise) the temperature and humidity in northern India must have been markedly different. It is these climatic factors which had probably facilitated the migration of the Himalayan fauna and flora to Peninsular India.

Distribution of Terrestrial Fauna

During the Pleistocene when the glaciers had come down to some 1828 to 2438 metres (6000 to 8000 feet) lower than at the present time, conditions in the montane and bordering zones of northern India must have resulted in a diminution of the temperature in the Peninsular India which had undoubtedly facilitated the spread of the terrestrial fauna southwards as far as the western ghats and further south to the hills of Sri Lanka. But the glacial theory does not explain the distribution of the hill-stream or torrential fishes of India whose distribution is influenced by certain dynamic ecological conditions. The factors affecting the distribution of freshwater fishes are quite different from those governing the distribution of terrestrial plants and animals. The former are generally restricted, according to their mode of life, to specific water

channels or drainage systems and they remain restricted unless their habitats are disturbed by orogenic movements or stream captures. The latter are relatively so easily spread that the whole of India must have become ecologically fit, under pluvial conditions to support their uniform distribution and after the retreat of the glaciers they had colonised the hill tops of the Peninsula where favourable ecological conditions prevail up to the present day.

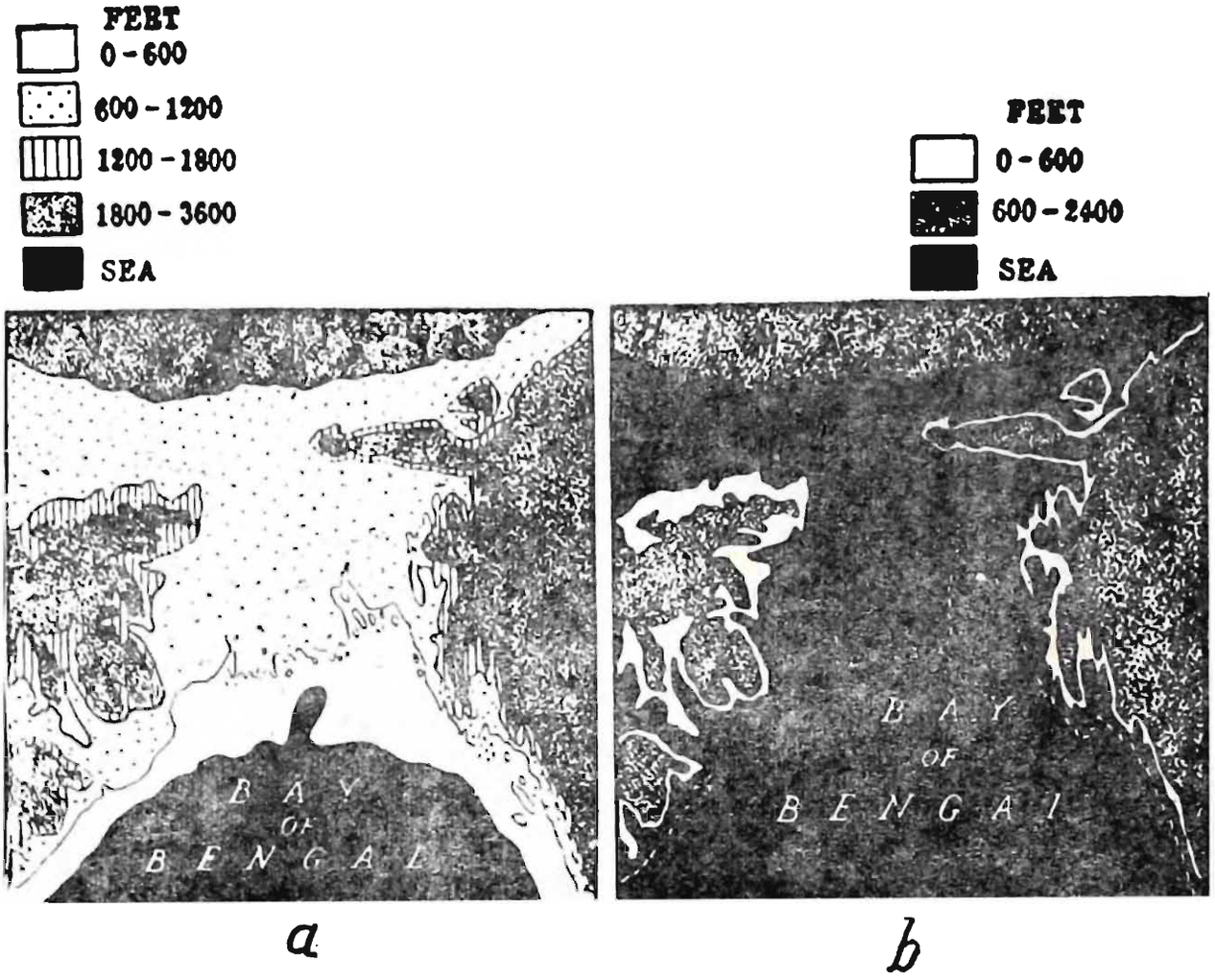

Fig. 2. Orographic features of the Garo-Rajmahal gap. a. Condition during the glacial period ; b. Condition during the interglacial period (*After* Hora, 1951).

Distribution of Torrential Fish Fauna

It should be remembered that the Satpura Hypothesis was propounded and developed to account for the anomalies of distribution observed among the hill-stream or torrential fishes of India. The original stock of the present day Ostariophysi and other freshwater fishes of India seems to have invaded south-east Asia during the Eocene period some sixty million years ago, but India began to receive the Malayan forms only during the Pliocene Siwalik period (Menon, 1973). The highly specialised torrential fauna developed much later, probably in the Pleistocene. The origin and distribution of this fauna is associated with

late Himalayan orogenic movements. There are 89 genera of primary freshwater fishes, of which excepting 23 endemic genera, 66 can be traced to centres of dispersal in south-west China or Yunnan region. Only with the major upheaval of the Himalaya during the Pliocene and the establishment of the land connections between India and further east, migration of fish fauna along the base of the Himalaya took place (Menon, 1954). Fossil records of *Clarias*, *Heterobranchus*, *Channa*, *Rita*, *Bagarius* and *Silurus* from the Siwalirs indicate that during the Pliocene the migration of fish was entirely along the Himalaya. The Garo-Rajmahal gap was still under the sea and did not permit the Pliocene fish fauna to migrate to the Peninsula (Menon, *op. cit.*).

In the modern conceptions of the Satpura Hypothesis there is no need to assign the Garo-Rajmahal gap a recent age against the geological evidences contrary to it. During the glacial epochs of the Pleistocene the aeustatic drop in the sea level of 182 metres (600 feet) had actually bridged up the gap topographically and climatically enabling the fresh-water fishes, especially the hill-stream forms, to cross over from the north to the Peninsula (Hora, 1951). The colder climate favoured increased precipitation, less evaporation and greater run off, this producing ideal conditions for the spread of torrential fishes across the gap. Every glacial period favoured the migration of torrestrial fishes and every interglacial period isolated stocks, with evident efforts on speciation, in different geographical areas. This concept of the glacial theory has been considered as the chief cause of the presence of Malayan element in the fish fauna of the Peninsula and it is quite possible that the route of migration of torrential and other aquatic animals lay along the Narbada-Tapti drainage of Vindhya-Satpura trend of mountains (Menon, 1951).

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Zoologiana, No. 1

THE ENDANGERED REPTILES OF INDIA

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India's herpetofauna is rich and varied. But in our country as in other parts of the globe, man has exercised a deep and lasting influence on some of the large and conspicuous reptiles of India resulting in their rapid destruction. The reasons for their fast decline are attributable chiefly to the following factors : (1) destruction of virgin forests, the ruthless draining of their waters, and construction of gigantic irrigation or hydroelectric dams resulting in the restriction of their natural distributional areas (2) merciless slaughter of several conspicuous reptiles for their skins or palatable flesh, and (3) the trade in live specimens.

The present status of these endangered species, their economical value and the need for taking necessary steps to conserve them are briefly discussed in this article.

ENDANGERED SPECIES

LIZARDS

1. The spiny-tailed lizard (*Uromastix hardwicki*)

Diagnosis : It is a burrowing form. Its head and eyes are small. Adults dull sandy in colour, throat stippled dark. Scales on the tail enlarged forming short and heavy spines which gave the common name to the lizard.

Distribution : North-west India.

Economic value : This harmless lizard is hunted chiefly by the desert people for its curious spiny tail which is considered a great delicacy, and the meat is said to be excellent and sweet like chicken. The fat of the body is found to be a medicant. The oil extracted from the fat is used as an embrocation, and also as a supposed cure for impotence.

Remarks : Despite the ban, the spiny-tailed lizard is caught in largd numbers for exporting it alive to foreign countries as a souvenir. The timie

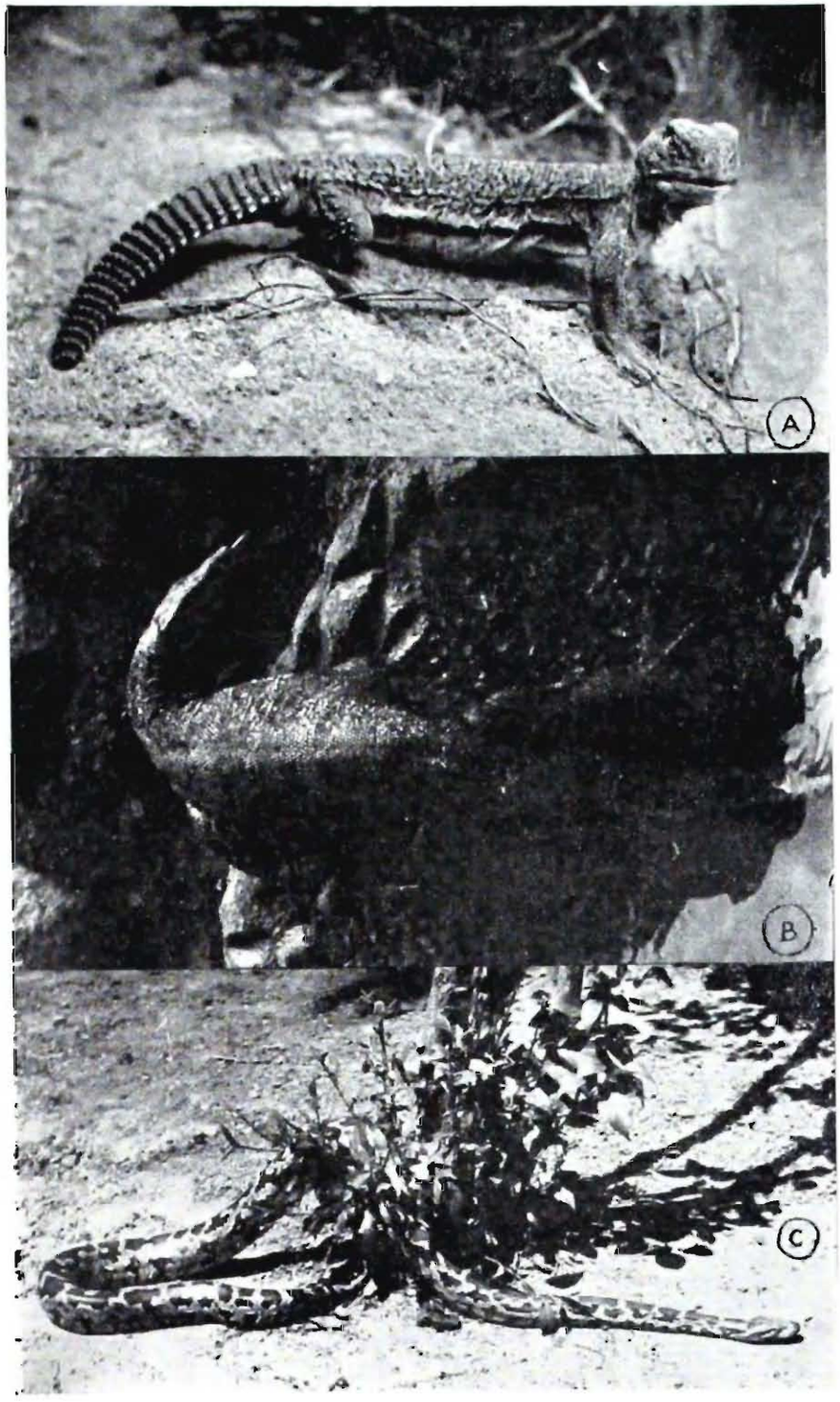

Fig. 1. A. The spiny-tailed lizard (*Uromastix hardwicki*)
B. The water monitor (*Varanus salvator*)
C. The Indian Python (*Python molurus*)
(Courtesy : A & C-S. Vijayaraghavan, B-R. Whitaker)

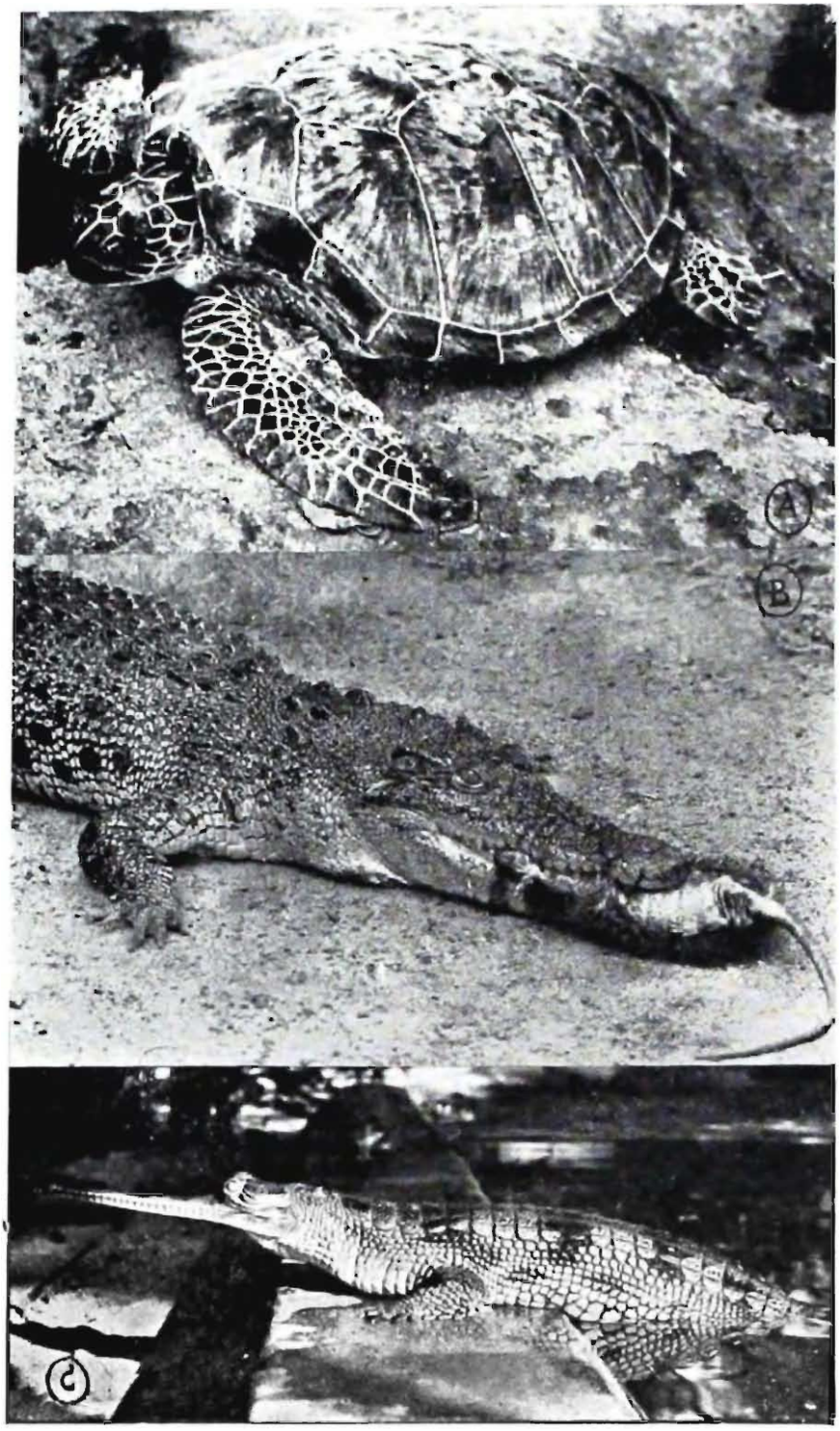

Fig. 2. A. The Green Turtle (*Chelonia mydas*)
B. The Esturine crocodiile (*Crocodilus porosus*)
C. The Gharial (*Gavialis gangeticus*)
(Courtesy : A & B-R. Whitaker, C-Lala A. K. Singh)

disposition of this lizard has been taken advantage of by the traders in live specimens who do not spare even the gravid females.

2. Monitor lizards :

Four kinds of monitors occur in India and all are seriously endangered. They are (a) The Common Indian monitor (*Varanus bengalensis*), (b) Indian desert monitor (*Varanus griseus*), (c) The water monitor (*Varanus salvator*), and (d) The yellow monitor (*Varanus flavescens*).

Diagnosis : The monitor lizards are heavy bodied and large reaching a length of 2.5 m. The tongue is slender and forked like that of a snake and can be extruded. The feet are provided with strong and sharp claws.

Distribution : The common monitor is found throughout India while the yellow monitor is restricted to some pockets in North India. The most conspicuous of India's lizards, the water monitor is found only in the coastal mangrove regions of Orissa, Sunderbans in West Bengal, Andaman and Nicobar Islands and parts of Assam.

Economic value : Eggs of all the Indian monitors are a great delicacy and the animals themselves provide a wholesome meal. Their skin is highly prized for its durability and suppleness. Since the favourite food of these lizards consists of poultry and their eggs, they are labelled as a menace and killed on that score too. But the fact that they devour large numbers of rats and mice is little realised.

Remarks : The water and desert monitors are protected under Schedule I of the Wildlife Act, 1972 while a total ban has been clamped on the trade in the skins of others.

TURTLES

3. The Green Turtle (*Chelonia mydas*)

Diagnosis : The popular name 'Green Turtle' is due to the olive taint that suffuses the dorsal aspect of the adult. The forefeet are modified as flippers. It is coloured greenish above, yellowish below. May attain a weight of over 250 kg and a carapace length of 120 cm.

Distribution : Throughout the Indian and Pacific Oceans but abundant in and around Krusadai Is. (South India) and the Andaman-Nicobar group of Islands.

Economic value : The flesh of this turtle is good to eat and is also the main source of the famous 'turtle soup'. In addition to its flesh, the eggs of a green turtle are a staple diet for natives in several parts of the world. Green turtles are sought for their oil which is used in the manufacture of cosmetics.

4. **Tortoise-shell Turtle** (*Eretmochelys imbricata*)

Diagnosis : This turtle's bird-like beak and slender head gave it its popular name 'Hawksbill' Shields of the carapace overlapping. Colour olive. Carapace reaches a length of about 85 cm while the animal weighs upto 125kg.

Distribution : Though not plentiful as the green turtle, it is found fairly in Indian waters and Indo-Chinese seas.

Economic value : The Hawksbill Turtle, though not eaten, is famous for its dermal plates which yield the famous tortoise shell known as 'Carey' in trade. It is said that the best tortoise shell comes from the species of the Indian Ocean.

Remarks : Since the turtle nests in the sandy beaches were indiscriminately dug up for the eggs and hatchlings, only one in a thousand babies reach adulthood. Even the baby turtles are caught in large numbers for export as "curios".

Thanks to the IUCN, sea turtles are listed as threatened species and now they are protected under Schedule I of the Wildlife Act.

CROCODILES

5. **Mugger or Marsh crocodile** (*Crocodilus palustris*)

Diagnosis : Found primarily in freshwaters. It is coloured olive green above and whitish or yellowish below. It has a broad snout and reaches a length of 3.4 to 4.2 m.

Distribution : Found in the stagnant waters, jheels, reservoirs, and rivers with placid current. Reported even from the Himalayan foot-hills.

6. **Estaurine crocodile** (*Crocodilus porosus*)

Diagnosis : Marine in habit. Snout narrow with a strong serrate ridge starting in front of the eye. Colour dark olive or brown above. Largest living marine reptile reaching a length of 9.1 m but the average size is 6.0 m.

Distribution : Till recently it was found on the east coast of India. But it is now restricted to the brackish waters of Chandbali coast (Orissa), Sunderbans (West Bengal), and Andamans and Nicobars.

7. **Gharial** (*Gavialis gangeticus*)

Diagnosis : Snout long and beak shaped with slender jaws. A lump on the extremity of the nose. Attains a length of 6m or beyond. Dark olive or brownish above, whitish or yellowish below.

Distribution : Primarily a North Indian species inhabiting the fast flowing rivers rising in the Himalayas, it is now found in the Ganges, Brahmaputra, the Indus systems, and the Mahanadi in Orissa. A rare animal.

Remarks : For all its gigantic size the Gharial is a harmless reptile feeding mainly upon fish. In fact it is known to prey on "Goonch" the greatest destroyer of eggs and young of the commercially importent fishes of the Gangetic system. Of the other two Indian crocodiles, the salt-water crocodile is no more a hazard as it is on the verge of extinction. The common crocodile will not attack humans unless provoked.

Though all the crocodiles are now strictly protected under the Wildlife Act of 1972, the indiscriminate killing of these gigantic descendents of a bygone age goes on unabated for the sake of their valuable hides. The drying up and damming of rivers and intensive fishing in the rivers have caused havoc to the Gharial, which is listed as the most endangered reptile of India.

SNAKES

8. Indian Python (*Python molurus*)

Diagnosis : Easily the largest and heaviest snake of India. Its unrivalled colouration—brownish patches on a greyish background with a trident like mark on the head-makes it the prettiest among Indian snakes. It reaches a length of 18 feet or beyond.

Distribution : Found in scrub jungles, rain-forests and jheels in undisturbed areas.

Economic value : The skin of this snake is highly valued for its ornamental colouration. Its flesh is eaten by some tribals in India.

Remarks : The Python is a protected species now. Though its life span is about 35 years, few of them are able to live that long because of the continuous demand for their skins.

CONSERVATION

It is gratifying to note that the appreciation of the fact that many harmless and even dangerous reptiles benefit humanity in several ways has been realised in our country and steps are afoot to save them from the danger of total extinction. It is suggested that an in-depth study of the Indian reptiles should be undertaken as a primary step before we proceed further to harness them as a resource for further exploitation. A serious attempt should be made to set up turtle farms wherever there is considerable scope since turtle farming is an ideal

industry benefitting us in two ways : (1) the feeding of the growing population and (2) the conservation of the natural populations. In addition to the enacted laws protecting the endangered species, stricter laws enforcing seasonal control on the capture of gravid females of monitor lizards and turtles should be enforced.

The conservation of the saltwater crocodile now on the verge of extinction calls for immediate attention of the authorities concerned in view of the fact that this animal inhabits the coastal mangrove swamps. Thus the retention of its original habitat is advantageous to us. The mangrove forests while affording protection to the crocodile and other animal life comprising mostly of valuable fishes act also as effective barriers against the recurring fury of the seas during cyclonic storms and floods. One other way to prompt others to take kindly to the protection of the endangered reptiles is to declare them as economically valuable animals and thus inducing them to take to captive breeding of the endangered species on a commercial scale. The skin trader and the conservationist stand to gain by the captive breeding of crocodiles if the programme is undertaken on scientific lines and sustained yield basis.

Zoologiana, No. 1

THE GIANT AFRICAN LAND SNAIL *ACHATINA FULICA*

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The giant African land snail (*Achatina* (*Lissachatina*) *fulica fulica* Bowdich), a native of East Africa (Kenya) was first introduced in India (Calcutta) in 1847. Since then it has been reported from the Indian Union as well as from a number of Pacific Islands where it is thriving well. It is said that the snail was taken from East Africa to Madagascar prior to 1800 by the natives who intended to establish it as an accustomed source of food. L.A.G. Bosc, a French naturalist, reported that the wife of a Governor of Mauritius, with chest ailment, had on doctor's orders fetched it from Madagascar in large numbers. She died shortly thereafter and the snail spread all over the island, increasing to the extent of becoming a pest.

The giant snail (Fig. I) as the name implies is the largest land snail on earth with a shell reaching 20 cm. and body 30 cm. in length. The shell is brilliantly coloured and well decorated, factors which attracted naturalists and resulted in importing it to new territories. Similar was the case of the conchologist W. H. Benson who went to Mauritius and took several specimens along with him to Calcutta in 1847. Having started its journey from East Africa the giant snail has travelled half-way round the globe by 1950.

It is much common in West Bengal, Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Tripura, Bihar, Orissa, Maharastra, Tamil Nadu, Kerala and also in Andaman and Nicobar Islands. The snail is known to confine itself to an altitude below 1,200 metres. It is unfortunate that the snail poses itself as a serious agrihorticultural pest in areas where it has spread and its eradication is still a problem.

It is nocturnal, hiding by day in a contracted quiescent state. The favourite haunts of the snail are dilapidated and damp brick buildings, adjacent to residential areas with vegetations, kitchen gardens etc.

The snail feeds on a number of economic and wild plants. The economic plants include different kinds of vegetables *viz.* amaranth, lettuce, garden spinach, gourds, lady's finger, beans, cabbage, cauliflower, radish, drum stick, fig, sweet potato, basella, chilly, tomato, vegetable sponge, squash, carum carui

etc. ; Oil producing plants *viz.* mustard, castor and sunflower ; fibre plant like jute ; flower plants *viz.* balsam, bougainvillea, canna, china rose, cosmos, clitoria, chrysanthemum, dhalia, gardenia, jasmin, kathchampa, land lily, hiptage, marigold, portulaca, oleander, rose, vinca and zinnia ; fruit plants *viz.* banana, cucumber and papaya, and a number of ornamental plants. All of them are subjected to serious damage. It is interesting to note that the snail prefers vegetable plants to others. It consumes the seedlings of gourd, cabbage, cauliflower, beans and tomato completely. The older plants are generally defoliated and sometimes denuded ; in some cases the stems are often cut into pieces. It is a serious threat particularly to papaya cultivation as it feeds exclusively on the floral buds.

The snail is moisture loving and its activity is dependent on humid atmosphere which coincides with the rainy season. It is, therefore, found active only in monsoon times in all the States. But in Assam. Meghalaya, Manipur and Andaman and Nicobar Islands where rains continue almost throughout the year, the snail also remains active accordingly. This offers the snail a longer active period. As a result, the degree of damage is also much higher in these areas than in places where monsoon is restricted only to a few months.

At the onset of winter the snail undergoes dormancy and overcomes the adverse climate (dry period), both in winter and summer, through aestivation. Majority of the snails aestivate on the ground in shady or covered places with the shell aperture directed downward and in most cases the outer lip of the aperture is buried in the soil. The preferred sites are bushes, crevices of trees, empty pot, under bricks, log of wood, dccaying twigs and leaves and also inside the leaf bases of young coconut trees. A large number of aestivating specimens huddled together on the ground in a small area, often one above the other, is rather common. Some sort of age dependent aggregation is present during aestivation.

However, the degree of damage is dependent on the number of snails present in an area and the number of snails is dependent on the rate of multiplication. *A. fulica* is hermaphrodite but mating is essential for reproduction. When the snail is about $5\frac{1}{2}$ months old it starts laying eggs and it continues to lay upto 5 years which is its life span. During the first brood it lays 50-80 eggs while the number reaches as much as 300-450 during the last brood *i.e.* in the fifth year. From a statistical calculation it is estimated that an individual snail may lay 5,000,000,000 eggs during its life span of 5 years in West Bengal. The number would be much higher in Assam and Andaman Islands as the snail can breed for a period of 8 months in contrast to only 4 months in West Bengal.

A number of animal species, especially the bandicoot (*Bandicota indica*) and the tree Pie (*Dendrocitta vaqabunda*) have been found to predate on this

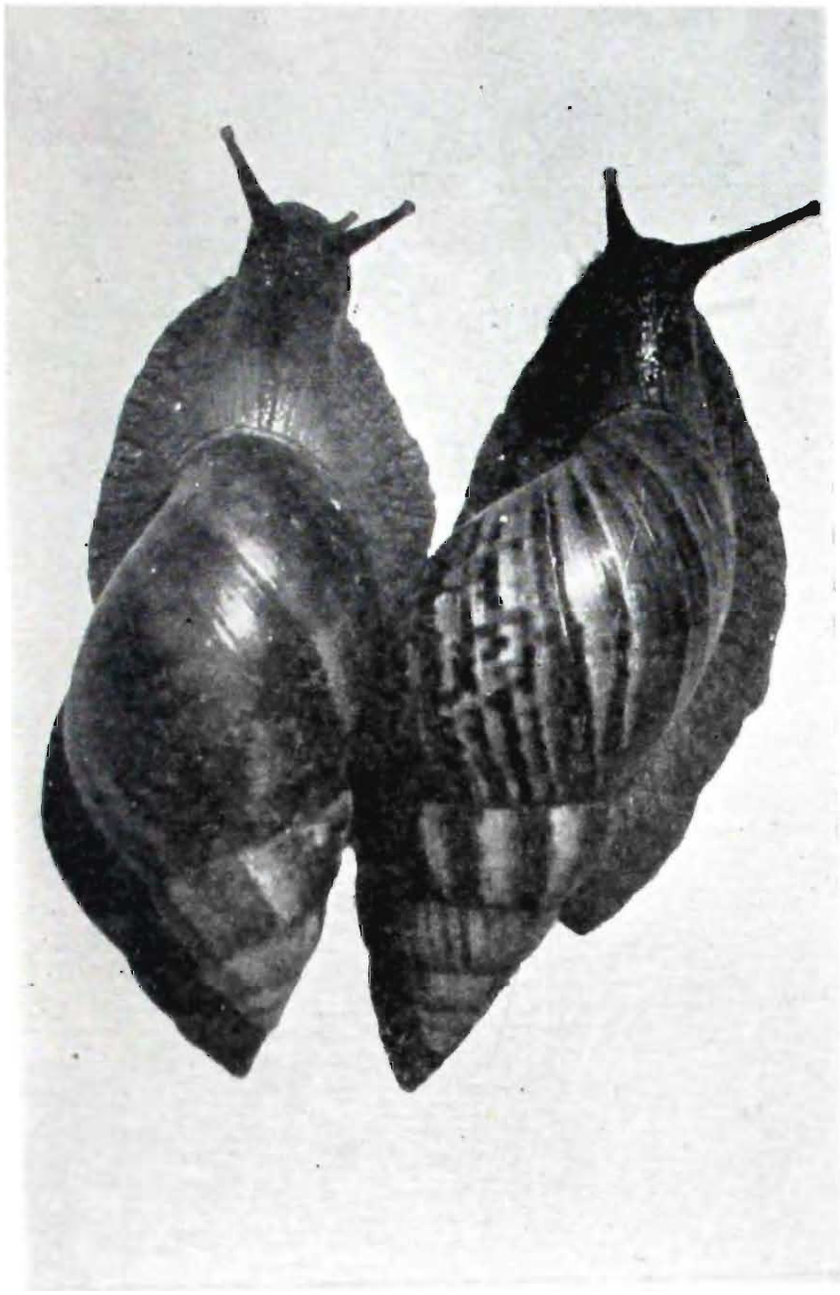

Fig. 1. The giant African land snail *(Achatina (Lissachatina) fulica fulica)* Bowdich ; two live specimens (dorsal view), (Note the difference in pattern of shell colour).

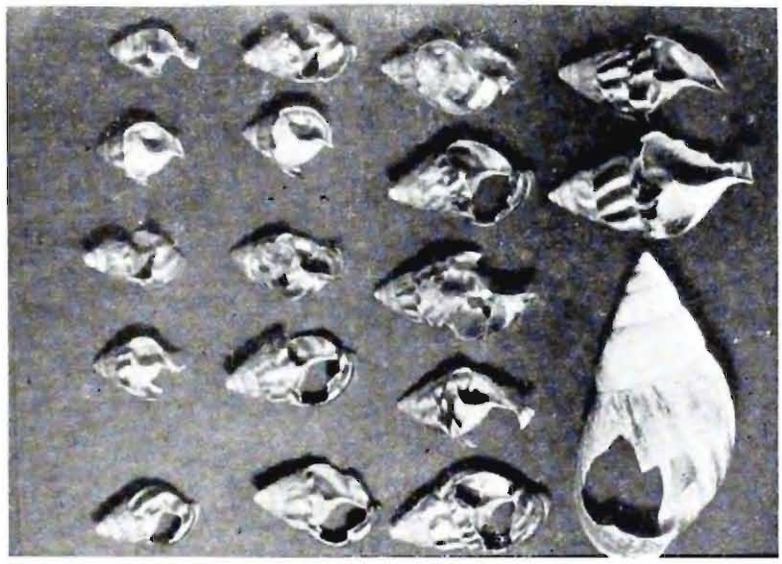

Fig 2. Shells with different age-groups of *Achatina fulica* showing characteristics damage caused by the bandicoot rat, *Bandicota indica*.

land snail. *B. indica* feeds both on active and aestivated snails. The bandicoots break the shell by their incisors and draw out the flesh. Some shells comprising different age groups with characteristic damage caused by the rats are shown in Fig. 2. The predation of *D. vagabunda* is restricted only to daytime following rain. Biological control to reduce the snail population with the help of predatory bandicoot is rather effective. However, the bandicoot, as we know is a serious pest so it would not be wise to employ a pest in controlling another pest.

The loss to the agri-horticultural economy produced by this snail pest has engaged the attention of a number of scientists to find out an effective measure to control it. Presently, the author himself is engaged in studying the ecology and population dynamics of the giant snail in collaboration with the members of the Mollusca Section, Zoological Survey of India. More than 50 molluscicides have been tried by workers but none is found effective in minimising the snail population. Biological control measures have not been very encouraging. Various attempts have been made by introducing predatory snails to check the giant snail population in Hawaii and Andaman Islands but have not been very successful. Even then, the search for any controlling device, either chemical or biological still continues and one would wish that an effective measure is discovered early. However, a great risk is involved in ignoring the problem and allowing the snails to do harm to the plants in the mean while. It would be wise, if people in the infested localities keep themselves engaged in collecting the snail either in active period or in aestivation or both by hand and destroying it. If this would be continued even for one year the snail population could be reduced considerably.

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Zoologiana, No. 1

LIMNOLOGY IN THE SERVICE OF MANKIND

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Limnology, mainly deals with the sources and nature of freshwater, its motion, changing conditions and life it supports. Although the study of freshwater systems is varied and old, the field was not established as an area of systematic, scientific exploration until F.A. Forel, a Swiss physician published a paper describing the bottom fauna of Lake Geneva in 1869. The term Limnology was originally applied only to the study of lakes, in its current use also refers to the study of streams. In recent years ecologists, hydrologists and engineers have been giving special attention to this field for various applied investigations like fish culture, public health engineering, environmental protection and pollution on studies.

Limnology In India

Pure Limnological studies are currently undertaken in various Universities and Research Institutes of our country. Mention may be made of Madurai University, North-Eastern Hill University, Kashmir University, Osmania University and Zoological Survey of India. The Central Inland Fisheries Research Institute and other state fishery laboratories mainly deal with applied Limnological investigations in relation to fish culture. In Environmental Engineering Research Institute, studies in relation to public health engineering problems are carried out. The Department of Science and Technology is organising many projects under the programmes like Environmental Protection and Man and Biosphere. The important Limnological projects currently undertaken under these schemes are that of River Cauvery and Idukki reservoir.

Fish Culture

In India, natural lakes are estimated to have an area of about 0.72 million ha. and more or less the same amount of area is covered by reservoirs. From the view point of inland fish production our country ranks third in the world. For culture fisheries, which cover the major portion of still waters, an estimate of potentialities of available freshwater areas of different categories is a prerequisite. For this purpose, the different freshwaters have to be studied for

their ecological characters. The collected physical, chemical and biological parameters form the basis of fish culture. Also the methods of using different organic and inorganic fertilizers for fish production are evolved on these studies. As freshwater fish are reared on a considerable scale in our country much Limnological knowledge is utilized for this purpose.

Medical Application

A considerable amount of original research on Limnology helped the medical field in finding out the reasons for the spread of certain diseases and measures to be adopted for control. During the course of these studies, certain life histories bring out the role of intermediate hosts of parasites harmful to man and domestic animals. This knowledge has permitted a control to be applied to worst pests at the most effective stages of their development. The important diseases controlled in this manner are malaria and schistosomiasis. Besides water quality studies have revealed the role of certain chemicals causing dangerous diseases. Recently a news item indicated the role of pesticides like folidol and endrin in causing the crippling disease, Handigodu syndrome of Malnod. Also the antibiotic properties of some freshwater algae have been brought to light recently.

Water Supply

First essentials of a civilized community is pure water supply. Now scarcely a week passes without our hearing of some scheme for flooding this valley or damming that river. For water supply, water of good quality free from harmful substances, without objectionable taste and smell, containing no bacteria is essential. When water is drawn from either rivers or from soils rich in nutrients many side problems develop. For example when such waters are stored in reservoirs they produce abundant plankton. Also they will quickly develop objectionable smells, taste and block the purifying filters. To overcome these difficulties the rich Limnological knowledge is effectively employed.

Sewage Disposal

Most quantity of water finds its way eventually into surface waters as sewage effluents. From these sewage waters the problem of pollution and hygiene starts. Here the branch of Limnology namely waste water treatment is effectively utilized to overcome these day to day problems. Waste water can be treated either chemically, mechanically or biologically depending upon the quality and requirement. Now many specialised techniques like trickling filters and activated sludge are employed. Also experiments have been conducted for effective utilisation of nutrient loaded sewage water. Already there is an

appreciable amount of pollution of in India's water courses by the discharge of untreated effluents from factories, distilleries, tanneries, coal washeries and raw sewage. The worst polluted water courses are the Ganges near Kanpur, the Mahi river near Baroda, the Periyar river in Kerala and the Palar river in Tamil Nadu. The above facts indicate the role of waste water treatment in the present day society.

Conclusion

Freshwater will always remain as one of the important natural resource. Increasing human populations make it essential that our freshwaters are conserved wisely and unpolluted. This can be achieved through proper education, persuation and selective regulation. All of us who find interest and enjoyment in studying the living things in freshwater have a special responsibility in widening this interest.

Zoologiana, No. 1

CRUSTACEA AND MAN

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Most of us have seen crustaceans at one time or another. Prawns, crabs, lobsters, wood-lice, barnacles, etc. are popular enough. But there are myriads of smaller and less conspicuous (Fig. 1) forms unknown to the layman. Ever since man acquired a taste for animal food and also the skill to capture the aquatic animals, prawns and crabs have been consumed by him. These creatures are in many ways of greatest importance to man, not only as a number of them are valued as food, but their vast numbers, in many cases virtually myriads, form fóod in turn for other valued animals, specially marketable fishes, and thus largely contribute to the maintenance of crustacean fisheries. From this point of view, a study of the habits and distribution of the commoner species may be off immense value.

The study of commercially and economically important Crustaceans has been carried on continuously in the Zoological Survey of India for well over sixty years.

Habits and Habitats

The crustaceans are known for their remarkable adaptations. Some occur in freshwater, while others resort to estuaries and some to brine pools. Records of forms found in estuaries adapting to purely freshwater are not uncommon. Some of the Indian forms living in the sea are littoral, others pelagic and some abyssal descending down to great depths of the sea covering hundreds of fathoms. Some of these creatures adapt to live on land and a few survive in deep caves. Besides, some members of this group are found to occur as parasites on a large variety of animals including the crustacean themselves.

Crustaceans live solitarily as in the case of rock lobsters and in gregarious form as in shrimps. Another remarkable feature of these organisms is their size, from the microscopic forms such as *Daphnia*, *Cyclops*, etc., to crabs and lobsters which grow fairly large in size. Most of them are brilliantly coloured and some present instances of protective colouration. Mimicry and modification of form, etc., are also common among the crustaceans. Many of these carry sponges, alcyonarians on the carapace. Hermit crabs are found to live

together with other animals such as sea anemone (Fig. 3A) and the gastropod mollusc, the sea anemone and hermit crabs acting as commensals. Some crabs and prawns live inside the mantle cavity or oysters and echinoderms respectively. The robber crab, *Birgus latro* (Fig. 2C) is perhaps the best known among the hermit crabs. This is a large form weighing upto 5-6 lbs., and is widely distributed in the Indo-West Pacific region.

Many crabs of the family Grapsidae and some among other families live in burrows which are quite deep in some what marshy grounds. Hora's account of *Sesarma tetragonum* (Fig. 2D) living underneath vertical burrows between 6 to 8 feet until the burrows reach the subsoil water is extremely interesting. He observed these crabs living in burrows on either side of the road near Uttarbagh on the high banks of water channels during early February and March.

The food of crustacean includes living and dead animals and vegetable matter. As scavangers of the sea and shore they play an important role in nature.

Benevolent Crustaceans

(i) *Edible crustaceans* : Man is perhaps the most omnivorous of all living animals and this is reflected in the number of different crustacea which he consumes. The large crustaceans such as lobsters, prawns, etc. provide the greatest yield of edible meat. However, many other smaller crustaceans caught in large numbers are also of considerable value, though in their size they are almost negligible. Many of the smaller species such as shrimps, mysids, etc. are made into pastes in Asia and other parts of the world. Even the brine shrimp, *Artemia salina* (L.) is also converted into paste and eaten with dates in some parts of North Africa.

Among the commercially important crustaceans of India, prawn undoubtedly occupies a dominant place by virtue of the magnitude and the value of the fishery they support.

Practically all species of prawns and crabs are edible and a very large number of these are consumed all over the world. Majority of the commercially important species live in the sea and in estuaries of our great rivers. Penaeid prawns are the commonest among them and they can be distinguished from others by the first three walking legs ending in claws and not in hooks. Among the penaeid prawns, four species are found fairly common in large numbers in the Gangetic delta and other parts along the Indian coast. The commonest large sized penaeid prawn of Calcutta, sold in enormus quantities in local markets, is *Penaeus monodon* (tiger prawn) (Fig. 5A). This is locally known as Bagda chingri and is consumed in large quantities in one form or another, but mostly served as cutlets. This species grows to a length of nearly a foot and

available in abundant quantities from the Hooghly delta and also from other parts along the Indian coast. Equally abundant in Calcutta, but smaller in size is yet another species of prawn *viz. Penaeus indicus* (Fig. 5B). It is popularly known locally as Chapda chingri since the animal is somewhat laterally compressed. This species grows to a length of 8 inches.

Besides these two, there are two other species locally called Dhanbone and Koraney chingri (or Honye chingri) and scientifically known as *Metapenaeus brevicornis* (Fig. 5C) and *M. monoceros* (Fig. 5D). The former is found in vast numbers in the paddy fields during and after the rainy season. The latter generally arrive in the market living and they are hardy creatures. Hence the local name Koraney chingri. Since it jumps about even after some time of capture, it is probably termed also locally as Honye chingri or mad prawn.

Among the freshwater prawns, *Macrobrachium rosenbergii* (Fig. 5E) known in Calcutta markets as Golda chingri occur extensively in rivers, canals and tanks. Though this is a freshwater form, it is found in slight brackish water, when the larvae grows into juveniles. Perhaps due to tubular or rounded form, this prawn is called Golda chingri. This species also grows to a foot or more, as in the case of *P. monodon.* This prawn is fished in extensive quantities in several other parts of India. In addition to this, there are several other freshwater or partly brackish water prawns consumed in various parts of India. Among them *Macrobrachium lamarrei* (Fig. 5F) *Palaemon styliferus* (Fig. 6A) and *Caridina gracilipes* are commonly found in Calcutta. These are popularly known as Kuncho, Ghoraand Ghusha chingri respectively. These three species are comparatively small in size, the first two very rarely exceeding a couple of inches in length while the third is much less, say an inch or so. Besides, these there are two other species of freshwater prawns *viz. Macrobrachium rudis* (Fig. 6B) and *M. malcolmsoni* (Fig. 6C) growing to a large size and consumed in fairly large quantities. This is quite common in some parts of Bengal from August to October, when large number of females carrying eggs, are brought to the market. *M. malcolmsoni* grows to a length of six inches and is very extensively fished in the Chilka lake, Orissa, parts of Madhya Pradesh and in certain areas of peninsular India.

As referred earlier, tiny shrimps like creatures known as mysids are also utilised as food by certain sections of the people. These shrimps are so small that unless thousands are consumed it would not make a square meal. Though *Macropsis orientalis* (Fig. 6D) is predominant form in these heaps, *Potamomysis assimilis* (Fig. 6E) also occurs in fairly large numbers.

Apart from the prawns, lobsters (Fig. 3B) too play an important role in this direction. While tiny mysids fill the pot of the poorer sections of the people, the lobsters adorn the dining table of the much affluent. The spiny lobsters or sea craw fish, viz. *Panulirus polyphagus* or *Panulirus fasciatus*

(Fig. 6F) occurs in several localities along both the coasts, and prefers rocky or stony bottom, a little farther away from the lowtide zone. This species grows to about 15 inches in length and weighs a couple of pounds. The common species of Bombay coast is *Panulirus ornatus* (Fig. 6G) which hardly grows to foot in length and is found in fairly large numbers on rocky beds generally in waters somewhat shallower than that in which the other species referred to lives.

Though the resources of lobsters appear to be extensive, systematic exploitations have not so far been organised. For some time past, the Indian rock lobsters are greatly sought for in foreign markets of U.S.A. and Australia. Consequent on the increase in demand from abroad, several freezing and canning factories have sprang up along the west coast of India and appreciable quantities of specially the frozen lobster tails are exported annually. Never before was there such a demand for Indian lobsters as it is now. The possibility of earning enough foreign exchange by increased exports might perhaps give a new fillip to this hitherto less explored industry.

In addition to prawns and lobsters, many varieties of crabs are also utilised as part of food. Majority of swimming crabs belonging to the family portunidae contribute the largest portion in this direction. In these crabs, the last leg is in the form of a paddle. *Scylla serrata* (Forsk) (Fig. 4A) is the most common food-crab of India and is extensively fished all along the coasts. This species generally grows 5 to 6 inches across the carapace though there are a few records to show that they grow 38 to 46 cms. broad as stated earlier. This crab is really a brackish water form but can also adapt living in purely freshwater. Besides swimming about in water, it also lives on the edge in deep burrows. This crab known in Bengal as Nona kankra or salt water crab occurs extensively in the deltaic region. In addition to this, there are a few other species, viz. *Portunus pelagicus* and *Portunus sanguinolentus* (Fig. 4B) also consumed in considerable quantities in areas near the coast. These live mostly in the sea or brackish waters and the two species grow to at least 12 to 15 cms. in size. *Portuns pelagicus* is extensively fished in the Chilka Lake in Orissa.

Another crab of importance is *Varuna literata* (Fig. 4C) popularly called *Chitti kankra* in Calcutta. This is not a swimming crab. Though this species attains only a small size, very rarely exceeding a few inches in breadth, the smallness is more than made up by the enormous numbers in which it is found in the Gangetic delta at certain periods of the year, specially towards the middle of the rainy season. Though this crab is not of any great economic importance, it is extensively fished chiefly for consumption of poorer sections of the people.

The crabs dealt with till now are brackish forms. Apart from them, there are some freshwater crabs that are also largely consumed. The common

freshwater crab of Bengal is *Paratelphusa* (*Barytelphusa*) *spinigera* called *pati kankra*. This species occurs in large numbers near tanks and rivers, and grows to about 8 centimetres in width. Two other species of this genus viz. *Paratelphusa* (*Barytelphusa*) *jacquemontii* and *P.* (*Barytelphusa*) *hydrodromus* are common in Bombay and Madras states. The Bombay species grows to about 12 centimetres in breadth and is available in markets in fairly large numbers.

Prawn and Crab Fishery : The fisheries in India are primarily for fish but prawns and crabs form a very appreciable portion of the catch in quantity and in terms of value. The crustacean fisheries rank highest at nearly 60% of the total catch.

Among the crustaceans, prawns constitute one of the major foreign exchange earners of India. The export value from prawns and its products have increased from Rs. 17 million in 1960 to over Rs. 950 million in 1975, and in terms of quantity the total catch in India, during the same period, has increased from 68,000 tonnes to 2,00,000 tonnes (Kurian and Sebastian, 1976). Vast quantities of prawns and shrimps are caught in several areas all over the country. Some portion of the catch is usually consumed by the local inhabitants or sent to neighbouring markets and the surplus which is at times is dried chiefly for export purposes. Similarly, there are very extensive prawn fisheries in the Chilka Lake, along the Madras coast and in the backwaters along the Malabar coast.

The methods used for fishing of prawns are very similar all over the country. The commonest net used is a kind of fixed purse net, conical in shape, the length, mesh and diameter at the mouth varying with the local conditions and according to depth at which it is used. This net is called in Bengal as Behundi Jal, and may vary between 15 to 200 feet in length. On the Bombay coast there are two types of nets viz. *Bokshi* utilised for capture of prawns in shallow waters and the *Dol* employed in deeper waters may be as much as 700 feet in length with the mouth about 300 feet in diameter. Another net commonly used in shallow water is a sort of drag net known in Bengal as Moi Jal. This has its counterparts in other parts of the country.

i) *Prawn culture in paddy fields* : In the backwaters of Kerala State, a flourishing prawn industry has existed for a long time. Large scale fishing is carried on in the sea and in the backwaters. The extensive paddy fields on both sides of the backwaters and many of the connected canals in the northern parts of former Travancore and Cochin States, which are single crop lands, have been used for prawn fishing.

Soon after the paddy crop is harvested in October, the bunds of the fields are strengthened and sluices are installed. These sluices are fitted with adjustable planks so that the water level in the fields can be easily regulated. A lamp is hung at the mouth of the sluice at night in order to attract prawns.

The sluice gates are kept open at high tides and brackish water enters the fields freely bringing along it large numbers of young that abound in the backwaters at this time. The sluice gates are closed at low tide time. This goes on till the fields are well stocked with prawns. Thus the prawns are allowed to grow in the paddy fields for two to three months and are fished when they are 4 to 5 inches in length. Fishing generally starts at the end of December or beginning of January. The fishing usually starts with low tides. 4-5 days before every new and fullmoon and is continued for 7 to 8 days. The net used here is about 20 feet long has a rectangular frame tied to its mouth. Its end is tied up with a piece of rope to which a float is attached.

ii) *Crustacea acting as food of fishes* : Crustaceans constitute the food of large number of fishes. The pink or red colour of salmon is believed to be due entirely to the shrimps on which it feeds. The Bombay duck which is one of our important food fishes also feeds mostly on shrimps. The whales, which are of commercial importance depend on crustaceans for their food. Likewise whale bone whales consume large quantities of Copepods. In addition, zooplankton containing crustaceans also act as food of fishes. According to Venkataraman (1960) crustaceans form the largest group *viz.* 58.9% among the food of fishes.

iii) *Crustaceans used for medical purposes* : In addition to the above, Crustaceans are used for medicinal purposes. The crab meat served as curry is reported to be a cure for asthma in parts of Maharashtra and Gujarat states. Similarly, soup made out of *Scylla* and *Portunus* is commonly used by people just after recovering from Malaria, which it is understood acts as a tonic. Soup prepared out of fresh-water crab *Paratelphusa* is believed to be specific drug for colds. It is also learnt that crab curries are recommended by Ayurvedists in cases of chronic fevers.

Harmful Crustaceans

Apart from the parasitic crustaceans which cause in itself considerable damage to their hosts, another crustacean activity detrimental to man is the transmission of diseases. In tropical countries they play an important part in the life cycles of some parasites. One of this is the Guinea worm, *Dracunculus medinensis* which is a round worm and grows to a length of 3 to 4 feet. The adult worm remains in the tissues under the skin of man. They liberate young ones through ulcers, usually on the leg of the host, when the latter's limbs are in water and they move freely in water. Further development of the worm takes place only if these young ones are swallowed by a copepod viz. *Cyclops*. After three weeks in *Cyclops*, the worms are in an infective state and when *Cyclops* is swallowed by man with drinking water, the life cycle is completed.

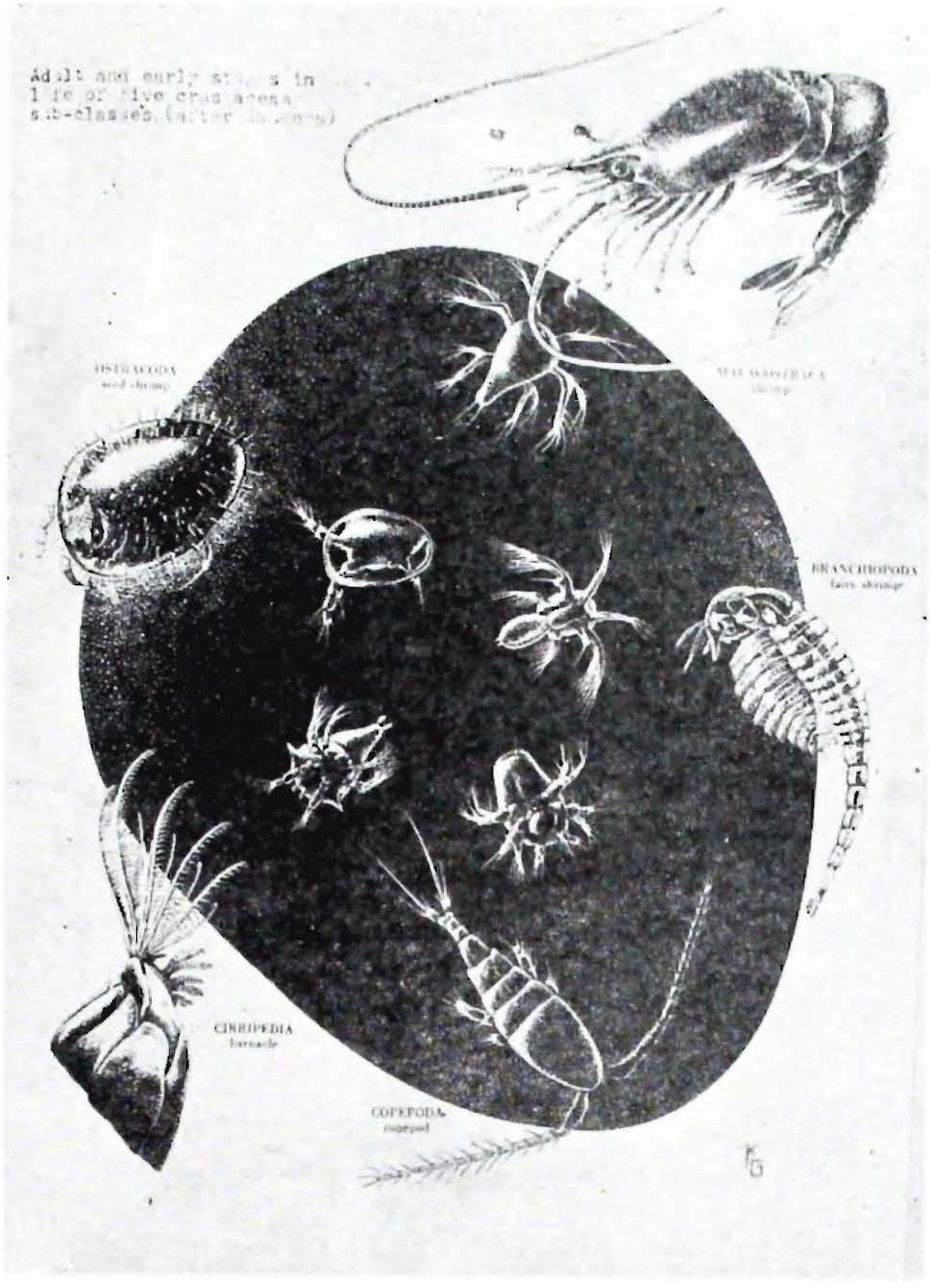

Fig. 1. Adult and early naupliar stage of five crustacean sub-classes
(*After* Sanders)

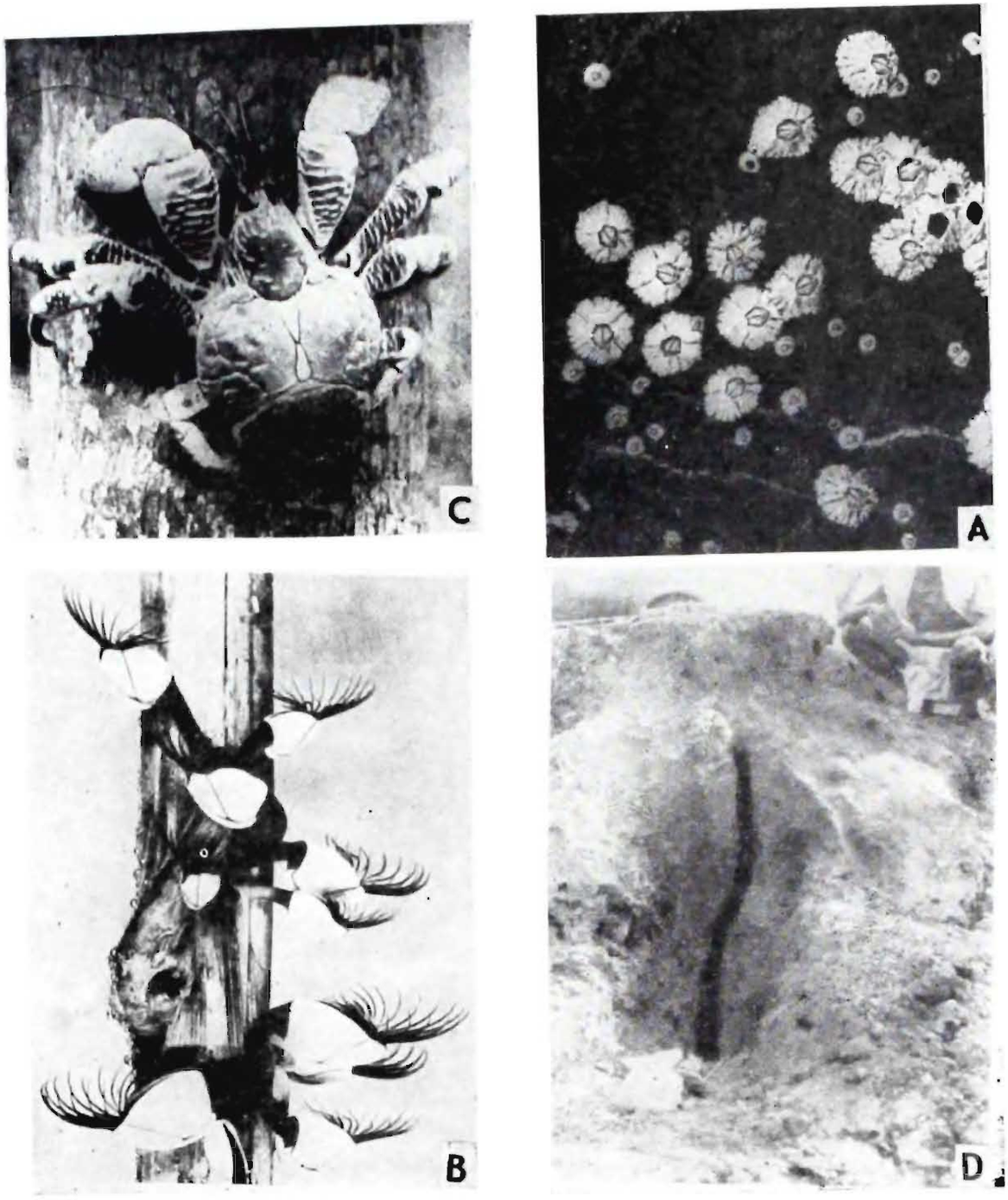

Fig. 2. A. A group of acorn-barnacles on a rock ; B. A group of Goose-barnacles (*Lepas anatifera*) on a piece of wreckage (*After* E. L. Danois) ; C. Robber carb, *Birgus latro* ; D. The burrow of the crab *Sesarma tetragonum* (*After* Hora).

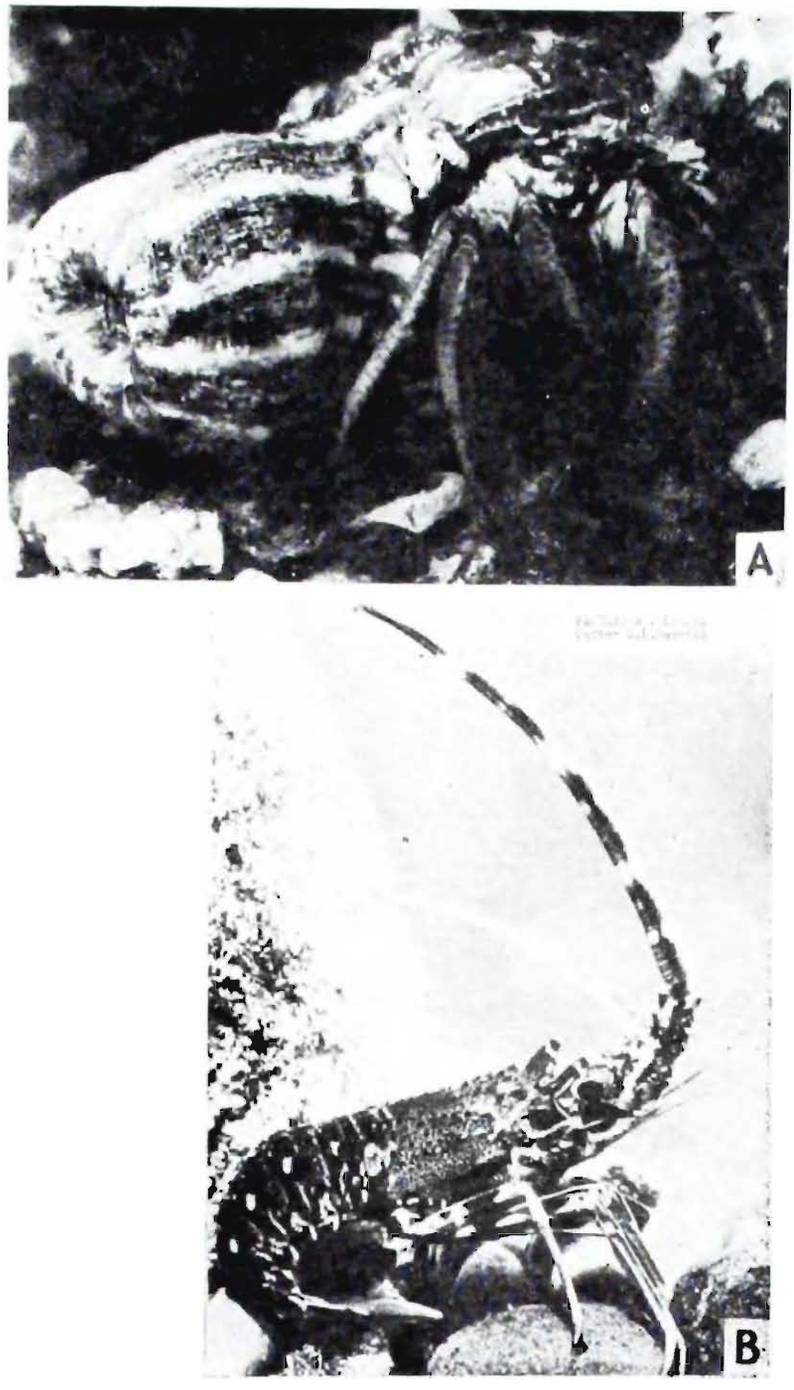

Fig. 3. A. Hermit crab in a shell covered by a commensal sea-anemone ; B. *Panulirus Vulgaris* (Craw fish) (*After* E. L. Danois).

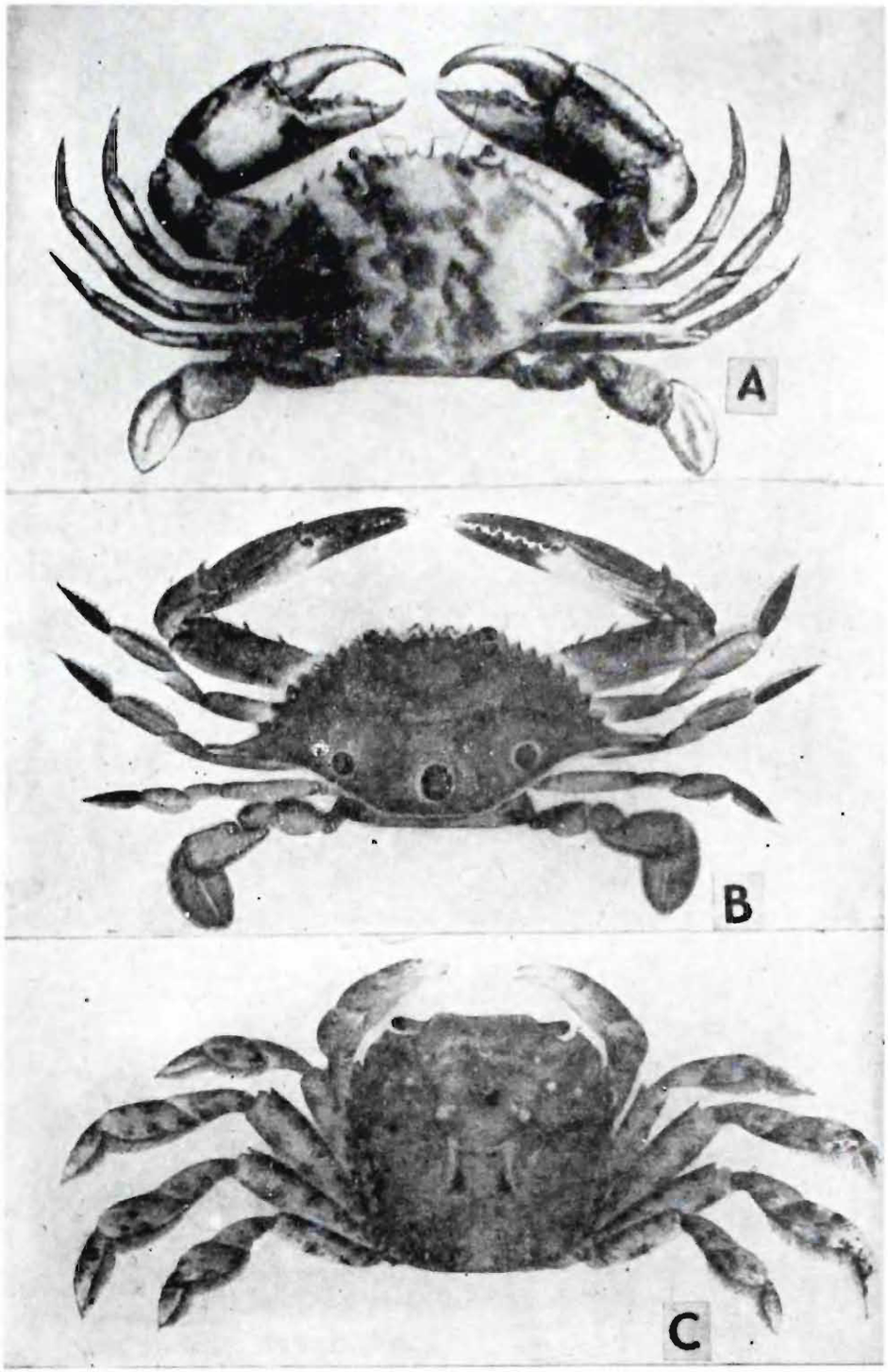

Fig. 4. A. *Scylla serrata* (Forsk.) (*After* Chopra); B. *Portunus sanguinolentus* (Herbst) (*After* Sakai); C. *Varuna literata* (Fabr.) (*After* Sakai)

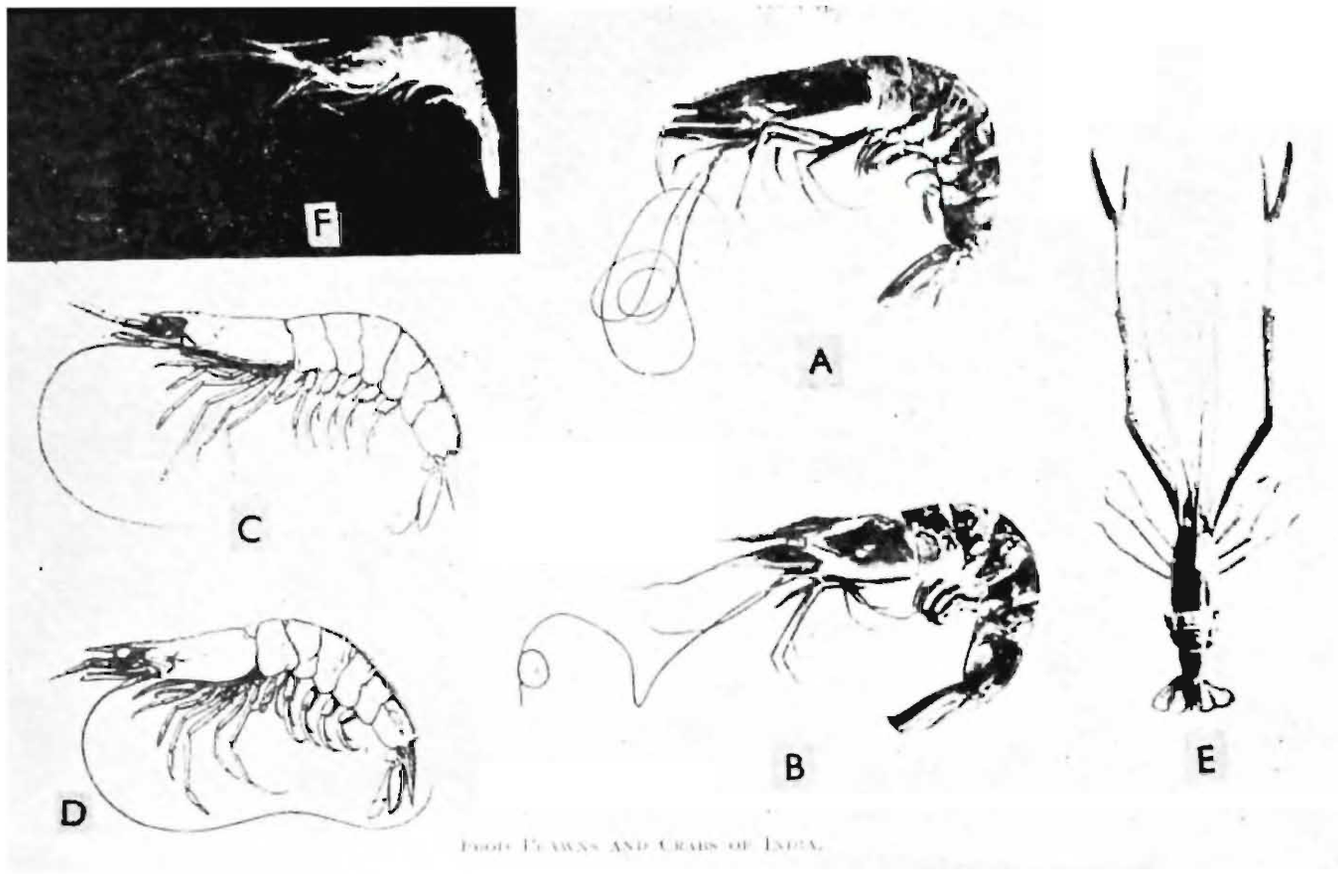

Fig. 5. Penaeid and freshwater prawns (*After* Chopra). A. *Penaeus monodon* ; B *P. indicus* M. Edw. ; C. *Metapenaeus brevicornis* (M. Edw.) ; D. *M. monoceros* (Fabr.) ; E. *Macrobrachium rosenbergi* ; F. *M. lamarrei* (M. Edw.).

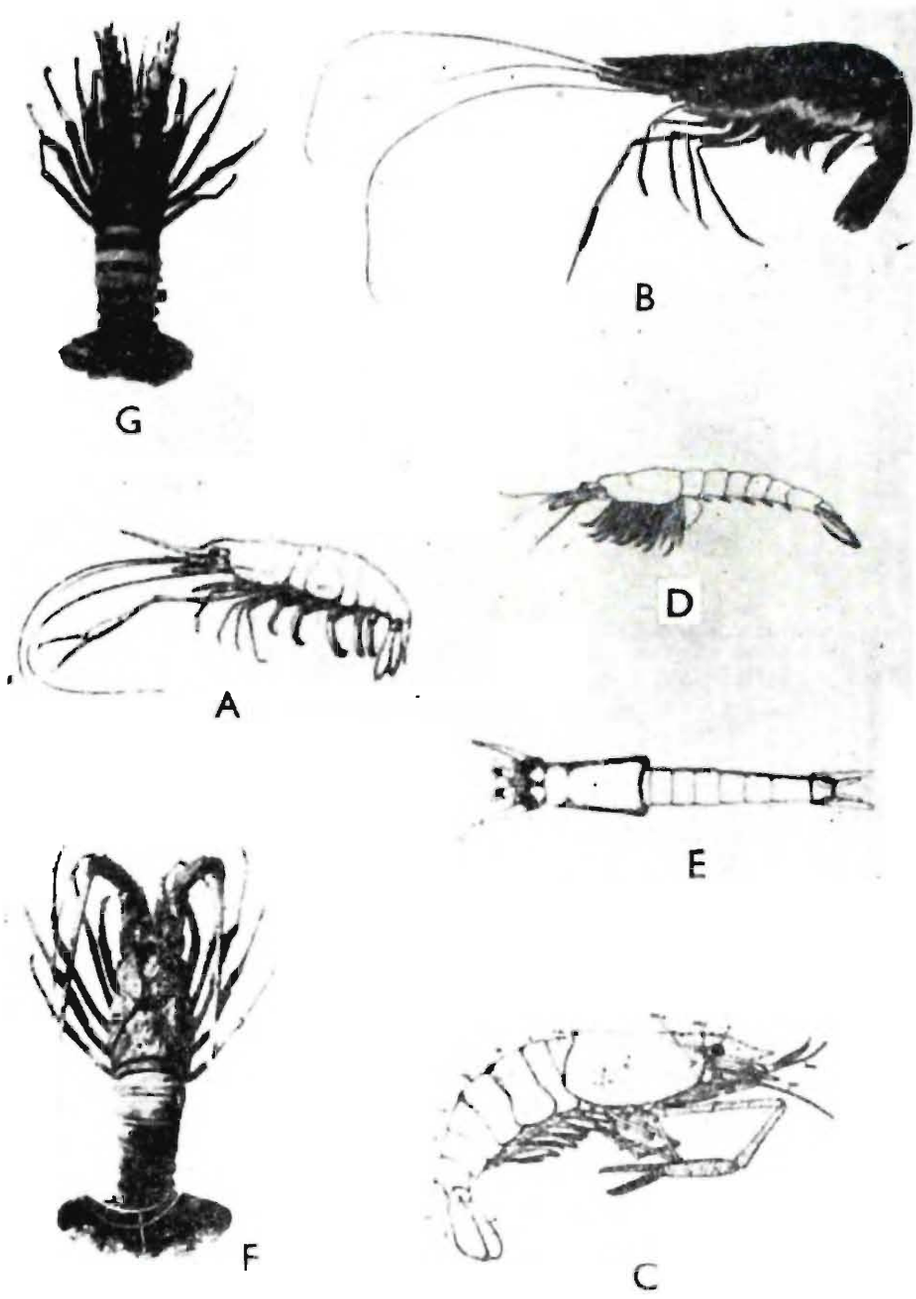

Fig. 6. Fresh water prawns, lobsters etc. (*After* Chopra) A. *Palaemon styliferus* M. Edw. ; B. *Macrobrachium rudis* (Heller) ; C. *M. malcomsoni* (M. Edw.) ; D. *Macropsis orientalis* Tattersal ; E. *Potamomysis assimilis* Tattersal ; F. *Panulirus polyphagus* (Herdst) ; G. *Panulirus ornatus* (Fabricius).

Another parasite viz. *Diphyllobothrium latum,* the large tapeworm infecting man also has to depend on a crustacean host for completing the life-cycle. Here the man becomes infected when he eats raw fish and fish becomes infected in turn either by swallowing an infected *Cyclops* or by consuming another fish that has eaten an infected *Cyclops.* Here the Copepods is not the direct transmitter to man but acts as an intermediate host.

Flukes of the genus *Paragonimus* infect certain river crabs. This parasite lives in the lungs of man and the eggs ejected out with the sputum and the larva emerging out of the egg infects a snail later giving rise to a different type of larva. This larva in turn attacks the river crabs and the infection passes on to the man when he consumes the raw crustacea. The young worms make their way through the wall of the gut and migrate to the lungs.

Another very interesting example of the indirect ways in which crustacea play in the affairs of man is proved by *Onchocerca,* a nematode which lives under the skin of man and has the tendency to migrate to the eyes and eventually cause blindness. Over a large part of Africa, this worm is transmitted by fly called *Simulium damnosum.* Control measures undertaken in this direction proved a failure since it was not possible to unearth the habits of the insect larva. Later on, it was discovered that the larvae habitually attach themselves to the backs of the river crabs and the crustaceans innocently defeated the efforts of medical entomologists in getting at the clue.

Some crustacea directly cause economic loss to man. The fouling of ships by barnacles might at first sight seem to be a trivial matter, but a heavy layer of fouling can increase by about 50% the amount of fuel needed to maintain a given speed. Such increased costs of transport will be directly responsible for the increased price of goods carried by them.

Several species of Cirripedes (Fig. 2A) viz. *Balanus tintinnabulum, B. amphitrite, B. balanoides, Lepas anatifera,* (Fig. 2B) etc., cause fouling in tropical waters. There are as many as 20 species of Cirripedes suspected to be causing fouling of ships and other naval crafts in India. As a general rule the tropics are the worst areas for fouling of ships. The temperate regions are no exception to this but the incidence is comparatively less. Settlement of barnacles takes place when ships are in the port. The cypris larvae can not establish themselves when the ship is moving. Natural control of fouling can be achieved by avoiding long stay in tropical ports. Antifouling paints are also efficient in killing cyrid larvae settling on the surface.

Damage caused by marine boring animals is also of great economic importance and of all the creatures responsible for such damages, two are well known. One is the mollusc *Teredo* the ship worm, the other being an Isopod crustacean of the genera *Limnoria* and *Spheroma.* Piles supporting wharfs and piers seem to be specially the targets by these borers. The damage caused by

these borers is very considerable. The Isopods, it has been ascertained from experiments are able to attack wood earlier than the shipworms. The Isopods burrow with the help of mandibles which is usually sharp. Each burrow has a male and female specimen. Pairing takes place inside the burrows and each female may produce three broods of twenty to thirty young ones in a season. The young which emerge from the female brood pouch as miniature adults start their own burrows from the side of the parents burrow. Altogether fifteen species have so far been reported to cause damage to wood in India.

Besides Isopods, an amphipod *Cehlura terebrans* is also found in burrows but it does not seem to be a good borer like Isopods.

In conclusion, it may be added that though none of the Crustaceans can be regarded as directly harmful to man as a scorpion, spider, centipede or insects inflict, but the damage caused by them indirectly as stated above is very considerable.

Acknowledgements

I am grateful to the Director, Zoological Survey of India for the encouragement and valuable suggestions and to Dr. K. K. Tiwari, Joint Director, for going through the manuscript and helpful criticism in preparation of this article.

Zoologiana, No. 1

EXOTIC THRIPS PESTS AND PLANT QUARANTINE

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In recent years thrips damage to several plants of economic importance has become a source of increasing concern to many an agriculturist, calling therefore for an overall assessment of damage to crop plants by both indigenous as well as exotic pest species. What they lack in size they easily make up by their numbers and the concentrated feeding both by larvae and adults leads to severe damage to young shoots, leaves, buds, blossoms, flowers and fruits through drainage of sap. Considering their size the economic losses they cause by their aggregate infestation would appear unbelievable and their depredations appear to be on the increase, particularly because many species tend to be polyphagous by habit and naturally the range of alternate host plants is so wide that the possibilities of their attack on crop plants appear consistent. In this context an attempt was made to provide a gross picture of thrips damage along with details of their bioecology (Ananthakrishnan 1969, 1971, 1973). An idea of the damage potential of exotic species would appear equally important so that appropriate quarantine measures may be taken to prevent their entry into this country. Added to this the role that thrips play as vectors of bacterial, fungal and viral diseases cannot be underestimated and certainly needs more detailed investigations, in this country.

Thrips feed at random and rarely as in *Selenothrips rubrocinctus* show definite patterns of distribution on cashew leaves conforming either alongside of the midrib and primary veins or in the distal intervenal areas of the lamina or in the immediate vicinity of the injured tissues (Fennah 1965). However most species concentrate their feeding activities to restricted regions on the plants, mostly preferring rapidly growing tissues, but some species like *Thrips tabaci* infest the bulbs, leaves and flowers of onion and the entire vegetative parts of the cotton plant. The age of the leaves is an important criterion in infestation and though very young leaves are often susceptible to it, species like *Selenothrips rubrocinctus* are known to invade cashew and cocoa leaves only after they have reached a certain stage of growth and have become mature and do not prefer young as well as senescent leaves. This is also the case with *Rhipiphorothrips cruentatus* attacking cashew leaves, and *Terminalia catappa.* The progeny of this species often abounds on the leaf that has matured and more than one generation is completed on the leaf. With the aging of the leaf

they disperse to younger leaves. But in gall forming thrips we come across the opposite condition, where only very young tissues, almost after the opening of leaf buds, are alone susceptible to gall formation, particularly at a time when the tissues are still undifferentiated.

Noninfestation of young leaves in some cases is due to the presence of more water content in relation to the total weight of the leaf and consequent dilution of cell solutes. As the leaf ages the water stress is increased, with consequent increase in concentration of cell solutes. Often the establishment of thrips on leaves in the dry season is associated with greater concentration of aminoacids, this being lower during the wet season, preventing infestation. Since the total nitrogen content of the leaf in relation to fresh leaf weight declines steadily and substantially with the age of the leaf, there is a decline in the available soluble nitrogenous food, which causes a decline in the numbers or ultimate disappearance of thrips (Fennah 1963). Infested leaves of plants susceptible to attack by thrips, as in the case of other insects, tend to show an increase in the concentration and in some cases also the number of free aminoacids unlike the more tolerant plants (like the brown stemmed variety of *Ricinus communis* tolerant to *Retithrips syriacus* infestation), where the number and concentration of free aminoacids do not differ considerably in the infested and healthy leaves (Ananthakrishnan and Muraleedharan, 1972). Further the lower concentration of the free aminoacids may evoke an aggregating response as against a feeding inhibition or host avoidance reaction when in higher concentrations. However, the deficiency in the number of free aminoacids and lower concentrations of the available ones do not appear to be conductive to the further development of the concerned insects. Differences also exist between the aminoacid content of the laminal tissue close to the midrib and that near the edge of the leaf in healthy leaves.

Feeding by thrips may be of the shallow or penetrative type according to the nature of the mouthcone. The maxillary stylets have a 'tongue and groove system' on either side and they fit into each other along their length. The maxillary sclerites enable free movements of the stylets and in view of latter being mutually adapted structures, the two grooved maxillary stylets form a tube through which the liquid food contents are sucked up. Thrips inhabiting flowers feed on pollen, while mycophagous species feed on fungal spores and in both cases the liquid contents are sucked during feeding. Tubulifera are known to ingest entire spores as well and many species show concentration of these spores in their gut.

Exotic thrips pests

As Ananthakrishnan (1969, 1971, 1973) has provided a consolidated picture of the indigenous thrips pests, an understanding of the more important

exotic thrips pests would appear useful so as to enable us to be aware of the possibilities of their entry into this country and take sufficient steps to guard against their adding to our already long list of indigenous thrips pest species.

Several economically important species are known to inflict serious damage to variety of crop plants in Europe, United States of America, Canada, Africa, Australia and other countries. Some of the noteworthy examples include the cereal thrips *Limothrips cerealium* Haliday, *Limothrips denticornis* Haliday, *Anaphothrips obscurus* (Muller), *Stenothrips graminum* and the Tubulieran species *Haplothrips tritici* Kurdj., the wheat thrips ; the pea thrips *Kakothrips robustus* Uzel ; the citrus thrips *Scirtothrips aurantii* Faure, *Scirtothrips citri* (Moulton) and *Thrips major* Priesner ; the apple and pear thrips *Taeniothrips inconsequens* (Uzel), *Thrips meridionalis* Priesner, *Thrips madroni* Moulton, *Thrips imaginis* Bagnall and *Caliothrips fasciatus* (Perg.) ; the carnation thrips *Taeniothrips dianthi* Priesner, the grape thrips *Drepanothrips reuteri* Uzel, the cotton thrips *Caliothrips impurus* Bagnall, *Caliothrips sudanensis* (Bagnall) and *Thrips tabaci* Lindeman ; the banana thrips *Chaetanaphothrips signipennis* (Bagnall), besides several species of grass seed infesting species of *Chirothrips*. Major pest species which are cosmopolitan include the cocoa thrips *Selenothrips rubrocinctus* (Giard) the onion thrips *Thrips tabaci* Lindeman, the greenhouse thrips *Heliothrips hæmorrhoidalis* (Bouche), the composite thrips *Microcephalothrips abdominalis* (Crawford) and the lily thrips *Taeniothrips simplex* (Morison).

Limothrips cerealium well distributed in Meditteranean and Western Europe, North Africa and Egypt was recognised as a pest even as early as 1875. Heavy oviposition followed by concentrated feeding of larvae and adults on tender parts of growing ears of oats, especially during the period when the ears as still confined to the leaf sheaths cause so much damage that individual florets fail to develop. The longer the ears remain within the folding leaves, the greater the damage (Sharga, 1933). *Limothrips cerealium* has two generations, mature females of the second generation hibernating beneath the bark of trees, under photo frames in houses and in spring adults become active and soon after the temperature rises to 20°C or over, they move on to winter cereals. After the maturation period of about a week, oviposition occurs, eggs being laid in glumes especially the lemma. The larvae of the first generation feed on the lemma, palia, ovaries, stamens and kernels. Wingless males are known to mate with female pupae and the females of the first generation leave the winter cereals and move on to the spring cereals where the second generation is developed. Females of the second generation move on to winter cereals. In some places rye is the most important host plant for the first generation and oats for the second.

The allied barley thrips *Limothrips denticornis* is native to Europe and has

been introduced to the United States of America. It causes the typical 'goose neck-like' stalks when the crop is infested. Yield is reduced to the extent of 2-3 bushels/acre and 13% reduction of plump kernels and a corresponding increase in thin seed have been reported. This species has also two generations, both living in leaf sheaths, the larvae being confined to the inner surfaces of the terminal sheaths. The first generation is exclusively on spring cereals and the second on winter cereals. *Frankliniella tenuicornis* has also been know to destroy barley in Europe. Alongside with the above species *Stenothrips graminum* and *Haplothrips aculeatus* also occur on oats and the dominance of species varies with year and climatic conditions. A density of 2000 larvae/100 panicles of oats reduced yield by 5%.

The oat thrips *Anaphothrips obscurus* causing sterility in oats and distributed over Europe, North America, Canada and Australia, is known to cause 36% loss of grains in Canada. Injury is confined to the basal parts of coleoptiles which wither due to severe attacks. Similarly thrips affecting production of grass seeds *Aptinothrips rufus* (Gmelin) and *Rhipidothrips brunneus* Williams have been reported from the United States. *Haplothrips tritici* the wheat thrips inflicts serious injuries to young leaves and ears of wheat all over Europe. Ovarian feeding results in spotting on grains. *Chirothrips pallidicornis* destroys a greater proportion of seeds by feeding on the florets of useful grasses and good grass seeds are lost through feeding by such species as *Chirothrips mexicanus, C. falsus, C. manicatus* and *C. hamatus* in Europe.

The larvae of *Kakothrips robustus*, the pea thrips of Europe do more damage than the adults, by feeding on the pods, flower buds and terminal shoots, effecting a 20% loss of seed yield. Adults infest terminal shoots only in cases of very early attack, before the appearance of flower buds. When half opened flowers are attacked, they shrivel and turn brown and in bad cases the pods may not be formed at all. When small, the pods become sickly, undersized, curled and covered by silvery brown areas and turns blackish through fungal attacks. Infested parts show cracks which gradually enlarge, leading to seed losses. (Frannsen, 1960). Similarly *Odontothrips confusus* and *Thrips flavus* cause sterility of lucerne flowers by feeding on the keel petals. The flower is damaged with the stamens trapped inside the shrivelled keel petals. *Frankliniella fusca* (Hinds) is responsible for peanut 'pouts' resulting in the inhibited development of the pea plant in the very early stages and delays development. In the early stages of development of the peanut plant, many terminal buds are black in appearance as if they are burnt. (Poos, 1941).

The Flax thrips *Thrips angusticeps* and *Thrips linarius* alone are known to breed on flax (*Linum* sp.) and of the two *T. angusticeps* is far more, important having both a brachypterous and a macropterous generation. The brachypterous generation hibernates in the soil and young flax plants may be

killed by brachypterous thrips attack. In the larger plants only growing tips die off or become retarded in growth and show branching, the branched plants being unsuitable as sources of good fibre. Even a slight attack of brachypterous thrips may cause silver spots on the stalks and the fibres break at these points during processing. The larvae of the macropterous generation and of *T. linarius* show a different type of damage, the infested plant showing a yellow grey colour. Instead of the plant tips drooping, they stand erect, leaves become dark splotted, the terminal shoots appear swollen ; the leaves drop, the growth of the crop is retarded and the infested crop is shorter than the uninfested. (Franssen and Mantel, 1961, '62, '65).

Several species of Terebrantian thrips have been known to seriously damage fruit crops in the United States, Canada and Australia. *Taeniothrips inconsequens* (Uzel) prevents fruit formation in prunes and apple blossoms in Australia and California. The pear thrips in the course of a few years caused a total loss of over 140 million pounds of fruit and the activity of this thrips also spread to other fruits like cherries, apricots, almonds and peaches. *Thrips madroni* is known to cause pits on the skin of golden and red delicious apples as a result of egg laying in the flowers. *Frankliniella tritici* has also been known to destroy almost half the blossoms of sweet cherries and plums. *Caliothrips fasciatus* causes serious injuries to pears causing dropping of a large number of leaves with the resultant migration of thrips to the fruit which is known to be infested by over a 1000 nymphs, causing ugly scars and excretory drops making the fruits unmarketable.

Scirtothrips aurantii and *Scirtothrips citri* (Moulton) are well known citrus thrips pests in the United States and Africa causing scarring of fruits. The type of damage they inflict are known as 'russety markings', thrips marking, 'thrips scarring' and 'tear-staining'. Stunting and malformation of fruits, with destruction to nearly half the crop annually are reported. Another citrus pest is *Thrips major* in Europe, causing silvery marking of the epidermis of lemons and oranges and producing the white blast or silvery top followed by the curling and gradual drying of the entire foliage.

In view of several pest species presenting different control problems, it would appear very necessary to enforce quarantine control measures to prevent such pests entering into the country. Quarantine regulations assume much greater importance in view of the increasing speed and amount of travel between various countries of the world. Natural barriers, therefore, are no longer sufficient to prevent spread of the pests. It may be mentioned that till 1950 *Retithrips syriacus* was unknown in this country and today it has become highly polyphagous. *Selenothrips rubrocinctus* and *Chaetanaphothrips orchidii* are also gaining ground and as such it would not be surprising if some of the exotic pest species gain entry into the country and start their depredations. It is

noteworthy to mention that the majority of species of *Dichromothrips* discussed by Mound (1976) were intercepted by Plant Quarantine Stations from imported orchids, originating in India, Thailand, Philippines and New Guinea.

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Zoologiana, No. 1

BUTTERFLIES AS PESTS OF FOOD-PLANTS

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Introduction

Although both butterflies and moths belong to the same natural order of insects, the Lepidoptera, only the moths are well known as serious pests of food-crops. The butterflies are generally considered as harmless from the economic point of view. In fact, they are not at all so serious pest on any food-plant as the moths. Wynter-Blyth (1957) and Sevastopulo (1973) have listed the food-plants of butterflies of the Indian region in detail, but without distinguishing the pests among them. Some species of butterflies, which cause harm to our food-plants and may be recognised as pests, are recorded here. Their distribution in the Indian region is also indicated.

List of butterfly-pests

Family PAPILIONIDAE

1. THE LIME BUTTERFLY

Papilio demoleus (L.)

Its larvae (caterpillars) feed on various species of *Citrus* (oranges, citron), bel, curry leaf-plant and also on ber (*Zizyphus mauritiana*). It is treated as pest of all Rutaceae. The young larva is brownish, but full-grown larva is green with few oblique brown bands. Sometimes they appear in large number and eat up all leaves of the host-plant.

This butterfly is found throughout India, as well as in Sri Lanka, Burma and other countries.

Family PIERIDAE

2. THE MOTTLED EMIGRANT

Catopsilia pyranthe (L.)

Its larva feeds on chakaur (*Cassia occidentalis*), Indian laburnum (*Cassia fistula*) and other *Cassia* (*C. tora*, *C. auriculata*) and also reported on *Sesbania*

and other Leguminosas. The colour of its larva is pale leaf-green, with black dots on sides. Another sister species, *Catopsilia crocale* is also a pest of *Cassia.*

This butterfly is recorded in India, Sri Lanka, Burma.

3. THE COMMON GRASS YELLOW

Eurema hecabe (L.)

Syn. *Terias hecabe* (L.)

The larva of this species is reported to feed on agathi, daincha and other species of *Sesbania* ; *Cassia tora* and other several species of *Cassia.* It is also reported pest on *Acacia, Caesalpinia* and *Albizzia* plants. In Bengal it has been reared onjainta (*Sesbania aculeata*). The larva of this butterfly is hairy, pale green with a lateral white stripe and transverse wrinkles. The sometimes fully strip the leaves of young plants. It is occasionally a pest of *Albizzia* planted as shade for tea plants.

The butterfly is distributed throughout India, Sri Lanka and Burma.

4. THE CABBAGE BUTTERFLY or THE LARGE CABBAGE WHITE

Pieris brassicae (L.)

It is a pest of cabbages and other garden Cruciferae, particularly *Brassica* plants. This butterfly migrates from the hills in cold weather, breeds freely in the plains, and returns to the hills during the summer.

It is found in the sub-himalayan tracts of Assam, Bengal, Bihar, U.P. and Punjab in India and Baluchistan in Pakistan. This pest is also recorded from Europe.

Family SATYRIDAE

5. THE RICE BUTTERFLY or THE COMMON EVENING BROWN

Melanitis ismene (Cramer)

Syn. *Melanitis leda* (Drury)

Its larval food plants are mainly grasses (Graminae). It is known as a pest of paddy (*Oryza*), but does little damage. The larva is pale green, with rough wrinkled skin, and bearing two slender processes each on its head and the anal extremities. Its larva is reported to feed at night only.

Distribution—Throughout India, from sea level to above 7000 feet, exccpt in the extreme North-West. Also recorded from Sri Lanka and Burma.

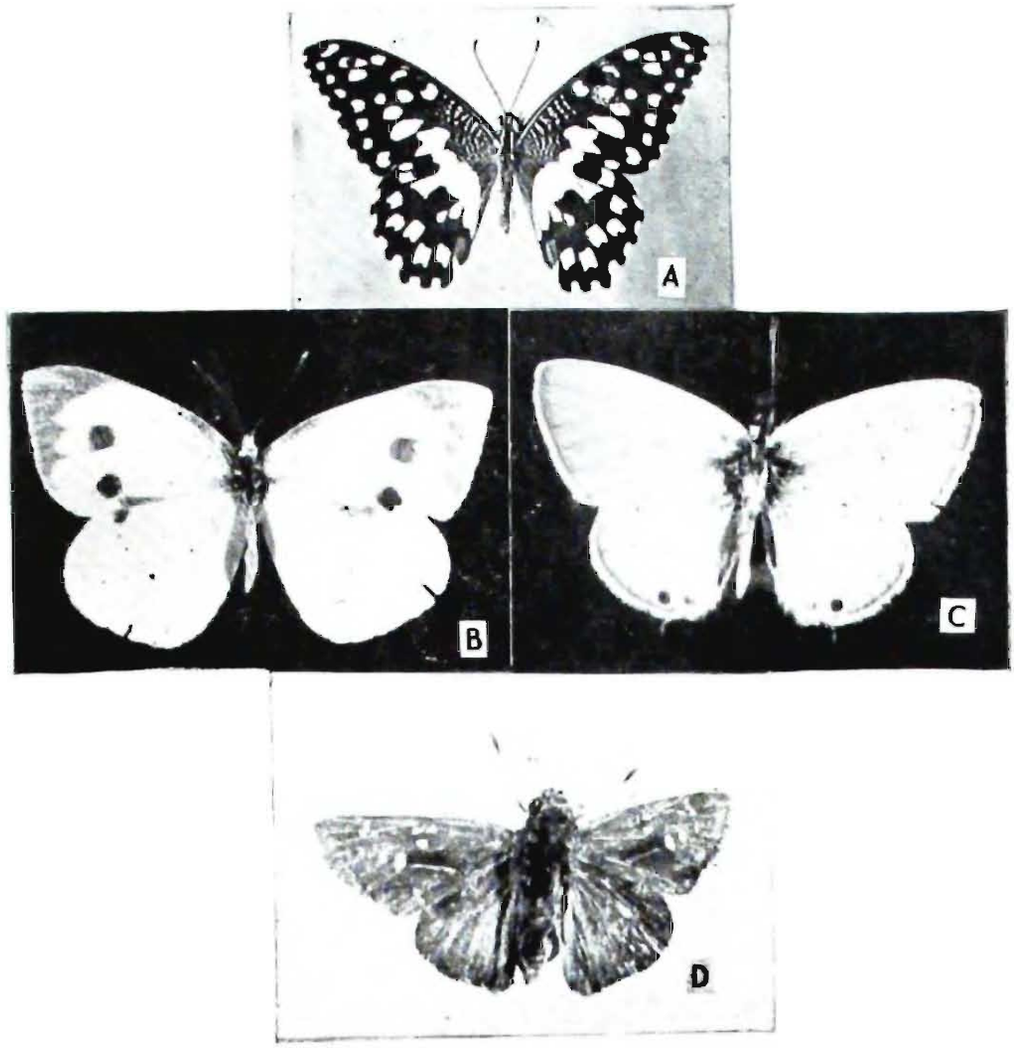

Fig. 1.

A. *Papilio demoleus*
B. *Pieris brassicae*. C. *Euchrysops Cnejus*.
D. *Udaspes folus*.

Family NYMPHALIDAE

6. THE CASTOR BUTTERFLY or THE COMMON CASTOR

Ergolis merione (Cramer)

Its larva feeds on castor leaf (*Tragia cannabina* and *T. involucrata*), *Ricinus communis* and other Euphorbiaceae. The full grown larva is about 3 cm. in length ; it is green with dorsally a pale whitish line and spines on all segments.

The range of this butterfly is in Sri Lanka, India except the arid north and north-west regions, Burma.

7. THE PEACOCK PANSY

Precis almana (L.)

Sym. *Junonia atmana* (L.)

Its larvae are known to join other bands of swarming larvae (caterpillars) and destroy the rice fields on a large scale. The larva is cylindrical, with rows of spines and processes, and dull in colour.

This butterfly is found commonly in India and Burma, but its dry season form is rare in Sri Lanka.

Family LYCAENIDAE

8. THE GRAM BLUE

Euchrysops cnejus (Fabr.)

Sym. *Catochrysops cnejus* (Fabr.)

It is a pest of red-gram. lab-lab (*Phaseolus trilobus* and *Dolichos catjang*), and other pulses. When in large number, its larvae empty out most of the pods of the host-plant. The full-grown larva is about 13 mm long, pale greenish and covered with short spine like hairs.

Distribution—India, Sri Lanka, Burma. It is recorded as a minor pest of gram crops in South India.

9. THF PEA-BLUE

Lampides boeticus (L.)

Syns. *Polyommatus boeticus* (L.), *Cosmolyce boeticus* (L.)

The larvae of this butterfly are found on *Crotalaria* and various species of pea (*Pisum*) and on most of the pulses, including arhar (*Cajanus cajan*). It is

a serious pest where *Crotalaria* is grown for seed. The full-grown larva is pale green, about 12 mm long, and with a rough skin. It feeds on pods and flower-heads of the host-plant.

This butterfly is found all over India, Sri Lanka, Burma.

10. THE ANAR BUTTERFLY or THE COMMON GUAVA BLUE

Virachola isocrates (Fabr.)

Syn. *Deudoryx isocrates* (Fabr.)

It is a pest of pomegranate (*Punica granatum*), guava (*Psidium guajava*), loquat, tamarind and oranges. However, it attacks seriously pomegranate only. The larva repeatedly bores into the fruit until full-fed and pupates there.

It is distributed in Sri Lanka, India to North Shan States in Burma. It ascends to about 7000 feet in the Himalayas.

Family HESPERIIDAE

11. THE SMALL BRANDED SWIFT

Pelopidas mathias (Fabr.)

Syns. *Parnara mathias* (F.), *Baoris mathias* (F.)

It is a minor pest of paddy, cholam and various kinds of grasses. Also reported on *Saccharum.* The larva is palegreenish with faint yellow-white bars on the back and a whitish line along the sides. It lives in rolled up leaves of the host-plant. A sister species, *P. colaca* (Moore), is also known as a minor pest of paddy.

Distribution—India, Sri Lanka, Burma, at low elevations. In South India upto 7000 feet, but not as high in North India.

12. THE GIANT RED-EYE

Gangara thyrsis (Fabr.)

It is a large butterfly. Its larva is a minor pest, occasionally doing some damage to ornamental palms and Young coco-palms. The full-grown larva is pale-green, reddish in parts, and covered with white waxy filaments. It lives inside the rolled up palm leaves.

This butterfly is reported as past from Coimbatore. Its range covers Sri Lanka, S. India to Bombay and Calcutta, and Sikkim to Assam and Burma.

13. THE INDIAN PALM BOB

Suastus gremius (Fabr.)

A minor pest. The larval food-plants are palms, mostly palmyra. Also recorded from coconut palms. The larva is pale-green with a narrow blue line down the back ; and it lives inside rolled and formed tubes of the palm leaves.

It is reported pest from Bangalore, Godavari and Coimbatore ; and may be found in all palm growing regions of India, Sri Lanka and Burma.

14. THE PALE PALM DART

Telicota augias (L.)

Its larva is reported on sugarcane (*Saccharum*) and also said to feed on the bamboo and the paddy. It is a minor pest. The greenish larva folds the leaves of food-plant into a tube where it lives.

Distribution—Throughout South India, where as pest it is noted in Vizakhapatnam, Coimbatore and South Arcot.

15. THE GRASS DEMON

Udaspes folus (Cramer)

It is occasionally a serious pest of ginger aud turmeric. Also probably attacks the wild lilies. The folded leaves of host-plant contain its larva, which is greenish with a dark stripe along the back.

It is recorded as pest from Northern Circars and Coimbatore in South India ; and its range includes Sri Lanka, S. India to Gujarat, M.P., U.P. and Calcutta ; and from Kangra to Assam and Burma.

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